CHARACTERIZATION OF RABBIT PRODUCTION SYSTEMS IN CENTRAL, COASTAL, EASTERN AND RIFT VALLEY REGIONS OF KENYA

A thesis submitted in partial fulfillment of requirements for Masters Degree in Livestock Production Systems

By

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January 2014
DECLARATION

This thesis is my original work and has not been presented for award of a degree in any other University.

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Acknowledgements

I would like to acknowledge my supervisors Prof Margaret Wanyoike and Prof Charles Gachuiiri for their guidance through the proposal writing, data collection and thesis writing and the National Council for Science and Technology for their financial support. Mr. Mailu (KARI) for his assistance during data analysis and the logistical support of Ministry of Livestock Development field staff. The participation of Mukurweini Rabbit Farmers, Rabbit Breeders Association of Kenya (RABAK), Gilgil Rabbit Meat Centre and Kajiado Rabbit Farmers Association together with all the rabbit farmers for their willing participation during questionnaire administration is also highly appreciated.
Dedication

I dedicate this work to my beloved parents Mr. and Mrs. Hosea Rono who continually supported me both financially and morally throughout my education.
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<tr>
<td>MOLD</td>
<td>Ministry of Livestock Development</td>
</tr>
<tr>
<td>KNBS</td>
<td>Kenya National Bureau of Statistics</td>
</tr>
<tr>
<td>ARBA</td>
<td>American Rabbit Breeders Association</td>
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</tbody>
</table>
CHARACTERIZATION OF RABBIT PRODUCTION SYSTEMS IN CENTRAL, COASTAL, EASTERN AND RIFT VALLEY REGIONS OF KENYA

Thesis supervised by Prof. Margret Wanyoike and Prof Charles Gachui, Department of Animal Production.

Abstract

To characterize rabbit production systems, a study was conducted in five counties within four regions of Kenya with significant rabbit farming. These included: Rift valley (Nakuru county), Central (Kiambu and Nyeri counties), Eastern (Meru county) and Coast (Taita Taveta county). Data were obtained through a field survey, questionnaires and personal observations between August and September 2011. This study covered the key areas of rabbit production such as: General farm details, number of rabbits, breeds and breeding practices, housing, feeds and feeding practices, diseases and disease control, constraints to production and recommendations appertaining to the key production challenges. Results showed that rabbit production in Kenya was mainly small scale (84.8%) principally for income generation and home consumption (89.6%). The rabbit breeds kept included: New Zealand White (29%), Crossbreds (24%), Californian white (12%), Chinchilla (11.5%), Dutch (8%) Flemish giant (5.5%) and French lop (4%), with the main breeding stocks being selected from own stocks or from the neighboring farms (90%). The majorities (75%) of the rabbits on farms were owned by either the household heads or by the spouses as opposed to children as it had been recorded in the past. However, at the coastal region (Taita Taveta county), rabbits were mainly kept by young people (54%) (sons) in contrast to other counties such as central (Nyeri) where only 1.7% of rabbit owners were
young. Majority of the farmers (76.7%) had encountered at least one rabbit disease/symptom at the farm in the six months preceding the study period. The main rabbit diseases included; diarrhea (21%), mange (13.3%), bloat (11%), ear canker (10.6%) and pneumonia (10%). Disease control measures were practiced by only 43% of the farmers due to un-availability of either veterinary drugs or information on rabbit diseases.

The five most important challenges to rabbit farming were: Lack of market for rabbits (51%), inadequate husbandry knowledge (28%), lack of quality breeding stocks (15.5%), insufficient funds for expansion (11%) and lack of rabbit feeds (8.7%). In conclusion, small scale rabbit production system were predominant, aimed at home consumption and income generation. The main cited challenges to production were: Lack of market for rabbits, inadequate husbandry knowledge, lack of quality breeding stocks, insufficient funds for expansion and lack of rabbit feeds. In order to address these challenges, some farmer suggested intervention measures were recorded as follows: Better rabbit breeding stocks should be introduced to the farmers through registered breeders, farmers should be trained on proper rabbit husbandry practices, sensitization of the Kenyan population on the benefits of rabbit meat and rabbit production should be conducted, and last but not least, research on rabbit feeding and disease management should be intensified and facilitated so as to inform rabbit production practices.
CHAPTER ONE

1.0 INTRODUCTION

Many developing regions of the world are currently faced with the double burden of a growing population and low food supply leading to malnutrition (Weingartner, 2005). The problem is made worse by the fact that most of the available food is produced on small farms which have continued to get smaller as the human population pressure increases (McIntire et al., 1992).

Human food originates from products of both plant and animal agriculture. Crop production has been, and in many situations continues, to be the most economical way of producing human food. Decline in land sizes and climate change is likely to reduce overall world crop yield in the future (Stern, 2005). Additionally, most plant proteins do not supply all the amino acids in the proportions required by the human body and animal proteins with superior amino acids balance are needed.

Livestock play important roles in many production systems of the developing regions of the world not only as a source of high quality food but also as a source of soil nutrients that sustain crop production, as a means of accumulating wealth and as insurance against severe drought (Kitalyi et al., 2005). Livestock contributes significantly to the economies of many developing countries. For example, in Kenya, the sector contributed about 12% of the Gross Domestic Product (GDP), 40% to the agricultural GDP and employs 50% of agricultural labour force (Irungu et al, 2009).
Currently, most of the animal protein available for human consumption is from large ruminants, poultry and pigs. However large ruminant numbers are continually declining due to decline in household land holdings and additionally their costs of maintenance are high (Vietmeyer, 1985; Schiere, 2004). Poultry and pigs on the other hand require more of commercial feeds which often incorporate ingredients in direct competition with humans and are usually too expensive for most small scale farmers. Therefore, in order to maximize food production in developing countries like Kenya, all viable options including the use of non-conventional livestock must be explored and evaluated (Chukuigwe et al 2008; Owen et al 2008).

Rabbits (*Oryctolagus cuniculus*), which can be considered as non-conventional livestock species, appear to be a cheap and sustainable means of producing high quality animal protein for the expanding populations of the lower developing countries. This is due to the rabbit’s established prolificacy, early maturity, fast growth rate, high genetic selection potential, high feed conversion efficiency and economic utilization of space (Lebas et al., 1997; Hassan et al., 2012).

In Kenya, rabbit keeping was for a long time seen as an activity for the youth and children who kept them as a hobby (MOLD, 2004). However, there has been renewed interest in rabbit keeping for commercial purposes. The population of rabbits was estimated to be about 600,000 with the greatest numbers in the Rift valley, Central and Coastal regions (MOLD, 2010). Other livestock populations were reported as 31.8m chicken, 17.5m cattle, 27.7m goats, 17.1m sheep, 3m camels, 1.8m donkeys and 0.33m pigs (KNBS, 2009). These population figures clearly bring out the fact that rabbit keeping is not a common practice when compared to other comparable small livestock such as chicken. This is also reflected in the fact that there is very little documentation on rabbit production from the Government of Kenya ministry responsible for
livestock production. The current study was designed to describe the rabbit production systems in Kenya and provide baseline information on which to build and develop this subsector.

1.1 Problem statement

There is lack of documentation on rabbit production systems and constraints to rabbit keeping in Kenya.

1.2 Justification

Rapid increase in human population in Kenya has led to a continual decline in household land holdings that has increased competition of resources for both livestock feed and human food production. This leads to the need to search for alternative protein sources that are cheap, readily available and pose minimal competition to man (Akinmutimi, 2007). The rabbit, a micro-livestock species with low demand on land, capable of producing high quality protein with minimal competition for food with humans becomes a viable option. There has been renewed interest in rabbit keeping for commercial purposes in Kenya, but this has been hindered by lack of sufficient documentation on rabbit production systems and constraints of rabbit keeping (Borter and Mwanza, 2010), hence the need for this study.
1.3 OBJECTIVES

1.3.1 GENERAL OBJECTIVE

To characterize current rabbit production systems used in Kiambu, Nakuru, Nyeri, Meru and Taita Taveta counties.

1.3.2 SPECIFIC OBJECTIVES

1. To establish the current status of rabbit production systems in selected regions of Kenya.
2. To document the constraints to rabbit production in selected regions of Kenya.
3. To analyze appropriate intervention measures to boost and enhance contribution of the rabbit.

1.3.3 Research questions

1. What types of breeds and breeding practices exist in the study areas?
2. What are the main feeds and feeding practices in the study areas?
3. What type of housing is practiced in the study areas?
4. What are the main rabbit diseases and their management in the study areas?
5. What are the rabbit markets and rabbit meat consumption patterns in the study areas?
CHAPTER TWO

2.0 LITERATURE REVIEW

There has been a rising global awareness on the virtues of rabbit meat production in the recent times (Lukefahr and Goldman, 1987). This has contributed significantly to the growth of the sector since the European rabbit was first domesticated.

2.1 Rabbit domestication history

The European rabbit (Oryctolagus cuniculus) evolved in the Iberian Peninsula and southern region of France (Callou et al., 1996). True domestication occurred during the middle ages in the 16th century, in remote monasteries where rabbits were first reared in hutches (Sandford 1992). By the 19th century, backyard production of hutch-raised rabbits, used mostly for family consumption, was a common activity throughout Western Europe and Northern Africa (Lebas et al., 1997).

2.2 Benefits of rabbit farming

The domesticated rabbit has been kept mainly for the provision of meat (Payne and Wilson, 1999) and income both for rural and urban households (FAO, 2001). According to Holmes et al. (1984), rabbit meat is of high quality protein and low in fat compared to other sources of meat. It also has low sodium and cholesterol levels (Owen, 1976; Lebas et al., 1997), making it safe for consumption especially today when lifestyle diseases are on the increase. Rabbit farming is also
suitable for small scale farmers and could meet the challenge of nutritional imbalance in the human population of most developing regions of the world (Vorster & Hautvast, 2002).

Rabbit slaughter yields vary with breed, age at slaughter and nutritional level (Mississippi Agricultural and Forestry Experiment Station, 2010). For instance the Dutch rabbit was found to have a higher dressing percentage (63.3%) compared to New Zealand White (59.9%). Regarding age, dressing percentage of rabbits increased to 13 weeks of age when it began to decline. Rabbits on higher nutritional level (low fiber and high energy) produced over 60% carcass yields compared to those under lower nutritional levels (Lebas et al., 1997).

Rabbits also provide by products such as skins and high quality manures. The skins have been used in various industries for the production of toys, craftwork and garments in cottage industries (Leach and Barrett, 1984; Mississippi Agricultural and Forestry Experiment Station, 2010). Adult rabbits produce quality skins. However, in production systems where the rabbits are slaughtered early, at 10-12 weeks, as is the norm in intensive production systems that are common in developed countries, the skins are thin and unstable and unsuitable for furs (Lebas et al., 1997). Where rabbits are slaughtered older, at 4-6 months, as is common in many Tropical countries, quality skins can be produced if proper skinning and preservation is done. Rabbit manure is relatively rich in phosphorous and nitrogen when compared to the manure of other livestock (Casady, 1975), and therefore is good for crop agriculture.

There are numerous factors that currently make the rabbit one of the most suitable sources of meat. These include the proverbial prolificacy, early maturity, fast growth rate, high genetic selection potential, high feed conversion efficiency and economic utilization of space (Lukefahr and Cheek, 1991; Hassan et al., 2012). Furthermore, the establishment of the rabbit enterprise
requires low inputs and has been used as a vehicle to empower women who live in poverty in Cameroon (Lukefahr et al., 2000). When compared to other livestock enterprises such as dairy, rabbit farming pose minimum economic risks, allowing the resource-poor famers to either downscale or upscale the enterprise without incurring heavy losses. Due to their small body size, rabbits have low individual value further limiting their risks in investment (Cheeke and Patton, 1981). Their small size makes them easy to raise and handle even by vulnerable members of the household including women and children thus labor input can be shared among all the family members (Lukefahr, 1992; Schiere, 2004). Rabbits are quiet animals suitable for the peri-urban and urban farmers who can raise them with minimal disturbance to their neighbors (Omole, 1988).

2.3 Challenges facing rabbit farming

In Sub-Saharan Africa, the main challenges facing rabbit farmers are periodic scarcity of rabbit feeds, lack of reliable sources for quality genetic stocks (Oseni et al., 2008), poor housing (McNitt et al 2000), high rate of rabbit diseases complicated by a limited range of veterinary drugs (Schiere, 2004). Limited market access attributed to low consumer demand due to lack of awareness of the benefits of rabbit meat has also been identified as a major constraint (Nyete, 2000; Schiere, 2004).

In Africa, the main marketing constraint is the low acceptance of rabbit meat (Schiere, 2004). For example, Luzobe (1997) reported that only 35.5% of Ugandans had consumed rabbit meat and as suggested by Lukefahr (1998) this could be due to taboos and also the fact that rabbits morphologically resembles rats which traditionally are not consumed. This has been worsened
by insufficient promotion of rabbit meat, unsteady product supply, unreasonably high prices, competition with other meats such as broiler chicken, lack of product diversification and poorly developed marketing channels (Owen 1981; Gaspari 1984; Lukefahr and Goldman 1985; Bondoc et al., 1986; Lukefahr 2007). These factors may also apply to Kenya since there are a few butcheries selling rabbits (MOLD, 2010).

2.4 Rabbit production systems

Livestock production systems may be classified according to a number of criteria. The main ones being: Integration with crop production, the animal-land relationship, Agro Ecological Zone, intensity of production, and type of product (Notenbaert et al., 2009). Using the level of intensification, there are three systems of rabbit production depending on the levels of purchased inputs and the degree of commercialization (Stotz, 1983). These are: extensive, semi intensive and intensive production systems. In most of the developing countries, the extensive system is widely practiced (Lukefahr, 1998). However, rapid increase in human population has exerted pressure on the available land leading to an increasing shift towards more intensive and semi intensive systems of rabbit rearing (Onifade et. al., 1999: Adu et. al., 2008)

2.4.1. Extensive production system

In this production system, farmers keep a small number of rabbits mainly for home consumption and this is characterized by low initial costs of establishment and, including low feeding costs as the rabbits are raised purely on forages that are locally available (Lukefahr, 2007). Organized rabbit breeding programs do not exist and does nurse their young for five to six weeks, are rebred soon after weaning and are therefore serviced once every one and a half months. Projections of 20 to 35 marketable fryers per doe per annum under this system have been given (Lebas et al., 1997; Lukefahr and Cheeke, 1991). However, the total annual litter produced is much lower than
the projected number above (Lukefahr and Cheeke, 1991). This system has been described in the developing countries such as Cameroon and Tunisia, where rabbits are partially housed in structures constructed using locally available materials such as wood (Lukefahr and Goldman, 1985).

In the United States and the United Kingdom, fryers with slaughter weights of about 1.7 to 1.8 kg are attained using breeds such as the New Zealand White in this type of system (Lebas et al., 1997). Provision of kindling boxes is rare and an average of 5-8 kits per litter is born with 4-6 kits per litter being weaned (Adu et. al., 2008). The replacement stocks are obtained from own stock and under these circumstances, locally adapted breeds or crossbreds are usually more suitable than imported exotic animals from intensive production systems (Lukefahr (2007).

2.4.2. Semi intensive Production system

Due to decline in individual landholdings as a result of population increase, rabbit farming is moving towards intensive and semi-systems in many developing countries (Onifade et. al., 1999; Adu et. al., 2008). The semi-intensive system is dominated by small scale units (Colin and Lebas, 1996; Lukefahr, 2007), where the farmer keeps less than 10 does. The main objective of the semi intensive rabbit production system is both for home consumption and for sale (Schlolaut, 1985). Breeding management involves, servicing does 10 to 20 days after kindling and an average of 7 kits are weaned at four to five weeks, giving an average of 6 kindling per year and over 40 marketable fryers per doe per year (Lebas et. al, 1997).

To house the rabbits, most farmers use assorted locally available materials such as wood, bamboo, sacks, wire mesh, worn out tires for the construction of rabbit cages with single tiering being the most predominant (Oseni et al., 2008). Labor is provided by the family members and
rabbits are fed on forages with minimal supplementation using kitchen wastes or purchased concentrates (Cheeke, 1983). Adu et al., 2008 described a similar feeding system in Nigeria. Due to the low quality feeds, the daily body weight gains vary from 16-25g (Omole and Sonaiya, 1981), 8-13 g (Abu and Onifade, 1996), which is relatively low compared to the recorded gains of 42g per day (Onifade et al., 1999).

2.4.3. Intensive rabbit production system

This system of production is rare in the developing countries but commonly practiced in the developed regions (Lukefahr and Goldman 1985). In this system, feeding management is on commercial feeds which are compounded to increase growth rate and to minimize labor requirements (Walsingham, 1972). With the high levels of management and proper feeding, rabbits can produce 8.7 liters each of 6.4 live kits or a total of 55.7 live kits per year (Ayyat and Marai, 1998).

The housing system is of high cost mainly consisting of metallic cages (Stotz 1983). The use of tiered cages predominates in an attempt to house more rabbits and ensuring economization of space. The main objective of this production system is commercial and rabbits are mainly reared for meat. Other by products of rabbit production are equally important especially the skin, fur and the manure (Lebas et al., 1997). However the main challenge of intensive meat-rabbit production is usually incompatibility of the system with production standards for quality fur and skins due to the early age at slaughter (Lebas et al., 1997; FAO, 2004).
2.4.4 Characteristics of Rabbit production in Kenya

According to Hungu et al., (2013), rabbit farming in Kenya was small scale mainly for home consumption. Production is characterized by low inputs where rabbits are predominantly fed on forage based diets and housing constructed using locally available materials. In terms of rabbit ownership the same authors reported that adults were the main keepers and that for the majority of them the enterprise was relatively new. In terms of breeding, majority of the farmers were reported to obtain their breeding stocks from fellow farmers with only a few buying them from the certified multiplication centres (Borter et al., 2010). The main challenges recorded in the study were rabbit diseases, predation, lack of feeds and lack of rabbit market (Hungu et al., (2013); Borter et al., 2010).

2.5. Rabbit Breeds

Rabbit breeds are distinctively identified phenotypically by the body size, shape and the coat color (Lebas et. al., 1997). Using this basis of classification, American Rabbit Breeders association (ARBA), (2011) have recognized 47 distinct rabbit breeds of which only a few are kept in Kenya (MOLD, 2010). The most common rabbit breeds in Kenya include: New Zealand white, Californian, Chinchilla, French Lop, Dutch, Checkered giant, Flemish giant and Angora. The breed characteristics are as shown in the table below.
### Table 2.1 Recognized Rabbit Breeds

<table>
<thead>
<tr>
<th>Breed name</th>
<th>Weight</th>
<th>Purpose</th>
<th>Origin</th>
<th>Color description</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand White</td>
<td>Buck</td>
<td>Meat</td>
<td>America</td>
<td>All-white rabbit with red eyes.</td>
</tr>
<tr>
<td></td>
<td>Doe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Californian</td>
<td>Both</td>
<td>Meat</td>
<td>America</td>
<td>All white except for ears, nose, feet and tail, which are a dark gray or black.</td>
</tr>
<tr>
<td></td>
<td>buck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>doe 4.1Kg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Dutch</td>
<td>1.6-2.5kg</td>
<td>Exhibition purposes</td>
<td>Holland</td>
<td>Grey, brown/ black body with white belt around the neck/shoulders</td>
</tr>
<tr>
<td>The Rex</td>
<td>Buck 3.6kg, does, 4kg.</td>
<td>Meat/fur</td>
<td>America</td>
<td>Grey body with or without white spots</td>
</tr>
<tr>
<td>Checkered giant</td>
<td>5 kg</td>
<td>Meat</td>
<td>Germany</td>
<td>Either black or blue-spotted rabbit.</td>
</tr>
<tr>
<td>Chinchilla</td>
<td>2.3–3.4kg.</td>
<td>Fur</td>
<td>France</td>
<td>Under-color slate blue at the base, the middle portion pearl grey, merging into white and tipped with black much like the chinchilla.</td>
</tr>
<tr>
<td>Flemish giant</td>
<td>5-7 kg</td>
<td>Meat</td>
<td>America</td>
<td>Vary from silver grey to black color.</td>
</tr>
<tr>
<td>French lop</td>
<td>5-6 kg</td>
<td>Meat</td>
<td>France</td>
<td>White, grey black body with drooping ears hence the names lop.</td>
</tr>
<tr>
<td>Angora</td>
<td>2.5–4Kg</td>
<td>Fur.</td>
<td>America</td>
<td>Vary from white, grey and brownish long fur covering the head, neck and body.</td>
</tr>
</tbody>
</table>


Rabbits have further been classified as: small sized rabbits weighing about 1.4 – 2kg at maturity, medium sized breeds weighing 4 – 5.4kg, and large breeds weighing 6.4 – 7.3kg (USDA, 1972). In this classification New Zealand white and Californian white are medium sized breeds. They are the most popular for meat production due to good growth characteristics and a high meat: bone ratio (Oseni et al., 2008; Mailafia et al., 2010). The New Zealand white is also well
recognized as a dam breed based on its outstanding maternal genetic merits for litter size, milking, and general mothering ability (Lebas et al., 1997; McNitt et al., 2000). The good attributes of the two breeds are due to their specific selection for improved reproductive performance (King, 1978; Owen, 1981).

However, rabbit breeding experiments in the U.S.A. have documented the New Zealand White as generally inferior to crosses for post weaning fryer growth, feed utilization and carcass lean yield traits (Ozimba and Lukefahr, 1991; Lukefahr et al., 1992). Other common meat breeds are Flemish giant, French lop and Checkered giant mainly because of their large size. Smaller breeds, on the other hand, are mostly kept as pets and include Chinchilla, Dutch and the Angora (Moreki, 2007).

In a study comparing growth performance and mortality rates amongst the common meat rabbit breeds, purebred New Zealand white and Californian litters performed similarly but the crossbreds of the two were superior for the above traits compared to the purebreds (Ozimba and Lukefahr, 1991). However, in developing countries, the practice of indiscriminate crossing with perceived better exotic breeds has often led to the dilution or loss of the adapted breeds (Boulet, 1999). In Nigeria, as is the case for most developing countries, a major limitation to the development of smallholder rabbit production was reported to be the absence of reliable sources for quality genetic stocks of rabbits (Oseni et al., 2008). This lack of breeding stock could explain the indiscriminate crossing by farmers.

2.6. Rabbit reproductive physiology and performance

The rabbit is an induced ovulator and the sexually mature doe exhibits numerous ovarian follicles (Harkness and Wagner, 1983). On mating, the act of copulation stimulates hormonal
reaction that result in ovulation 10 hours later (Paufler, 1985). The doe can theoretically be bred 24 hours after parturition and has a gestation length of 28-32 days and thus can give upto 11 litters in a year. This makes the doe litter size the the most important economic character in rabbit production (Belhadi, 2004; Nofal et al., 2005). The best breeding plan is to have does serviced as soon as they reach 80% (or, at the latest, 85%) of the mature weight for their breed (Lebas et al. 1997).

On the 18th day of pregnancy, the doe begins to show signs of kindling by nest building (Sanford, 1975). When the young kids are born, they are blind and furless so they are fully dependent on the does. During this period, close attention should be paid to the kids to avoid mortalities. The litter size ranges from 4 for small breeds to 8-10 for large breeds (Cheeke, 1986). The overall means for litter weight at birth and weaning were 281 and 1296g respectively and 5.52 and 3.81 for the litter size at birth and weaning respectively (Ayyat and Marai, 1998).

The factors that have been reported to affect the breeding performance of rabbits are disease and the climatic conditions such as high ambient temperatures which can cause infertility in breeding rabbits, bucks being more sensitive than does (Lukefahr and Cheeke, 1991). Ambient temperatures of 30°C are considered the threshold point beyond which infertility may result. Therefore, a number of practical measures for alleviating heat stress in the tropics such as proper ventilation including the use of fans have been adopted (Cheeke et al. 1987).

Poor nutrition is documented as a cause of delayed sexual maturity and rabbits fed on pelleted feeds (a more nutritionally balanced diet) reached sexual maturity at 4 months of age as opposed to those on forage diet that matured later at between 8 and 10 months of age (Lebas et al., 1997). Ayyat and Marai (1998) evaluated the intensive rabbit production system under the sub-tropical
conditions of Egypt and recorded that doe conception rate is highest within the first 10 days and 30 days post partum. Highest weaning weights and litter sizes were realised with the longer open periods and thus suggested that re-breeding at the 30th day post-partum may be less stressful on the doe, improving her ability to nurture the young.

2.6.1 Growth potential of rabbits

One of the most important parameters in rabbit production is the growth rate (Chen et al. 1978). Growth rate is mainly dependent on breed, birth weight and maternal effects such as nutrition and milk production (Razzorenova and Solovkina 1985; Vakulenko 1985). Khalil et al. (1986) reported that the doe characteristics are the most important factors affecting body weight at birth and up to weaning. Zerrouki et. al (2007) studying local Algerian rabbits recorded an average birth weight of 51g. During the first three weeks of nursing, the young rabbit’s weight increased to 119 g at the end of the first week and 308 g at the end of the third week. At the weaning age of 4 weeks, the average weight of kits was 475 g. translating to an average of 15.7g/d pre-weaning growth rate.

Slaughter weights of rabbits vary with breed and nutritional level. Baiomy and Hassanien, (2011) observed average slaughter weights of New Zealand White and Californian rabbit to be 2270 and 2253 g respectively at the age of 16 weeks. Zelnik and Rafay (1986) recorded average slaughter weights of 2200, 2225 and 1720 g for Californian White, New Zealand rabbits and Chinchilla respectively at 12 weeks of age.
2.7 Rabbit Housing

Housing constitutes an important factor in rabbit production (Mailafia et al, 2006). The main purpose of housing is to protect the rabbits against adverse climatic conditions, predators, ectoparasites and endoparasites (Hoy, 2006). Poor housing, which is common to the lesser developed countries, is a limiting factor affecting growth of rabbits. (McNitt et al, 2000). The main welfare indicators to assess suitability of rabbit housing are mortality, morbidity, physiological parameters, rabbit behavior and production performance (Hoy, 2008).

The house floor, walls, equipment should cause no pain, suffering or injuries to the rabbits. Additionally, housed rabbits should be provided with feed and water according to their nutritional needs. Rabbit houses should also be kept clean and well ventilated to avoid accumulation of toxic gases such as ammonia (Hoy, 2008).

The sun and wind direction, security, drainage and proximity to the farmer’s house should be some of the factors to consider while selecting a construction site for a rabbit hutch (James Mcnitt, 2009). Rabbits can either be housed in group house pens or in single cage housing system. The housing system has been shown to affect growth, some carcass parameters and sometimes the meat quality (Dal Bosco et al. 2000). Group housing of social livestock is increasingly being considered as an essential development towards sustainable animal farming in the European countries (Maertens et al., 2004). A study conducted on 3–4-week-old rabbits indicated that they huddle together regardless of the cage size (Maertens et al., 2004) which appears to support their preference for group housing. However, the loose group housing has some disadvantages such as aggression and injury among the rabbits and an increase in conflictual behavior has been reported (Bigler and Oester, 1996). Additionally, in case of a disease outbreak and infestation with ecto-parasites such as mites, the spread within the flock
may be more pronounced in loose group housing since the rabbits are in close contact. With individual cage housing, rabbit behavioral patterns have been reported to change considerably and this is suggested to be a consequence of the reduced space that hinders free movement and reduces opportunities for social interaction (Lehmann, 1987; Szendro and McNitt, 2012). Individual housing increases the cost of housing and by extension rabbit meat production. The rabbit cages can either be placed indoors or outdoors and litter mortality was varying with the cage placement, where higher than expected mortality rates occurred in outdoor cages (Brzozowski et al. 1994). Whatever the housing system, it is important that rabbits have enough space to minimize conflict between individuals and avoid abnormal behavior (Lehmann, 1987). The recommended spacing for different rabbit age groups are shown in Table 2.2.

### Table 2.2 Recommended housing area for different age groups of rabbits

<table>
<thead>
<tr>
<th>Rabbit group</th>
<th>Recommended spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doe and litter up to 5 weeks of age</td>
<td>0.56m²</td>
</tr>
<tr>
<td>Doe and litter to 8 weeks of age</td>
<td>0.74 m²</td>
</tr>
<tr>
<td>Rabbits 5-12 weeks of age</td>
<td>0.07 m² per rabbit</td>
</tr>
<tr>
<td>Rabbits over 12 weeks</td>
<td>0.18 m² per rabbit</td>
</tr>
<tr>
<td>Adult does for breeding</td>
<td>0.56 m² per rabbit</td>
</tr>
</tbody>
</table>

*Table adapted from Standing Committee on Agriculture and Resource Management (SCARM), 1991*

Stocking density in the rabbit house affects growth and litter size at weaning. Feed intake by growing rabbits is improved in less crowded housing and translates to higher daily weight gain (Ferrante et al. 1997; Lambertini et al. 2001). Rabbits in larger cages develop wider, heavier
bones, and low fluctuating asymmetry, as a result of favorable housing (Buijs et al., 2012). The influence of cage space area has been found to significantly affect the litter size at weaning where limited space caused increased pre-weaning mortality rates (Brzozowski et al., 1994). Fluctuating asymmetry (FA), the random left-right differences in bilateral traits (left or right body deviations), has been suggested as an indicator of developmental instability in individual rabbits due to stress caused by poor cage spacing. Palmer and Strobeck (1992) and Tuyttens et al., (2005) reported greater FA in rabbits housed in high density pens than in those in enriched low density pens, suggesting decreased welfare. Housing 15–16 rabbits/m\(^2\) (38–40 kg/m\(^2\)) at the end of growing period is considered the threshold for the compatible expression of normal behaviors of caged rabbits (Trocino et al, 2004). The height of the hutch from the floor to the roof should not be less than 45cm high to allow rabbits sit upright with ears fully erect (Standing Committee on Agriculture and Resource Management (SCARM, 1991).

Pre-weaning kit mortality rates of up to 20% or higher have been reported in commercial production units with individual cages (Gualterio et al., 1988). The causes of this high mortality include: hypothermia, weakness, starvation, trauma and bites, poor nest quality, crushing and cannibalism, all of which have been attributed to environmental stress (Baumann et al., 2005). Proper hygiene and management of cages have been reported to prevent the spread of epidemic diseases such as Pneumonia (Lukefahr and Cheeke 1991). Hygiene level is reported to be higher in small scale producers since they tend to invest more time in management activities that reduce disease incidence than do large scale producers (Owen, 1976).

Construction of hutches from locally available materials such as old packing cases, intermeshed branches or bamboo strips (Action for Food Production, 1974), or local hard wood and bamboo-like material (Owen, et al., 2007) should be encouraged to cut costs of production. This may
encourage rabbit keeping by resource poor farmers as the capital investment on housing would be low.

Raised housing is often adopted as a means to control diseases of rabbits because it separates the animals from their droppings that act as a potential source of disease (Animal Research Review Panel, 2003). In such housing, wire mesh can be used as both wall and floor construction materials. However, research findings by Drescher (1992) indicated that the rabbits spend less time resting on wire net compared to other floor types such as wood, which could be an indication of discomfort on the wire net floor. For the non raised floors on the other hand, bedding materials such as wood shavings been used though rabbits have been reported to consume the bedding material (Dal Bosco et al., 2002) which may increase incidences of coccidian infection.

Feeders and watering equipments must be provided in the rabbit house. Regular use of both a forage rack, a feeder for ground/pelleted feeds and watering equipment is important. It has been shown that litter size at birth and litter size at weaning are significantly higher where these equipments are used (Brzozowski et al. 1994) as opposed to rabbits feeding directly from the floor.

2.8. Diseases

The highest cause of reduction in production and mortality in rabbits is disease occurrence. Rabbit health combined with feeding, determines the body condition score and breeding performance of both the buck and the doe (Sanchez et al., 2012). Rabbits are mostly susceptible to conditions associated with nutritional deficiencies and ingestion of contaminated feed, mainly
with mycotoxins such as aflatoxins (Szilagyi et al., 1994). Aflatoxins are often found in low-cost rabbit feed constituents such as maize-milling wastes and when consumed, these toxins cause destruction of the body tissues of rabbits by oxidizing proteins causing immune-suppression (Kumar et al., 2008). Aflatoxicoses may also cause gastrointestinal problems, internal bleeding, hemorrhages or bruising, stomach ulcers, mouth sores, kidney or liver damage (Szilagyi et al., 1994; Aziz et al., 1995). All of these conditions are often encountered in rabbit farms.

The main infectious agents causing rabbit digestive disorders are bacterial (Licois, 2004), which may present as diarrhea with associated mortality reaching 12% during the fattening period (Koehl, 1995). Other factors that predispose rabbits to disease are poor/unhygienic housing and feeding conditions which lead to high prevalence of bacterial infections especially those caused by *Escherichia coli* (*E. coli*) associated with gut oedema and enteric colibacillosis manifesting as diarrhoea and sudden death in rabbits (Gross, 1991). However, cleanliness and good management, which do not necessarily have to be sophisticated or involve the use of expensive drugs, can be extremely effective in the prevention of the infectious diseases (Stewart, 1974).

Though fibre digestibility is low in the rabbit, it is an important component of rabbit feeds and necessary for maintaining gut health, stimulating gut motility, reducing fur chewing, and preventing enteritis (McNitt, et al., 1996). A minimum level of 20-25% dietary fibre is recommended below which gut hypomotility, reduced cecotroph fermentation, prolonged retention time in the hindgut and enteritis have been reported (Cheeke, 1994).

The level of intensification has been reported to have an impact on disease levels. Owen (1976) observed a trend of lower disease incidence and higher productivity levels in rabbit operations managed as small-scale family units as opposed to intensive, commercial units. This may be explained by the fact that in large operations, management quality per animal may be inferior.
and close confinement may mean greater likelihood of rapid disease outbreaks, particularly of myxomatosis and pasteurellosis.

Coccidiosis is one of the most important infectious causes of digestive disorders in commercial rabbit production. This is caused by a protozoan parasite of the genus *Eimeria* which are reportedly always present in rabbit farms and virtually impossible to eradicate (Vancraeynest et al., 2008). In a study investigating the incidence and prevalence of coccidian infection among rabbits in Egypt El-Shahawi et al., (2012) identified eight species of *Eimeria*. *Eimeria intestinalis* and *Eimeria coecicola* were generally the most predominant species. These authors reported an overall prevalence of 70%. Higher incidences of coccidiosis are associated with contaminated hutch bedding and floor materials that come into contact with feed and water, and are ingested by the rabbits (Dal Bosco et al., 2002). Although coccidiosis occurs in all ages of rabbits, weaners are more susceptible and the infected rabbits exhibit diarrhea, anorexia, rough hair coat and unthriftiness (Aduku and Olukosi, 1990).

Mange is another common problem with rabbits and is a skin parasitic condition caused by *Sarcoptes scabiei* and as a result of pruritis, it leads to scab formation and alopecia. This causes the rabbits to lose appetite, body condition and stunts the growth rate (Merck, 2010). Mange also is common in rabbits and has been reported in other parts of Africa including Nigeria (Adu et al., 2008).

Pinworm and ear mite infections are also common to the rabbit (Rai, 1988). Fungal skin conditions are problematic in rabbit production and mainly caused by *Trichophyton mentagrophytes*. The main clinical signs include alopecia and skin lesions capped with white bran-like flaky material (Mercks, 2010). Infectious myxomatosis is a fatal disease caused by a
virus and is transmitted by mosquitoes, biting flies and by direct contact (Aduku and Olukosi, 1990).

2.9 Rabbit feeds and feeding practices

Rabbits are non ruminants and are classified as hindgut (caecum and colon) fermenters (Cheeke, 1987; McNitt et al., 2000) assisted by their large caecum that harbors a large microbial population (Stevens and Hume, 1995). The presence of these caecal microbes enables the rabbit to digest large amounts of fibrous feed compared to other non ruminant species (Taiwo et al., 1999). Additionally, Lukefahr and Cheeke (1997) reported that rabbits are able to utilise herbage biomass more efficiently than cattle and sheep. It is for this reason that rabbits can be successfully reared on diets consisting wholly of forages (Cheeke, 1986). This is an important characteristic especially in many subsistence agriculture systems of the tropics and sub-tropics where concentrate diets are expensive and often include ingredients directly used as human food (Akinmutimi, 2007). If palatable greens are fed ad-libitum, amount of concentrate fed can be reduced by 50% with no adverse effects on performance of rabbits (Cheeke et al., 1987).

Careful management and balancing of diets is necessary for rabbits (Aduku and Olukosi, 1990). Pound et al., (1984) reported that the more appropriate approach for smallholder farmers is to grow trees and shrubs that produce much higher protein per unit area in the form of leaf biomass rather than cultivating traditional protein crops, such as soybeans, groundnuts or sunflowers, as components of their farming systems.

According to Hongthong (2005), the palatability and nutrient content of forages is important in rabbit production, particularly in situations when the forages are expected to provide a major part of the daily nutrient intake. This is because the two most common deficiencies encountered in
such diets are of energy and protein rather than minerals or vitamins (Aduku and Olukosi, 1990). Raharjo and Cheeke (1985) reported that tropical legumes especially *Leucaena leucocephala* were preferred by rabbits over grasses such as Setaria, Brachiaria, and Elephant grass (Raharjo, 1987). Pok Samkol *et al* (2006) reported growth rates of 14 to 20 g/day for rabbits on water spinach (*Ipomoea aquatica*). Doan Thi Gang *et al.* (2006) fed sweet potato vines as the sole diet to growing rabbits reported similar daily weight gains.

Sweet potato is a crop with great potential as a source of rabbit feed. The forage is high in protein, is highly digestible and is reported to be more palatable to rabbits than *Leucaena leucocephala* (Raharjo and Cheeke, 1985). It has been ranked among the five most important food crops in tropical regions where a high population of the world’s poorest people live (Woolfe, 1992). It is advantageous in that it can be planted once and vines harvested to provide animal feed for a whole year with daily harvesting (Le Van An *et al*., 2004). In addition, the crop is highly tolerant of weeds, allowing farmers to devote more time to other crops (Consultative Group on International Agriculture Research (CGIAR, 2004). Another crop whose contribution to rabbit feed should increase is cassava. Cassava root meal and cassava peel meal have been successfully incorporated in the rabbit feed at levels of upto 30% and there are suggestions that cassava leaf meal can be an important high protein forage (Omole, 1988). In tropical and sub-tropical areas it is recommended that rabbit diets should consist of nutritious and palatable grasses, forages and legumes that can be cultivated by farmers in small plots (Raharjo and Cheeke, 1985; Grant *et al*., 1996).

Although rabbit production in developing countries is based on low cost feeding using locally available forages/weeds (Mailafia *et al*., 2010), rabbits should also be supplemented with concentrates either purchased or locally made as this improves the growth and breeding
performance of the rabbits. For example in Vietnam, supplementation with diets consisting of molasses blocks and leaves from mulberry and *Trichanthera gigantea* resulted in better performance of breeding does compared to those on local weeds without the supplement (Le Thu Ha et al., 1996).

In Kenya, Mutetikka (1991) reported that *Chloris gayana* hay, sweet potato vines and maize leaves had higher levels of gross energy (3840-3970 Kcal/kg) compared to that recommended for rabbits (3600-3700 Kcal/kg). However, these forages had a crude protein level of about 2-15% which was lower than the (17.5%) recommended for rabbits (Cheeke et al., 1985). Commercial concentrates on the other hand often have a fibre level below the 15-16% recommended for rabbits (Fekete and Gippert, 1985). This therefore requires that some supplementation should be carried out in order to balance the crude fiber, crude protein and gross energy for the optimal rabbit performance.

The feeding system impacts on meat yield and carcass composition of slaughter rabbits. It has been established that the dressing percentage decreased with low supplementation levels as the weight of the viscera tended to increase with increased level of fiber in the diet (Chawan et al., 1982; Mutetikka, 1991). Holmes et al. (1984) established that the meat from animals on high fiber and low concentrate diets was high in protein and low in fat. These findings agree with those of Pote et al. (1980) who reported higher carcass fat levels of 14.1% in animals fed on pelleted high energy commercial diets compared to 4.2-4.8% in those fed low energy diets.

When provided with feed and water *ad libitum*, rabbits will consume 5% of their body weight in dry matter and drink about 10% of their body weight in water (Okerman, 1994). For the mature rabbits, limiting water access to 2 h and 1.5 hours per day reduced feed intake by 18% and 22%
respectively (Boisot et al., 2004; VerDelhan et al. 2004). Water restriction to 2 and 4 hours a day decreased the growth rates by 19% and 11% of the ad libitum access respectively (Boisot et al., 2004). Restricting access to water has been reported to regulate intake of newly weaned rabbits resulting in lowered mortality rates (Adjare, 2003; Verdelhan et al., 2004; Bovera et al., 2013). However, Rayana et al., (2008), reported that feed intake and weight gain of growing rabbits decreased with the degree of restriction and that there were no differences in mortality rates of growing rabbits. In the latter study, mortality rates were generally low with only 2 deaths by 8 weeks of age out of 36 experimental animals and the authors indicated that it was difficult to make a conclusion on effects of water restriction on mortality rates.

2.10 Rabbit Meat Consumption:

Rabbit meat production is a rapidly growing industry, with an estimated increase of 38.3% in the decade between 1990 and 2009 (FAOSTAT, 2010). Most of the rabbit production systems in the developing regions of the world are geared towards home consumption and equally important as a source of income (FAO, 2001). China was ranked the highest producer and consumer of rabbit meat in the world with other significant producers being: Italy, France, Spain and Egypt (European Food Safety Authority (EFSA), 2005). Consumer preference for rabbit meat has been ranked at a low level when compared to other meats (Hoffmann et al, 1992). Adu et al., (2008) reported that the markets for rabbit meat exist in Nigeria but are not organized and attributed this to production systems being directed towards subsistence. Hoffman et al. (2004) reported that demand for rabbit meat exceeded supply in South Africa.

In East Africa, rabbit meat consumption remains low. Luzobe (1997) reported that only 35.5% of the Ugandans had consumed rabbit meat and as suggested by Lukefahr in (1998) this could be due to taboos and also the fact that rabbits resemble rats which traditionally are not consumed.
Sonandi et al., (1996) had also reported that there were African beliefs which forbid the consumption of rabbit meat.

Other factors such as: Insufficient promotion, unsteady product supply, unreasonably high prices, competition between other meats, lack of product diversification and poorly developed marketing channels, may also explain limited rabbit market success (Owen 1981; Gaspari 1984; Lukefahr and Goldman 1985; Bondoc et al 1986). These factors apply to Kenya since there are a few butcheries slaughtering rabbits (MOLD, 2010).
CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study area

The study was conducted in five counties, which were purposively selected based on population of rabbit keeping farmers as per the Ministry of Livestock Development report of 2010. The five counties were: Kiambu, Nyeri, Nakuru, Meru and Taita Taveta.

3.1.1. Kiambu County

Kiambu, located in Central Kenya, has geographical coordinates: 1° 10' 0" South, 36° 50' 0" East. Temperatures range from a minimum of 12.8°C to a maximum of 24.6°C with an average of 18.7°C. The average rainfall is 989mm per annum. The average human population density is 638 people per km square.

3.1.2. Nyeri County

Geographical coordinates of Nyeri County are 0° 25' 0" South, 36° 57' 0" East. It is located in Central Kenya. Temperatures range from a minimum of 12°C to a maximum of 27°C and an average of 19.5°C. The average rainfall is 1025 mm per annum. The human population density is 208 people per Km square.

3.1.3. Nakuru County

The geographical coordinates of Nakuru county are; 0° 17' 0" South, 36° 4' 0" East It is located in the Rift Valley. The temperature regimes experienced in the county is between 10°C and 20°
Celsius with an average of 15°C. The average annual rainfall is approximated to be 850mm per year. The population density is estimated at 213 people per km square.

3.1.4. Meru County

Geographical coordinates for Meru County are 0° 30' 0" North, 37° 39' 0" East and is located in Eastern Kenya. During the hottest months temperatures rise up to 33°C and 20°C in the cold months and the average of 26.5°C. The average rainfall received in a year is 840mm. Population density is estimated at 195 people per km square.

3.1.5. Taita Taveta County

Geographical coordinates 41° 12' 0" South, 174° 57' 0" East. Taita Taveta County is located in the former Coastal Province. Temperatures range between 18°C in the highlands and 24.6°C in the lowlands with an average of 23.3°C. The average rainfall received in a year is 650mm. The population density is 16 people per km square. Sixty Percent (60%) of the total land covered by Taita Taveta County is not suitable for agriculture due to various factors such as high temperatures and low rainfall.

3.2 Sample size

The sample size was based on the general rule of a minimum 30 respondents per county (strata) (Cohen, 1988). However, due to the vastness of the counties and in an effort to capture variations due to land use intensity and agro-ecological zones, 60 rabbit farmers in each county were purposively selected with the assistance of the Ministry of Livestock Development extension officers. This sample size also took into consideration the fact that larger samples more accurately represent the characteristics of the populations from which they are derived (Cronbach et al., 1972; Marcoulides, 1993).
Furthermore, an additional 20 non rabbit households in every County were also purposively sampled and interviewed so as to understand their perception of the rabbit industry.

3.3 Data collection

Data were obtained through a field survey, complemented with secondary data from other similar publications and the Ministry of Livestock Development annual reports. Primary data was obtained through a semi structured questionnaire (see Annex A), conceptualized as a multi-topic household survey. The instrument was designed from previous livestock modules of Living Standards Measurement Study (LSMS) type questionnaires with a maximum recall period of 12 months for a number of items. The choice for this format was to get data which ultimately would be comparable with questions from other LSMS type surveys in other countries.

3.4. Information collected covered the following:

1. General livestock details and production on the farm,
2. Rabbit numbers, breeds and breeding practices,
3. Rabbit housing structures and equipments,
4. Common rabbit feeds and feeding practices,
5. Rabbit diseases and disease control practices,
6. Rabbit meat consumption and rabbit marketing,
7. Constraints and suggestions appertaining to rabbit production challenges.

Questions took a closed ended format but were also interspersed with open ended questions where necessary. The flow of questions was designed to aid the interviewer and interviewee with some psychological order, so that one question in a section leads easily and naturally to the next
and was related to those on one aspect e.g. housing or diseases. Some questions were included to act as an aid to check for consistency of responses to some of the questions.

The questionnaire was pretested with rabbit farmers in Ngong and later adjusted to take account of interview length while some questions were reformulated based on observations from the pretest and tested again in Naivasha and Nakuru. It was subsequently implemented by enumerators who were assisted by an interview manual constructed to accompany the questionnaire. The enumerators underwent one day training on subject matter of the questionnaire to ensure understanding and uniformity.

As an additional quality control measure, questionnaires filled during the first week of data collection were scrutinized for completeness and any inconsistencies noted and communicated to the enumerators. Ministry of Livestock Development officers on the ground were relied upon to provide logistical support to the interviewers and identification of respondents. A total of 400 respondents were targeted with 80 from each of the counties viz; Nakuru, Meru, Kiambu, Taita Taveta and Nyeri between August and September 2011.

3.5 Data analysis

The collected data was keyed into MS access and later exported to the statistical package (SAS V9.0) for analysis. Descriptive statistics (central tendencies and dispersion measures) were then derived from the data to describe rabbit production practices such as average numbers of rabbits and breeds kept by the farmer; breeding practices, rabbit housing structures and equipments used by the farmers in rabbit production, rabbit feeds and feeding practices, rabbit diseases, rabbit meat consumption and marketing, and farmer suggested interventions for the identified production constraints.
The significance of the effects of the independent variables on the dependent variables were determined using Chi-square tests at p<0.05 (Snedecor and Cochran, 1967).
CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Farmer and Farm Characteristics

Of the total (n=400) respondents in all counties, 53% were males while 47% were females. The sex proportion of the respondents did not differ significantly across the counties. For those interviewed, 27% were young (19-30 years), 58% adults (31 to 60 years), and 15% mature adults (above 60 years).

Fig 4.1 Proportion of the Household members owning rabbits in the study areas (n=300)

The results shown in Figure 4.1 indicate that rabbit farming was undertaken by all the household members unlike the past when the activity was relegated to the youth (MOLD, 2004). Earlier reports by Borter and Mwanza, (2010), in a study set to establish current status or rabbit farming
in Kenya and by Hungu, (2010) also indicated that rabbit farming as being undertaken by all age groups in agreement with current results.

The proportions of different members of a household keeping rabbits in the various counties are shown in the table 4.1. The main rabbit keepers were household heads followed by the spouses across the counties except in Taita where the activity was relegated to the youth (sons) who kept them as pets and for meat.

### Table 4.1 Proportions of household member keeping rabbits in different counties.

<table>
<thead>
<tr>
<th>County</th>
<th>Head</th>
<th>Spouse</th>
<th>Son</th>
<th>Grand child</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meru</td>
<td>51.7%</td>
<td>39.7%</td>
<td>5.2%</td>
<td>3.4%</td>
</tr>
<tr>
<td>Nyeri</td>
<td>52.5%</td>
<td>42.4%</td>
<td>1.7%</td>
<td>3.4%</td>
</tr>
<tr>
<td>Taita</td>
<td>35.6%</td>
<td>8.5%</td>
<td>54.2%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Kiambu</td>
<td>51.0%</td>
<td>32.7%</td>
<td>12.2%</td>
<td>4.1%</td>
</tr>
<tr>
<td>Nakuru</td>
<td>40.3%</td>
<td>26.3%</td>
<td>21.1%</td>
<td>12.3%</td>
</tr>
</tbody>
</table>

The level of formal education of the household heads is shown in Fig 4.2. The majority (78.9%) of farmers had basic education (primary and high school levels), 15.3% higher education (mid level college and university graduates) while only 5.8 % had no formal education. Level of formal education of the farmers differed across the counties, where Kiambu had the highest proportion (36.2%) of farmers with education level above high school, followed by Meru (16.6%), Nyeri (11.3%), Nakuru 10.6%, while Taita had the least at 10.6%. This may indicate that access to higher education in Kiambu was relatively easier compared to Taita County and
this could be as a result of proximity to the major urban center (Nairobi) associated with better education institutions and facilities.

Fig 4.2 Level of education of the household heads in the counties (n=300)

The distribution of education level among household heads (Fig 4.2) reflected current education status of Kenyans as described by Kenya National Bureau of statistics, (2009) that majority of the Kenyans were of basic education with university graduates comprising only 3%. Rabbit farming was therefore practiced by farmers of different education levels and was neither a preserve for the elites or for the least educated. A similar trend was also observed in Nigeria by Oseni et al (2008) in a similar study.
The number of rabbits kept by farmers of different education levels is shown in Fig 4.3. The farmers’ level of education had a significant (p=0.0009) effect on the number of rabbits kept. The farmers with a higher education level kept more rabbits, an average of 18.5 for mid level college and 14.5 for the university graduates with majority of them keeping rabbits for income generation at (64%) and (63.4%) respectively. Those with basic education on the other hand kept fewer rabbits (11.2) for primary and (10.2) for high school levels with 54.9% and 42.7% respectively keeping them mainly for income generation. These results are consistent with those of Mendoza et al., (2008) who reported that farmers with higher education levels were more commercially oriented, obtained more benefits from using new farming technologies and made more informed production decisions compared to those of lower education standards in Mexico. As a result their rabbits were more productive compared to those kept by persons of lower education level.
The average land size owned by the rabbit farmers was 1.9±2.3 acres and supported 4.8±1.98 family members. On the other hand, non rabbit farmers had larger landholdings of 3.32±3 and supported 4.6±2 family members. The difference in landholding sizes between the two groups was significant p=0.004. (Table 4.2)

**Table 4.2 Average landholdings and household membership size for the rabbit and non rabbit farmers.**

<table>
<thead>
<tr>
<th>Farmers</th>
<th>Land size</th>
<th>Household size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rabbit farmers</td>
<td>1.9±2.3</td>
<td>4.8±1.98</td>
</tr>
<tr>
<td>Non rabbit farmers</td>
<td>4.6±2</td>
<td>3.32±3</td>
</tr>
</tbody>
</table>

(p=0.004)

This indicated that land size could be an important factor in determining distinguishing whether a household was likely to keep rabbits or not. The fact that farmers with smaller landholdings were more likely to keep rabbits appears a logical response since these have low space requirements.

The average land sizes and household numbers for both the rabbit and non rabbit farmers were close to those indicated by the KIHBS, (2006) of 2 acres and supporting an average of 4-5 household members.

The number of rabbits kept by the respondents ranged between 1 and 74 with a mean of 12.7±12 rabbits and the mean distribution across the counties is shown in Fig 4.4.
Figure 4.4 Mean number of rabbits kept by land size (acres) per County (n=300)

Figure 4.4 shows the average number of rabbits kept in relation to average landholding for the different counties. There was a significant difference (P<0.0001) in the mean number of rabbits kept and land sizes. The mean numbers of rabbits kept per farm in Kiambu County were significantly higher for Taita and Nakuru while the numbers kept in Meru were significantly higher than those in Taita. Farmers with smaller land sizes kept more rabbits than those with relatively larger pieces of land. This could be attributed to the fact that as land sizes continue to decline, farmers opt for livestock that ensure economical utilization of space. Hassan et al., (2012) reported similar results from Sudan. Other factors that may have contributed to the large number of rabbits kept in Kiambu included proximity to large urban centers such as Nairobi, which have more potential rabbit meat consumers therefore motivating farmers to keep more rabbits. This may explain why farmers in Taita Taveta County which is far from any large urban center kept the fewest rabbits and mostly for subsistence (Figure 4.4).
The rabbit keeping farms were classified into four levels of scale of operation depending on the number of does as shown in Table 4.3.

**Table 4.3 Scale of production based on the number of does kept (n=300).**

<table>
<thead>
<tr>
<th>Number of females (does)</th>
<th>Scale of operation</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Ultra small-scale</td>
<td>121</td>
<td>40.2%</td>
</tr>
<tr>
<td>3-10</td>
<td>Small-scale</td>
<td>134</td>
<td>44.6%</td>
</tr>
<tr>
<td>11-50</td>
<td>Medium-scale</td>
<td>37</td>
<td>12.8%</td>
</tr>
<tr>
<td>Above 50 does</td>
<td>Large-scale</td>
<td>8</td>
<td>2.4%</td>
</tr>
</tbody>
</table>

*Classification scale as by Oseni et al., (2008)*

These results show that the majority (84.8%) of the rabbit farmers kept less than 10 does classified as ultra-small and small-scale. The dominance of small scale rabbit farming in the developing countries was also reported by Colin and Lebas, (1996). Similar results were also reported by Lukefahr, (2007) in South East Asia, and by Oseni et al., (2008) in south western Nigeria.

Within the counties, small and ultra small systems were practiced by 96.7%, 95%, 93.9%, 83.3% and 58.7% of the respondents in Nyeri, Taita, Meru, Nakuru and Kiambu respectively. The highest numbers of medium-large scale farmers (41.3%) were in Kiambu County, attributed to intensive land use compared to other counties. McIntire, (1992) in a study on crop-livestock interactions in sub-sahara Africa argued that as the household landholding declines, farming tends to shift from extensive to more intensive systems characterized by a large number of livestock on a smaller piece of land.
The average numbers of other livestock kept are shown in Table 4.4. The proportion of respondents who kept poultry was (86.2%) while those keeping cattle (mostly Bos taurus) were 62.6%. Other livestock kept in significant numbers included goats (42.3%) and sheep (30.1%).

### Table 4.4 Types and average numbers of livestock kept by county

<table>
<thead>
<tr>
<th>County</th>
<th>Land size (acres)</th>
<th>Rabbits</th>
<th>Cattle</th>
<th>Sheep</th>
<th>Goats</th>
<th>Poultry</th>
<th>Pigs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meru</td>
<td>2.1±2.0</td>
<td>14.3±12.4</td>
<td>3.2±2.4</td>
<td>3±1.5</td>
<td>3.9±2.9</td>
<td>13.1±21.0</td>
<td>1.6±0.6</td>
</tr>
<tr>
<td>Nyeri</td>
<td>1.5±1.4</td>
<td>12.6±14.8</td>
<td>2.3±1.5</td>
<td>2.6±1.6</td>
<td>3.6±2.5</td>
<td>12.0±28.2</td>
<td>6.0±2.8</td>
</tr>
<tr>
<td>Taita</td>
<td>1.8±1.7</td>
<td>7.5±8.1</td>
<td>4.1±8.4</td>
<td>5.2±4.6</td>
<td>7.6±12.7</td>
<td>10.4±9</td>
<td>2.0±0</td>
</tr>
<tr>
<td>Kiambu</td>
<td>1.1±1.8</td>
<td>18.2±14.9</td>
<td>3.7±2.6</td>
<td>3.9±2.0</td>
<td>8.9±1.6</td>
<td>30.6±6.0</td>
<td>16.7±3.5</td>
</tr>
<tr>
<td>Nakuru</td>
<td>3.0±3.3</td>
<td>10.1±10</td>
<td>3.6±3.2</td>
<td>6.8±5.9</td>
<td>3.5±2.2</td>
<td>10.4±9.9</td>
<td>--</td>
</tr>
</tbody>
</table>

It is expected that as farm holdings decline, the pressure on animal feed resources increases and farmers would keep chicken and other small stocks which require less feed. From the Table 4.4, the farmers in Kiambu not only kept more rabbits (18.2±14.9) but also more poultry (30.6±6.0), goats (8.9±1.6) and pigs (16.7±3.5), livestock that can be kept intensively on smaller pieces of land.

### 4.2 Purpose of keeping rabbits

The principal objectives for keeping rabbits are shown in Fig 4.5. Rabbits were mainly kept as a source of income and food for home consumption (89.6%), with few farmers keeping them as pets and for manure (10.4%).
The purpose of keeping rabbits did not significantly affect numbers of rabbits kept. It would have been expected that those who kept rabbits for commercial purposes would have kept significantly higher numbers of rabbits than the subsistence farmers. Oseni et al. (2008) and Abu et al. (2008) reported that 60% of Nigerian farmers surveyed kept rabbits mainly as a source of food, but occasionally sold them for income. In the current study, although the farmer stated main objective of keeping rabbits was income generation (Fig 4.5), only 45% of the rabbit keepers had sold rabbits. However, during the same period 73.6% of respondents had slaughtered rabbits for home consumption suggesting that the second objective of keeping rabbits had been realized.
The objectives for which rabbits were kept differed across the counties (Figure 4.6). Kiambu and Nakuru counties had the highest proportions of respondents (82.5% and 86.2% respectively) who kept rabbits principally for income generation, which could be attributed to the proximity to the urban centres with a potential market for the rabbits. In Taita and Nyeri counties, most farmers, (61.4% and 58.60% respectively) kept rabbits mainly for home consumption which could be attributed to scarce marketing opportunities and/or limited exposure to the potential of the rabbit as an income earner. Taita County had the highest proportion of farmers keeping rabbits as pets (37%), which may explain the lower levels of production intensity.

The average length of time the farmers had reared rabbits ranged from 0.5 to 17 years, with a majority 72 % being less than 3 years (Table 4.5). This upsurge of new farmers confirms reports that there has been a renewed interest in rabbit farming in Kenya as reported by Borter and
Mwanza, (2010). Analysis of variance showed that there was no significant (p=0.3856) difference between counties in period that the farmers had kept rabbits.

Table 4.5 Period respondents had reared rabbits (n=300)

<table>
<thead>
<tr>
<th>Time (years)</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>31</td>
<td>10.4</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>33.3</td>
</tr>
<tr>
<td>3</td>
<td>85</td>
<td>28.3</td>
</tr>
<tr>
<td>4</td>
<td>41</td>
<td>13.6</td>
</tr>
<tr>
<td>5</td>
<td>21</td>
<td>7.0</td>
</tr>
<tr>
<td>&gt;6</td>
<td>22</td>
<td>7.0</td>
</tr>
</tbody>
</table>

4.3 Rabbit breeds and breeding practices

The rabbit breeds kept by the farmers and their proportions are shown in Fig 4.7. The three most common breeds were New Zealand White (29%), Cross breeds (24%) and Californian white (12%). The New Zealand white and Californian white have also been reported to be most popular breeds for meat production in other parts of the world, mainly because of their good growth characteristics and a high meat: bone ratio (Lebas et al., 1997), McNitt et al., 2000), Mailafia et al, (2010). Among the crossbreds, the most common were the New Zealand and Californian rabbit crosses at 25% followed by Chinchilla and New Zealand White (20%). Thus, the common crossbreds consisted of the three breeds that were most available on farms; New Zealand white, Californian and Chinchilla (Figure 4.7).
Figure 4.7 Rabbit breeds and proportions kept by farmers in study area (n=300).

NZW=New Zealand White, CW= Californian, FG=Flemish giant, CC=Chinchilla, FEP=French lop, DU=Dutch, ER=English rabbit, CB=Checkered back, ANG=Angora, CRSS=Crossbred, KW=Kenyan White.

Breed preference was attributed to several reasons as shown in Table 4.6. The larger breeds such as the Flemish giant and the French lop had high levels of preference for their high carcass weights at slaughter therefore high market prices. New Zealand white, the most common rabbit breed, was preferred mainly for its good mothering ability and the number of offsprings per litter.
Table 4.6 Reason for rabbit breed preference

<table>
<thead>
<tr>
<th>Breed</th>
<th>NZW</th>
<th>CW</th>
<th>FG</th>
<th>CC</th>
<th>FEP</th>
<th>DU</th>
<th>CW x NZW</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>94</td>
<td>50</td>
<td>23</td>
<td>34</td>
<td>16</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>Most available breeding stock</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Good mothering ability</td>
<td>43.6</td>
<td>38.0</td>
<td>17.4</td>
<td>38.2</td>
<td>18.8</td>
<td>26.7</td>
<td>7.7</td>
</tr>
<tr>
<td>High carcass weight at slaughter</td>
<td>28.7</td>
<td>42.0</td>
<td>86.9</td>
<td>26.5</td>
<td>100</td>
<td>33.3</td>
<td>38.5</td>
</tr>
<tr>
<td>Many off springs per litter</td>
<td>36.2</td>
<td>34.0</td>
<td>13.0</td>
<td>29.4</td>
<td>25.0</td>
<td>6.7</td>
<td>7.7</td>
</tr>
<tr>
<td>Best as pet</td>
<td>12.8</td>
<td>10.0</td>
<td>0</td>
<td>20.6</td>
<td>-</td>
<td>20.0</td>
<td>7.7</td>
</tr>
<tr>
<td>Breed preferred by other farmers</td>
<td>15.9</td>
<td>8.0</td>
<td>8.7</td>
<td>11.8</td>
<td>0</td>
<td>6.7</td>
<td>7.7</td>
</tr>
<tr>
<td>High disease resistance</td>
<td>10.6</td>
<td>4.0</td>
<td>8.7</td>
<td>11.8</td>
<td>0</td>
<td>20.0</td>
<td>15.4</td>
</tr>
<tr>
<td>High market price</td>
<td>14.9</td>
<td>16.0</td>
<td></td>
<td>11.8</td>
<td>43.7</td>
<td>0</td>
<td>23.1</td>
</tr>
<tr>
<td>Eats a wide variety of forages</td>
<td>2.1</td>
<td>2.0</td>
<td>0</td>
<td>2.9</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>High growth rate</td>
<td>2.1</td>
<td>10.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Beauty</td>
<td>13.8</td>
<td>16.0</td>
<td>0</td>
<td>5.9</td>
<td>6.2</td>
<td>26.7</td>
<td>15.4</td>
</tr>
</tbody>
</table>

NZW=New Zealand White, CW= Californian, FG=Flemish giant, CC=Chinchilla, FEP=French lop, DU=Dutch, CWXNZW=Californian and New Zealand White crossbred.

Californian white was also preferred for its good mothering ability (38%) and high carcass weight (42%). The perceived desirable traits: large litter size and good mothering ability of New Zealand white and Californian rabbit; the high carcass weights by Flemish giants and French lop, were also reported by Lebas et al., (1997) and by McNitt et al., (2000).

The rabbit breed preference varied across the counties as shown on the Table 4.7.
Table 4.7 Main Breed preference by County

<table>
<thead>
<tr>
<th>County</th>
<th>NZW</th>
<th>CW</th>
<th>FG</th>
<th>CC</th>
<th>FEP</th>
<th>DU</th>
<th>CWXNZW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meru</td>
<td>42.4%</td>
<td>13.6%</td>
<td>10.0%</td>
<td>13.5%</td>
<td>3.4%</td>
<td>5.1%</td>
<td>8.5%</td>
</tr>
<tr>
<td>Nyeri</td>
<td>20.0%</td>
<td>48.3%</td>
<td>6.7%</td>
<td>5.0%</td>
<td>1.8%</td>
<td>1.7%</td>
<td>3.3%</td>
</tr>
<tr>
<td>Taita</td>
<td>33.9%</td>
<td>6.7%</td>
<td>0.0%</td>
<td>22.0%</td>
<td>0.0%</td>
<td>8.5%</td>
<td>3.4%</td>
</tr>
<tr>
<td>Kiambu</td>
<td>27.6%</td>
<td>12.1%</td>
<td>17.2%</td>
<td>8.0%</td>
<td>17.2%</td>
<td>5.2%</td>
<td>5.2%</td>
</tr>
<tr>
<td>Nakuru</td>
<td>42.4%</td>
<td>12.0%</td>
<td>5.1%</td>
<td>15.0%</td>
<td>6.8%</td>
<td>11.7%</td>
<td>1.7%</td>
</tr>
</tbody>
</table>

NZW=New Zealand White, CW= Californian FG=Flemish giant, CC=Chinchilla, FEP=French lop, DU=Dutch, CWXNZW=Californian and New Zealand White crossbred.

From the Table 4.7, New Zealand white and Californian white preference was higher in all the counties compared to the other breeds, explaining their presence in most of the farms. Preference for the large breeds, Flemish Giant and French lop was highest by farmers in Kiambu, This is probably due to the fact that rabbits were kept mainly for commercial purposes in the county and these breeds fetched higher market prices. The farmers did not always keep their preferred breeds indicating that a shortage of breeding animals may have forced many to keep whatever breed was available to them.

The average purchase price for mature breeding does and bucks for different breeds ranged from Ksh. 930 for the cross bred to a high of Ksh. 3315 for the Angora (Table 4.8). For the more common New Zealand White, the price ranged from Ksh. 100 to Ksh. 3000 with an average of Ksh. 1880. Immature breeding rabbits of the Dutch retailed at an average of Ksh. 800 while Chinchilla sold at Ksh. 900. It was noted that the price for Flemish Giant for breeding was high averaging Ksh. 2850 probably due to its larger mature weight of 5 to 7 Kg. The high price paid
for the Angora mostly in Kiambu, a small breed kept mainly for fur and not common in Kenya may reflect its novelty. The large price disparities within the breeds may reflect a poor pricing mechanism and/or market structure. The costs of the breeding stocks varied across the counties as shown in Table 4.8. In general the prices for most breeds tended to be higher in Kiambu followed by Nakuru and were lowest in Taita. This may indicate a higher demand for breeding stock in Kiambu compared to the rest of the counties. This harmonizes with the earlier findings in this study which suggested that rabbit production was more developed and more commercialized in Kiambu than in the other counties.

Table 4.8 Costs (Kenya shillings) of breeding stock in different counties

<table>
<thead>
<tr>
<th>Breed</th>
<th>Meru</th>
<th>Nyeri</th>
<th>Taita</th>
<th>Kiambu</th>
<th>Nakuru</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand white</td>
<td>1350±670</td>
<td>1870±1700</td>
<td>820±135</td>
<td>2900±890</td>
<td>1080±970</td>
</tr>
<tr>
<td>Californian White</td>
<td>1830±930</td>
<td>1255±920</td>
<td>760±890</td>
<td>2020±1020</td>
<td>2250±1780</td>
</tr>
<tr>
<td>Flemish Giant</td>
<td>2500±700</td>
<td>2200±1320</td>
<td>--</td>
<td>2700±900</td>
<td>2900±2300</td>
</tr>
<tr>
<td>French lop</td>
<td>1100±705</td>
<td>890±900</td>
<td>--</td>
<td>750±660</td>
<td>400±280</td>
</tr>
<tr>
<td>Chinchilla</td>
<td>460±320</td>
<td>360±370</td>
<td>480±130</td>
<td>2400±1240</td>
<td>830±780</td>
</tr>
<tr>
<td>Angora</td>
<td>--</td>
<td>--</td>
<td>1100±1172</td>
<td>3160±760</td>
<td>1500±970</td>
</tr>
<tr>
<td>Crossbred</td>
<td>750±280</td>
<td>1200±380</td>
<td>230±70</td>
<td>2000±700</td>
<td>600±490</td>
</tr>
<tr>
<td>Dutch</td>
<td>660±720</td>
<td>1200±35</td>
<td>600±940</td>
<td>2100±1095</td>
<td>870±230</td>
</tr>
</tbody>
</table>

Average age of bucks at first service was 3.4 months and that of the doe was 4.3 months. It was recommended by Lebas et al., (1997) that rabbits be bred when they attain 80-85% of their mature weight. The age at which this is attained is dependent on feeding level but has been
reported as 6-7 months with the males maturing one month later than females (Agricultural alternatives, 2008; https://arban.net/faq.htm). As such, the farmers in the study sites may be breeding their rabbits too early, a practice which has been reported to negatively impact on growth and development of the animals affecting their ultimate productivity (Agricultural alternatives, 2008)

However, the average kindling interval was recorded as 82.6 days with an average litter size of 7.2 at birth and 5.4 at weaning. The number of the young weaned per doe was close to the 5.8 reported by Adu et al, (2005), and within the range of 4-6 reported by Abu et al., (2008) in studies describing rabbit production in Nigeria. The kindling interval of 82.6 days was longer than the 77 days reported by Onifade et al., (1999) and 45 days recommended by American rabbit breeders association (2012) (https://arban.net/faq.htm).

The majority (42.5%) of the farmers obtained their breeding bucks through exchanging with neighbors, 32.6% used both own and bought in bucks, 19.1% used bought in bucks and 6.8% selected breeding bucks from own stock. The choice of the source of the breeding stock depended mainly on the reliability of the source. The farmers were generally aware of the need to replace the breeding bucks to avoid the deleterious effects of inbreeding. However the regularity with which this was done varied with (27%) doing so between 1-2 years, 25.5% between 0-1 years and 22.5% after 2 years. Some (25%) of the farmers did not have a regular interval at which they replaced their breeding bucks (Table 4.9).
Table 4.9 Frequency of breeding buck replacement (n=300)

<table>
<thead>
<tr>
<th>Period of replacing buck</th>
<th>Farmer Proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between 1-2 years</td>
<td>27.0%</td>
</tr>
<tr>
<td>Between 0-1 years</td>
<td>25.5%</td>
</tr>
<tr>
<td>Between 0-1 years</td>
<td>22.5%</td>
</tr>
<tr>
<td>Irregular intervals</td>
<td>25.0%</td>
</tr>
</tbody>
</table>

The buck replacement from neighbors may not rule out inbreeding as rabbits reared by most farmers in Kenya are suspected to have originated from the same source, the National Rabbit Multiplication Centre, Ngong. Due to lack of breeding records, avoidance of inbreeding was difficult. The non existence of organized rabbit breeding programs is a characteristic of the developing countries (Onifade, 1999) and could be the reason why rabbit productivity is still low in these countries. This therefore, requires that efforts are made to develop a rabbit breeding program as well as promote a record keeping culture among farmers to enhance rabbit production in Kenya.

4.4 Rabbit housing

All the respondents housed their rabbits but the housing type differed (indoor to outdoor, caged to loose, single to multilevel) as shown in Figs 4.8, 4.9 and 4.10.

Caged housing was the most common (87%) compared to loose housing practiced by 13% of rabbit keepers. Rabbit cages have been reported to facilitate close monitoring of animals and also ease disease control when compared to loose group housing (Animal Research Review
Panel, 2003). The popularity of caged housing observed in this study could be as a result of these advantages.

![Figure 4.8 Rabbit housing system in the study areas.](image)

The cages were mostly at levels 1 (67%) and 2 (26%). A high proportion of 1 level tier cage housing system was also reported by Oseni et.al. (2008) among rabbit farmers in Nigeria, and attributed this to ease of design and low costs of construction. The proportionate cage tier level use by county is shown in Figure 4.9.
Multiple tiered cages were more common in Kiambu, Nyeri and Nakuru counties, probably a reflection of the higher human population densities and thus lower *per capita* landholdings compared to Meru and Taita counties (Figure 4.4). Furthermore, the use of two or higher tier cage level could also be a reflection of the rabbit numbers kept (Figure 4.10) and scale of rabbit farming in terms of higher investment and high level of management. In Europe where large scale rabbit production is common, the cages are arranged in three or four tiers in an attempt to house more rabbits within a small area (FAOSTAT, 2010). In the current study there was a significant increase (*p*<0.0001) in multiple tier cage housing as the number of rabbits kept in a farm increased (Figure 4.10).
Despite the benefits of using caged housing, some (13%) farmers opted to use loose grouped housing. Loose group housing was used by majority (56.8%) of the rabbit farmers in Taita. Other findings in this study suggested that rabbit enterprises in Taita were of low investment level compared to those in Kiambu, Meru and Nyeri counties. In the latter counties, rabbits were mainly kept for commercial purposes while in Taita rabbits were kept for non-commercial purposes; home consumption and as pets (Figure 4.6). Loose group housing is cheaper both in terms of construction and maintenance, and is mostly used where production systems are of low investments (Animal Research Review Panel, 2003).

Different materials were used to construct the rabbit hutches. The roof was mainly made of iron sheets (95.3%), walls made of either wood (28%) or wood and wire mesh (30%) and the floor mainly wooden (67%). The use of these materials, especially wood, to construct rabbit hutches, agrees with Hungu et al., (2013) and Owen, et al., (2008) in similar studies in Kenya and
Nigeria, citing the main reasons of their use as being affordability and availability. Use of locally available construction materials for rabbit housing is amenable to participation of resource poor farmers in rabbit production as suggested by Lukefahr et al., (2000) in a study in Cameroon where rabbits were used to empower women and children. However, Schiere, (2004) encouraged the use of wire mesh rather than wood for the floor so that the maze can let down the droppings reducing disease incidences. This is because a wooden floor would soak up urine and ammonia will accumulate in the hutch (www.howtodothings.com/pets-and-animals/a2426-how-to-design-and-build-a-rabbit-hutch.html) and is also difficult to keep clean.

An average housing floor area of 4162 cm$^2$ was allowed per mature rabbit (range: 720 to 45000 cm$^2$). The majority (63.9%) of the farmers used spacing of 1000-5000 cm$^2$ per rabbit. Those with less than 1000 cm$^2$ were 13% while farmers allowing more than 5000 cm$^2$ per rabbit were 23.1%. This showed that majority of the farmers used the correct space allowance of between 1800 cm$^2$ for rabbits above 12 weeks of age to 4500 cm$^2$ per breeding rabbit as recommended by Standing Committee on Agriculture and Resource Management (SCARM) (1991).

Feeding/watering equipments were mainly plastic containers for watering (77.7%) while fired clay dishes and wooden troughs were used as feeders by 33.5% and 30.5% of respondents respectively. Regular use of a forage rack is important as it has been shown to significantly increase litter size at weaning since the rabbits do not take feed contaminated with faeces and urine (Brzozowski et al., 1994) as opposed to rabbits feeding directly from the floor. The use of plastics, tin cans, or similar-type open waterers are discouraged since they are unsanitary. Rabbits tend to soil their water which would increase incidences of gastrointestinal diseases. Metallic feeders and automatic nipple-type water system are recommended (www.fao.org/docrep/t1690E/t1690e08.htm). The use of plastics winterers by the majority
farmers is unsuitable as these are difficult to clean and could be contributing to high disease rates.

4.5 Rabbit feeds and feeding management

The types of feed commonly fed to rabbits in the study areas are shown in Fig 4.11. Only 38.3% of the farmers fed their rabbits on locally available forages/weeds as the sole diet while 57.0% fed a combination of locally available forages and purchased concentrates. A very small proportion of 2.4% fed their rabbits on purchased concentrates only, 1.1% a combination of locally available forages and homemade concentrates and 1% on homemade concentrates only.

![Graph showing the proportion of farmers using different feed types and rabbit numbers kept.]

**Figure 4.11 Type of feeds offered to the rabbits in the study areas**

LOCAFOR=locally available forages, PURCONC=purchased concentrates, HMECONC=Homemade concentrates, LOCAFOR & PURCONC=locally available forages and purchased concentrates, LOCAFOR & HMECONC=locally available forages and homemade concentrates
These findings were similar to those of Hungu et al., (2013) and Cheeke (1986) who in an attempt to establish the potentials of rabbit production in tropical and subtropical countries reported that rabbits in the developing countries were mainly fed on a forages with little or no supplementation. However, this was different in the developed countries where rabbits were mainly fed on commercial feeds and that these were compounded to increase rabbit growth rate and reduce labor requirements (Walsingham, 1972, FAOSTAT, 2010). Where supplements were offered to the forage/weeds diets, the level of supplementation ranged from 20g to 150g with an average rate of 70g concentrates per rabbit per day. This level of supplementation was higher than the minimum recommended level of 25 grams per day under production systems where forages constitute a greater proportion of the rabbit diet (www.therabbithouse.com/diet/rabbit-food.asp). However most of the farmers did not supplement the rabbits daily but rather as and when concentrates were available. The intensity of feeding would be expected to reflect on the intensity of production and indirectly the purpose for which the rabbits are kept. Thus, producers with lower numbers and those keeping rabbits mainly for home consumption and/or pets would have lower levels of investment in feeding the rabbits. The type of feed used therefore differed across the counties in harmony with earlier discussed indicators of production intensity as shown in Table 4.10.
Table 4.10 Type of feeds offered to the rabbits per county

<table>
<thead>
<tr>
<th>COUNTY</th>
<th>LOCAFOR R N=112</th>
<th>%</th>
<th>PURCONC N=2</th>
<th>%</th>
<th>LOCAFOR &amp; PURCONC N=169</th>
<th>%</th>
<th>HMECONC N=4</th>
<th>%</th>
<th>LOCAFOR &amp; HMECONC N=13</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meru</td>
<td>10</td>
<td>17.0</td>
<td>0</td>
<td>0</td>
<td>48</td>
<td>81.4</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3.4</td>
</tr>
<tr>
<td>Nyeri</td>
<td>17</td>
<td>28.3</td>
<td>0</td>
<td>0</td>
<td>40</td>
<td>66.6</td>
<td>1</td>
<td>1.7</td>
<td>2</td>
<td>3.4</td>
</tr>
<tr>
<td>Taita</td>
<td>44</td>
<td>75.8</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>22.4</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>5.1</td>
</tr>
<tr>
<td>Kiambu</td>
<td>7</td>
<td>12.1</td>
<td>2</td>
<td>3.5</td>
<td>47</td>
<td>81.0</td>
<td>1</td>
<td>1.7</td>
<td>3</td>
<td>5.1</td>
</tr>
<tr>
<td>Nakuru</td>
<td>34</td>
<td>57.6</td>
<td>0</td>
<td>0</td>
<td>21</td>
<td>35.5</td>
<td>2</td>
<td>3.4</td>
<td>3</td>
<td>5.1</td>
</tr>
</tbody>
</table>

LOCAFOR=locally available forages, PURCONC=purchased concentrates, HMECONC=Homemade concentrates, LOCAFOR & PURCONC=locally available forages and purchased concentrates, LOCAFOR & HMECONC=locally available forages and homemade concentrates
Locally available forages without supplementation were most commonly fed in Taita (75%) and Nakuru (57.6%). Use of a combination of locally available forages and purchased concentrates was common in Meru (81.4%), Kiambu (81%) and Nyeri (66.6%). The purchased concentrates were mainly in the form of pellets. These results reflected the low input into feeding rabbits by farmers in Taita who kept an average of 8 rabbits mainly for home consumption. However, in Kiambu, the feeding system reflected a higher level of inputs in tandem with the higher production intensity in the county with farmers owning an average of 18.2 rabbits, mainly as a source of income (32%). The important local forages used as feed are listed in Table 4.11. The five mostly used forages were kales (62%), cabbage leaves (59.7%), sweet potato vines (51.4%), black jack (50.7%) and gallant soldier (50.3%). The fact that the main forages used as rabbit feeds were either crop by-products; cabbage leaves and sweet potato vines, or weed species; black jack and gallant soldiers, suggests low levels of commercialization of the enterprise.
Table 4.11 Forages and weeds commonly used as rabbit feeds

<table>
<thead>
<tr>
<th>Feed</th>
<th>% Users</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forages</strong></td>
<td></td>
</tr>
<tr>
<td>Kales (Brassica oleraceae var acephala)</td>
<td>62</td>
</tr>
<tr>
<td>Cabbage (Brassica oleracea var capitata)</td>
<td>59.7</td>
</tr>
<tr>
<td>Sweet Potato vines (Ipomoea batatas)</td>
<td>51.4</td>
</tr>
<tr>
<td>Rhodes grass (Chloris gayana)</td>
<td>27.3</td>
</tr>
<tr>
<td><strong>Weeds</strong></td>
<td></td>
</tr>
<tr>
<td>Gallant Soldier (Galinsoga parviflora)</td>
<td>50.3</td>
</tr>
<tr>
<td>Black Jack (Bidens pilosa)</td>
<td>50.7</td>
</tr>
<tr>
<td>Wandering Jew (Commelina ensifolia)</td>
<td>29.8</td>
</tr>
</tbody>
</table>

In Taita county, the main forages used as rabbit feeds were Kales (80%) and Cabbage leaves (73%) while weeds such as gallant soldier (Galinsoga parviflora) was least used (23.6%). In contrast the latter was the most commonly used forage in Nyeri (85%) and Meru (75%). Sweet potato vines were also widely used as feed by farmers in Nyeri (81%) but least in Taita (20.6%). Black jack (Bidens pilosa) was most common in Nakuru (70.8%) and least in Nyeri (35%). Other feed types and forages used to a lesser extent in the various counties are listed in Annex B.

The choice of forage/weed for feeding of rabbits was dependent on several factors (Figure 4.12). The main factor for choosing forage was availability (81%). This was in agreement with the findings of Aduku and Olukosi, (1990) who reported that feeding practices varied widely in the tropics, depending on the types of feed material that were available locally. Other reasons given for use of the different forages were; high palatability to the rabbits indicated by high intakes (41.6%), perceived to be of high nutritive value (16.3%), high biomass yield (3.3%) and drought
tolerance (3%). Drought tolerance was an important consideration especially in the lowlands of Taita where inadequacy of rains posed a challenge. The data shows that few farmers (16.3%) considered the nutritional value of the forages as important in the choice of forage. Lukefahr, (1998) working in Uganda also observed that most farmers fed the rabbits on sweet potato vines only due to their ready availability rather than nutritional consideration. In conclusion this author indicated that there was a need to train farmers on how to balance rabbit diets.

![Figure 4.12](image.png)

**Figure 4.12 Factors affecting the choice of forage fed to rabbits.**

Majority of the farmers (71%) reported periodic forage scarcity during the dry season with few (29%) during the wet season. While feed scarcity during the dry season is common, it was surprising that some farmers experienced a shortage of feed in the wet season. This might be explained by the fact that some of the forages used as rabbit feed such as Black jack and Gallant soldier are classified as weeds. Thus, in the wet season the fields under crops would have been
weeded in preparation for planting. This would translate to a shortage of such forages. Of those who experienced periodic feed inadequacies, only 27.7% preserved forages during the period of plenty as hay. This is an indication of lack of preparation for the dry season which may reflect a lack of information on feed conservation and/or a generally low availability of forages and therefore no surpluses to conserve. The few farmers who preserved feed kept significantly (P<0.001) higher numbers of rabbits (20.4) compared to those not conserving (9.7). This may imply that those with more rabbits faced a more acute feed challenge compared to those with fewer rabbits and/or that such farmers were more commercially oriented and aware of the need for evening out feeding of the rabbits and productivity.

Water was offered ad libitum by 66.7% of farmers, 13% at irregular intervals while 20% did not offer any water as they did not think that water was essential to rabbits (Fig 4.13). Water deprivation especially of newly weaned young rabbits has been used to control feed intake and reported reduce mortality rates (Adjare, 2003; Verdelhan et al., 2004; Bovera et al., 2013). However, Bawa et al., (2006) reported that water deprived growing rabbits had lower growth rates and higher mortality rates These authors concluded that for optimum performance growing rabbits should have access to water for at least 12 hours every day. These differences in results of water deprivation may be due to differences in environmental conditions under which the rabbits are kept. In the study of Bawa et al., the results may reflect the high temperatures and relative humidity under which the experiment was conducted. These are factors that would increase water requirements and may explain the adverse effects of water deprivation to the growing rabbits.
Majority (76.3%) of farmers wilted the forages prior to feeding the rabbits. Of those who wilted, (48%) did so to avoid diarrhea and 11% to avoid bloat, indicating their awareness of the relationship between forage moisture content and these conditions. Others wilted the forage because the rabbits consumed more of wilted forage (2.9%), copied from their neighbors (1.3%) or were directed to do so by the extension staff (1.5%). Of those who did not, 6% said the forages acted as a water source for the rabbits, 2.3% did not have time to wilt, 3% did not know why they needed to wilt the forages. Animals fed on high moisture forages are reported to have low dry matter intake and thus performance (Adjare, 2003). This author also reported that succulent forages are associated with high incidences of diarrhea especially in young rabbits, leading to death and that pregnant does are liable to miscarry when fed on such feeds. Succulent forages should therefore be wilted before feeding for optimal utilization by rabbits.

4.6 Rabbit diseases and health management.

Disease occurrence was a problem in a majority (76.7%) of the farms. Different types of conditions/symptoms, ranging from diarrhea to hind limb paralysis were reported (Fig 4.14).
Figure 4.14 Incidences of rabbit Disease/symptoms in the study areas (n=230)

PNMN=pneumonia, BLOT=Bloat, DIAR=Diarrhea, MNG=Mange, OPU=Oral and paw ulcerations, EARC=Ear canker, UNTH=Unthriftiness, HLPA=Hind limb paralysis

Pneumonia mostly affected kits and weaners, abdominal distension (bloat) and diarrhea mainly affected weaners, mange, ear canker and hind limb paralysis mostly affected the adults, oral and paws ulcerations, unthriftiness, dullness/inappetance affected all ages. Schiere, (2004) observed that gastrointestinal conditions were the main cause of mortalities in rabbits followed by respiratory conditions such as pneumonia. Additionally, he observed that skin conditions were common in rabbits but would rarely cause mortalities if managed well and in good time. Aleri et al., (2012) summarizing the conditions of rabbits presented to University of Nairobi veterinary clinic reported ear canker to be the most prevalent followed by gastrointestinal conditions such
as diarrhea and bloat, then respiratory conditions mostly pneumonia while skin conditions such as mange were rare. The findings in the current study agree with these literature reports.

The main diseases/symptoms, encountered in respective counties were as shown in Fig 4.15.

![Graph showing disease/symptoms incidences in different counties]

**Figure 4.15 Rabbit diseases/symptoms by county**

There was a higher occurrence of pneumonia in Kiambu (21.8%) and Nakuru (41.6%) compared to Taita, Meru and Nyeri counties (Fig 4.15). Analysis based on rabbit numbers indicated that pneumonia incidences were strongly associated to the rabbit numbers kept (P=0.0009), as farmers who reported the condition kept an average of 20.6±15 rabbits while those who did not report the condition kept 11.9±12 rabbits. As such, the incidence rate could be associated to a higher level of intensifications in these farms resulting in inadequate ventilation, sanitation, and nesting in the hutches (Mercks, 2010). Owen (1976), in a study on rabbit diseases reported that the level of intensification had an impact on disease levels. This was explained by the fact that in
large operations, management quality per animal may be inferior and close confinement may mean greater likelihood of rapid disease outbreaks especially the digestive and respiratory conditions.

Almost all cases of mange (90.2%) were reported in Taita County. This could be associated with the altitude and thus prevailing environmental conditions, where rabbits kept in the lowlands of Taita had higher incidences compared to the highlands such as Kiambu, Meru and Nyeri. Similar results were recorded in Ethiopia by Enquebaher and Etsay (2009) in an epidemiological study of mange and other skin conditions of small ruminants where mange incidences were observed to be higher in the lowlands compared to the highlands. Mites and dermatophytes causing skin conditions are likely to be found where the parasites thrive well, mostly in hotter and drier environments as documented by Cafarchia et al., (2010). Therefore, Taita being in a semi arid environment could have facilitated the propagation of the disease condition. This condition also could also be attributed to poor hutch hygiene especially since, as stated earlier in Section 4.4, the rabbits were mostly under loose group housing in Taita.

Occurrence of ear canker was higher in Kiambu (40.6%) and Nyeri (28.1%) counties. Occurrence of this condition was also closely associated to the level of intensification as reflected in numbers of rabbits kept. Kiambu had the highest intensification and those reporting the condition kept an average of 63.9 rabbits while those who did not kept an average of 15.3. Bedding materials also seemed to have played a role since 72.7% of the farmers encountering the condition had soiled and less frequently changed bedding material.

When the disease/symptom were manifested, the farmers either administered treatment on their own (48%) or took no action (31.4%) while 20.6% sought assistance of animal health professionals and/or more experienced fellow farmers. The course of action was mainly
determined by: Severity of the disease and the number of rabbits affected (51.3%), knowledge on disease management (16.1%), availability of money (14.7%), availability of veterinary services and drugs (9%) or the advice given by the extension officers (3.3%).

In spite of the high incidences of diseases, only 43% of the farmers had carried out any disease control/treatment related activities during the preceding period of 6 months. Of those who had practiced disease control and/or treatment, 75% used modern drugs, 17.1% used indigenous knowledge/drugs while 7.9% used a combination of both.

The treatments based on indigenous knowledge included using plants known to have medicinal value such as Aloe vera, Mexican marigold (Tagetes minuta), Lantana camara, mnyinya (Launaea cornuta), and msisina (Albizia harveyi E. Fourn). Used engine oil/kerosene was also used by some farmers to control skin conditions/lesions. The use of used engine oil and kerosene to treat skin conditions such as mange was also observed by Adu et al., (2008), while use of the Mexican marigold for external parasite control in Kenya has been reported (The organic farmer, 2007). The effectiveness of indigenous medicine in treating livestock conditions such as coccidiosis, diarrhea and mange have been reported in other developing countries such as Cameroon (United Nations Educational Scientific and Cultural Organization (UNESCO), 2003). The reasons for their use were high cost of/and unavailability of modern drugs compared to indigenous 'medicines' which were found locally in the bush or grown in the gardens by the farmers.

Access to information on rabbit diseases was easier in Nyeri (29.5%), Meru (20.2%) and Kiambu (20.2%) and least in Nakuru (14%) and Taita (16%) counties. As reported earlier (Figure 4.4) respondents in Kiambu kept more rabbits per household (18.2). In response to what would be expected to be greater farmer demand, veterinary services and modern drugs were most readily
available in Kiambu and least available in Taita and Nakuru where rabbit keeping was mostly small scale with an average of 7.5 and 10.1 rabbits per household respectively. The preferred source of information on rabbit disease management was varied (Fig 4.16).

![Figure 4.16 Source of information for management of rabbit diseases (n=300).](image)

**Figure 4.16 Source of information for management of rabbit diseases (n=300).**

*FELLFARM= Fellow farmers, ANMHEXP= Animal health experts, GOKEXT= Government extension officers, FIELDD= Field days, NGOREPS= Nongovernmental organization representatives, INTNT= Internet.*

The results showed that the preferred source of information on rabbit disease management was mainly (68%) from non-professionals. This may reflect either unavailability of such professionals or a low value placed on the rabbits thus unwillingness of the farmer to call the professional for whom there may be expenses. Schiere (2004), describing rabbit production in the tropics cited unavailability of both veterinary drugs and experienced animal health experts for rabbit diseases as a hindrance to rabbit farming. It is also apparent from figure 4.6 that most farmers obtained information from fellow farmers than from any other sources probably because information from this source was readily available and is usually free of charge.
4.6 Consumption and marketing of rabbit meat

Of the 300 rabbit keeping respondents, only 26.9% consumed rabbit meat at least once every two months (regular consumers) while 28% had not consumed any. The other 45.1% were irregular consumers who consumed rabbit meat at intervals greater than two months, an indication that rabbit meat is not a regular part of the family menu even among rabbit keepers. For the non rabbit keeping farmers, regular rabbit meat consumers were fewer at 20%, implying that keeping rabbits encouraged rabbit meat consumption to some extent. A larger proportion (52.8%) of regular rabbit meat consumers were found in Kiambu, followed by Nakuru (43.4%), Meru (34.8%) while Taita had the lowest (18.5%). The observation that most respondents were irregular rabbit meat consumers was in agreement with Luzobe, (1997) who reported that only 30% of Ugandans had ever consumed rabbit meat. Among the hindrances to rabbit meat consumption in Africa as reported by Sonandi et al. (1996) and Lukefahr (1998) are traditional beliefs and taboos. The higher proportions of regular consumers in Kiambu and Nakuru may reflect the fact that these areas are more urbanized and the residents probably less bound by traditions thus more readily accepted the meat. The main sources of rabbit meat consumed was from own stock (73.6%) and neighbors (12.5%) as shown in Fig 4.17.
Availability of rabbits and/or rabbit meat in the market would be a prerequisite to support consumption especially by non-rabbit keepers. Only 35.6% of the total respondents had sold their rabbits while 64.4% had not sold any in the preceding 12 months. The average numbers sold per farmer were 15 bucks, 12 does and 8 weaners. The most active outlet was farm gate (89%) (Table 4.12).

Table 4.12 Average numbers of rabbits sold through various outlets in study areas

<table>
<thead>
<tr>
<th>Rabbit Type</th>
<th>Farm gate</th>
<th>Hotel</th>
<th>Market</th>
<th>Collection centre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bucks</td>
<td>4.0±6.1</td>
<td>2.7±3.9</td>
<td>2.5±5.0</td>
<td>5.2±7.1</td>
</tr>
<tr>
<td>Does</td>
<td>4.6±8.7</td>
<td>1.6±2.8</td>
<td>2.3±4.5</td>
<td>2.6±4.6</td>
</tr>
<tr>
<td>Weaners</td>
<td>5.6±9.0</td>
<td>0.0±0</td>
<td>1.6±2.5</td>
<td>1±0</td>
</tr>
</tbody>
</table>
The low sales could be attributed to a number of reasons. First is lack of organized market evidenced by the great price variation for rabbits (Table 4.13). Adu et al., (2008), in a similar study in Nigeria reported that though markets for rabbit meat existed in Nigeria these were not well organized resulting in low sales. Second is the low consumer preference for rabbit meat when compared to other meats as was described by Hoffmann et al, (1992) in his study on the potential of rabbit meat marketing in Burkina Faso. This could be due to taboos forbidding rabbit meat consumption as observed by Lukefahr (1998) in Uganda. It is therefore important that the marketing system be improved and the population be sensitized on the benefits of eating rabbit meat.

The prices of various categories of rabbits through the different outlets are shown Table 4.13. Prices for mature stock at farm gate tended to be higher than those in other outlets. The higher prices at the farm gate could be attributed to the fact that majority of those buying rabbits did so mainly for breeding purposes.

**Table 4.13 Prices (Ksh) of various classes of rabbits sold through different outlets**

<table>
<thead>
<tr>
<th>Rabbit Type</th>
<th>Farm gate</th>
<th>Hotel</th>
<th>Collection centre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bucks</td>
<td>1090±870</td>
<td>620±315</td>
<td>450±70</td>
</tr>
<tr>
<td>Does</td>
<td>1100±925</td>
<td>800±0</td>
<td>500±0</td>
</tr>
<tr>
<td>Weaners</td>
<td>732±628</td>
<td>--</td>
<td>1000±0</td>
</tr>
</tbody>
</table>
The prices of the rabbits did not vary significantly across counties. However, prices were generally higher in Kiambu County and lower in Taita (Table 4.14). This may reflect the purpose for which the farmers kept the rabbits and thus the value attached to them. In Kiambu, the rabbits were mainly kept for commercial purposes compared to Taita where rabbits were mainly kept for home consumption and or as pets (Table 4.4). These price differentials may also reflect proximity to the market and therefore demand. Kiambu County is closest to a major urban centre, Nairobi, and thus the producers may be benefiting from the larger consumer body and higher demand compared to the other counties.

**Table 4.14 Prices of rabbits (Ksh) sold through various outlets in different Counties.**

<table>
<thead>
<tr>
<th>County</th>
<th>Weaners</th>
<th>Does</th>
<th>Bucks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meru</td>
<td>830±265</td>
<td>670±330</td>
<td>700±295</td>
</tr>
<tr>
<td>Nyeri</td>
<td>900±760</td>
<td>1155±711</td>
<td>740±270</td>
</tr>
<tr>
<td>Taita</td>
<td>435±600</td>
<td>833±1300</td>
<td>1350±1860</td>
</tr>
<tr>
<td>Kiambu</td>
<td>610±260</td>
<td>1360±970</td>
<td>1360±925</td>
</tr>
<tr>
<td>Nakuru</td>
<td>500±570</td>
<td>890±880</td>
<td>780±660</td>
</tr>
</tbody>
</table>
4.8 Challenges to Rabbit Production in Kenya

The main challenges faced by the rabbit farmers were as shown in Fig 4.18.

![Challenges faced by rabbit farmers](image)

**Figure 4.18 Challenges of rabbit farmers in Kenya (n=300)**

The four most important identified challenges to rabbit farming were: Lack of market for rabbits (51%), inadequate rabbit husbandry knowledge (28%), lack of quality breeding stocks (15.5%) and insufficient funds for expansion (11%). The absence of reliable sources for quality genetic stocks of rabbits, inadequate feeds, lack of funds and poor marketing system were also reported by Oseni et al., (2008) in a similar study in Nigeria as constraints to rabbit production. Lack of awareness on the benefits of rabbit meat has been noted as a factor that influences rabbit meat demand. This lack of awareness influenced the consumer preference for other meats such as
chicken over rabbit in Burkina Faso as observed by Hoffmann *et al.*, (1992). In addition to the poorly developed market, Schiere, (2004) noted unavailability of both veterinary drugs and experienced animal health experts to be a hindrance to rabbit farming.

Currently, there are efforts to commercialize rabbit farming by the Government of Kenya, initially through revival of the rabbit multiplication centres. However, these multiplication centres are few and due to high demand for rabbits, farmers are forced to wait for a long time eventually resorting to purchasing breeding stock from unreliable sources mostly other farmers. There is therefore need to enhance and expand the capacity of these centres.

Further, rabbit husbandry information and hutch plans are still not available in the Ministry of Livestock Development and if available, farmers do not get this information due to inefficient livestock extension services. Currently, there are agricultural credit facilities for farmers mostly offered by the commercial banks. However, the farmers still cannot access such funds due to high interest rates and probably inability to service the loans due to other production challenges such as rabbit diseases and poor marketing system.

Of the 100 non-rabbit keeping farmers interviewed, 45% had previously kept rabbits while 55% had not. Reasons for discontinuing rabbit keeping by those who had been rabbit keepers are shown in Table 4.15. Prominent as a reason for discounting rabbit keeping was lack of market, again emphasizing the need to promote and develop this as a pre-requisite of promoting rabbit production.
Table 4.15 Reason for discontinuation of Rabbit keeping.

<table>
<thead>
<tr>
<th>Reason for discontinuation of rabbit farming</th>
<th>Frequency (n=45)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of market</td>
<td>21</td>
<td>46.7</td>
</tr>
<tr>
<td>Lack of labor</td>
<td>9</td>
<td>20.0</td>
</tr>
<tr>
<td>Rabbits died</td>
<td>4</td>
<td>8.0</td>
</tr>
<tr>
<td>Poor breeds</td>
<td>4</td>
<td>8.0</td>
</tr>
<tr>
<td>Poor housing</td>
<td>3</td>
<td>6.0</td>
</tr>
<tr>
<td>Insufficient rabbit husbandry knowledge</td>
<td>2</td>
<td>4.4</td>
</tr>
<tr>
<td>Insecurity</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>Sold all the rabbits</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>Do not consume rabbit meat</td>
<td>1</td>
<td>2.3</td>
</tr>
</tbody>
</table>

The data in Figure 4.18 and Table 4.15 show that the rabbit farmer in Kenya faces several challenges that can be summarized as being related to marketing especially amplified by low rabbit meat consumption, animal health and diseases, breeding and feed availability. In spite of these challenges, the farmers, both rabbit and non-rabbit keepers, were generally optimistic and indicated that the industry has a bright future. Only 17% of the non-rabbit keeping respondents thought that it had no future. Those who were optimistic that rabbit industry had a future gave the reasons shown in Figure 4.19 for their optimism.
Figure 4.19 Reasons for optimism about the rabbit industry (n=100).

Majority of the optimistic non rabbit famers (75%) indicated that better knowledge among the population about the benefits of rabbit meat was contributing to growth of demand for rabbit meat hence better market and price for the rabbit and rabbit meat products. Other reasons included high prolificacy, rabbits need for less space and capital and the fact that rabbits produce high quality manure.
CHAPTER FIVE

5.0 CONCLUSIONS

1. Small scale rabbit production system (<10 does per household) is the predominant production system in study areas and is aimed at home consumption and income generation.

2. The predominant rabbit breeds in study areas were New Zealand white, cross breeds of Californian and New Zealand white and Californian white.

3. Availability of breeding animals is a constraint. The main source of breeding stock is from own flock or neighbors, increasing the chances of inbreeding.

4. Outdoor caged housing system was predominant. Tiered cages were predominant in high human population density counties.

5. The main feeds for rabbits were locally available forages and weeds with or without supplementation with concentrates.

6. Rabbit diseases are a challenge to the farmers in the study areas and the most common diseases encountered were gastrointestinal conditions followed by respiratory conditions.

7. Lack of market is a major constraint to rabbit production in Kenya and rabbit meat consumption was not a common practice even among the rabbit keepers.
5.1 RECOMMENDATIONS

1. Sensitization of the Kenyan population on the benefits of rabbit meat should be carried out which will go a long way in promoting the marketing of the rabbits, eventually resulting in an organized marketing system and enhanced production.

2. Farmers should be trained on proper rabbit husbandry practices such as breeding, feeding, disease management and record keeping so as to boost their rabbit production.

3. Better rabbit breeding stocks should be introduced to the farmers through registered breeders so as to avoid exploitation of the farmers and minimize inbreeding.

4. Research in rabbit feeding and disease management should be intensified and facilitated so as to improve rabbit production.
CHAPTER SIX

6.0 REFERENCES:


Baiomy, A.A. and Hassanien, H.H.M. (2011). Effect of Breed and Sex on Carcass Characteristics and Meat Chemical Composition of New Zealand White and


Factors influencing rabbit production on small farms in Poland. WAR 90 Factors influencing rabbit production on small farms in Poland.mht.


Husbandry of Animals kept by Resource-poor people in Developing countries. DFID Nottingham University Press.


APPENDIX A:

Questionnaire used in the study

Project: Characterization of Rabbit Production Systems in Kenya

Date of interview .................................................................................................................

Time begin .........................................................................................................................

Interviewer’s name ............................................................................................................

Supervisor’s name .............................................................................................................

Name of Household Head .................................................................................................

SPECIAL CODES

RA = REFUSAL TO ANSWER, ALWAYS CODED -7 (USED RARELY)

DK = DON'T KNOW, ALWAYS CODED -8 (USED RARELY)

NA = NOT APPLICABLE, ALWAYS CODED -9 (USED RARELY)
FARM DETAILS

Location of the farm

REGION-----------------------------------------------

COUNTY................................................................

DISTRICT..........................................................

DIVISION................................................................

LOCATION..........................................................

Village name..........................................................

GPS READING (Latitude..................) Longitude (..........................)

Size of the farm in acres .....................

RESPONDENTS DETAILS

1. Name of respondent..........................2. Phone number..........................

3. Gender (Tick as appropriate) MALE [ ] FEMALE [ ]

4. Age in years (Tick as appropriate)
   (1) LESS THAN 19 [ ]
   (2) 19 to 30 [ ]
   (3) 31 to 42 [ ]
   (4) 42 to 60 [ ]
   (5) OVER 60 [ ]

5. What is your relationship to the head of household?
   (1) = HEAD, (2) = SPOUSE, (3) = SON/DAUGHTER, 4 = SON OR DAUGHTER IN LAW, 5 = GRANDCHILD 6 = OTHER (E.G. WORKER, SERVANT)

6. What is the highest level of education reached by the household head?
   (1) NO FORMAL EDUCATION [ ]
   (2) PRIMARY SCHOOL [ ]
(3) HIGH SCHOOL [ ]
(4) MIDDLE LEVEL COLLEGE [ ]
(5) UNIVERSITY [ ]

7. How many people normally live and/or eat their meals together in this dwelling?

……………………………

8(a) Please tell me, how much does your household spend on all expenditure items (FOOD, CLOTHING, ENERGY) on typical month?"………………………………..KES

8(b) Of this [X KSH ABOVE], how much of it is devoted to food in a typical month?………………..%
C. PRODUCTION ON THE FARM: OWNERSHIP, SALES, ACQUISITION, DISEASES, SLAUGHTER LABOUR

<table>
<thead>
<tr>
<th>OWNERSHIP</th>
<th>b) SALES</th>
<th>c) PURCHASES</th>
</tr>
</thead>
<tbody>
<tr>
<td>During the past 12 months [since…], has any member of your household raised or owned…[_______]…?</td>
<td>How many [____] of all ages are owned by your household at present?</td>
<td>During the past 12 months [since…..] have members of your household sold any..[_____]..?</td>
</tr>
<tr>
<td>YES = 1</td>
<td>NO = 2</td>
<td>CURRENT NUMBER</td>
</tr>
</tbody>
</table>

Local Cattle
Improved Cattle
Sheep
Goats
Pigs
Poultry
Bee hives
Rabbits

<table>
<thead>
<tr>
<th>18</th>
<th>19</th>
<th>20</th>
<th>21</th>
<th>22</th>
<th>23</th>
<th>24</th>
<th>25</th>
<th>26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you receive any [ANIMAL] as a gift in the last 12 months?</td>
<td>How many [ANIMAL] did you receive as gifts in the past 12 months?</td>
<td>From whom did you receive most of these [ANIMAL]?</td>
<td>Have you lost any [ANIMAL] to DISEASE in the past 12 months?</td>
<td>How many [ANIMAL] have you lost to DISEASE in the past 12 months?</td>
<td>Did you slaughter any [ANIMAL] in the past 12 months?</td>
<td>How many [ANIMAL] have you lost to DISEASE in the past 12 months?</td>
<td>What was the purpose of the slaughter?</td>
<td>In principal, who is responsible for managing [ANIMAL]?</td>
</tr>
<tr>
<td>YES = 1</td>
<td>NUMBER</td>
<td>FRIEND / RELATIVE = 1</td>
<td>YES = 1</td>
<td>NUMBER</td>
<td>YES = 1</td>
<td>NUMBER</td>
<td>HOME CONSUMPTION = 1</td>
<td></td>
</tr>
<tr>
<td>NO = 2</td>
<td></td>
<td></td>
<td>NO = 2</td>
<td></td>
<td>NO = 2</td>
<td>SALE = 2</td>
<td>OTHER = 3</td>
<td></td>
</tr>
</tbody>
</table>

Local cattle

Improved cattle

Sheep

Goats

Pigs

Poultry

Bee hives

Rabbits


Codes for 26: (1) = HEAD, (2) = SPOUSE, (3) = SON/DAUGHTER, (4) = SON OR DAUGHTER IN LAW, (5) = GRANDCHILD (6) = OTHER (E.G. WORKER, SERVANT)
27. Have you ever kept any rabbits before? YES = 1 NO = 2
28. Why are you not keeping rabbits at present? .................................................................
29. Would you consider keeping rabbits at any one time? YES = 1 NO = 2
30. Why don’t you keep rabbits at present? .................................................................
31. Why would you not consider keeping rabbits at any one time?..............................
32. For how long have you been keeping rabbits on your farm? .........................YEARS
33. What is the **main** objective of keeping rabbits?....................................................... 
34. What other benefits do you derive from keeping rabbits? ...........................................
35. Do you consider rabbit keeping as an important economic activity? YES = 1 NO = 2

**D RABBIT NUMBERS AND BREED TYPES**

36. Now I would like us to distinguish the [NUMBER OF RABBITS INDICATED ON QUESTION 10. ABOVE] by their sex and age. We have three age categories; those rabbits aged below 1 month (kits), those aged between 1-4 months (immature) and those aged over 4 months (adults).

   a. How many kits are currently kept? b. How many immature rabbits? c. Of the remaining rabbits, how many are adult male?

Please indicate in the table below the number and sex of rabbits on this farm

<table>
<thead>
<tr>
<th>i) Mature male (more than 4 months) bucks</th>
<th>ii) Mature female (more than 4 months) does</th>
<th>iii) Immature (1 – 4 months)</th>
<th>iv) Kits (less than 1 month)</th>
<th>v) Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number currently kept</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
37. Now, I would like to ask you to indicate the various breeds of rabbits that you have on your farm. What breeds are these [NUMBER INDICATED ON CELL E1] rabbits you are keeping? Are they different breeds? Do you know what breed types these are? Please tell me what the composition of your rabbits by breeds is”) Please indicate breed types and their number on the farm on the table below

<table>
<thead>
<tr>
<th>Breed (select as relevant)</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand white</td>
<td></td>
</tr>
<tr>
<td>Californian white</td>
<td></td>
</tr>
<tr>
<td>French lopped</td>
<td></td>
</tr>
<tr>
<td>Flemish giant</td>
<td></td>
</tr>
<tr>
<td>Chinchilla</td>
<td></td>
</tr>
<tr>
<td>Angora</td>
<td></td>
</tr>
<tr>
<td>Kenya white</td>
<td></td>
</tr>
<tr>
<td>Cross breed (Specify which breeds)</td>
<td></td>
</tr>
</tbody>
</table>
38. Of the above breeds [PLEASE ENUMERATE FROM THE TABLE ABOVE], which is your preferred breed? Insert breed name on the space provided below

………………………………………………………………………………………………………

39. Please tell me, what are the reasons that lead you to choose [BREED] as your preferred breed? Tick as appropriate

<table>
<thead>
<tr>
<th>Reason</th>
<th>[ ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>best for fur</td>
<td></td>
</tr>
<tr>
<td>most available</td>
<td></td>
</tr>
<tr>
<td>Good mothering ability</td>
<td>[ ]</td>
</tr>
<tr>
<td>high carcass weight at slaughter</td>
<td>[ ]</td>
</tr>
<tr>
<td>many offspring per litter(litter size)</td>
<td>[ ]</td>
</tr>
<tr>
<td>best as a pet</td>
<td>[ ]</td>
</tr>
<tr>
<td>breed is preferred by other farmers</td>
<td>[ ]</td>
</tr>
<tr>
<td>high disease resistance</td>
<td>[ ]</td>
</tr>
<tr>
<td>high market price</td>
<td>[ ]</td>
</tr>
<tr>
<td>most available breed</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

other reasons (please specify…………………………….. [ ]

40. What is the source of breeding rabbits on your farm? (Tick against correct answer)
(a) Own stock [  ]
(b) other farmers [  ]
(c) government farms [  ]
(d) research institutions [  ]
(e) imported [  ]

41. (IF NOT FROM OWN STOCK) How far is this [SOURCE] from your farm? ................. KM
   Bucks .................................. KM     Does ................................. KM

42. Now I would like you to indicate the price paid for breeding stock which you acquired outside your farm (Insert prices for both mature and immature breeding stock)

<table>
<thead>
<tr>
<th>Breed</th>
<th>Price (KES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breed (Tick as relevant)</td>
<td>Mature</td>
</tr>
<tr>
<td>New Zealand White</td>
<td></td>
</tr>
<tr>
<td>Californian White</td>
<td></td>
</tr>
<tr>
<td>French lopped</td>
<td></td>
</tr>
<tr>
<td>Flemish giant</td>
<td></td>
</tr>
<tr>
<td>Chinchilla</td>
<td></td>
</tr>
<tr>
<td>Angora</td>
<td></td>
</tr>
<tr>
<td>Kenya White</td>
<td></td>
</tr>
<tr>
<td>Cross breeds</td>
<td></td>
</tr>
<tr>
<td>Dutch</td>
<td></td>
</tr>
<tr>
<td>Others (specify)</td>
<td></td>
</tr>
</tbody>
</table>
43. When selecting **breeding stock** from your own rabbits, what factors do you consider? (*Tick as appropriate*)

a) Health Status [  ]
b) Ancestry [  ]
c) Growth rate [  ]
d) Mothering ability [  ]
e) Other (specify) [  ]………………………………………………………………

44. IF PURCHASED, what factors do you consider in the selection?

a) Breed type [  ]
b) Health Status [  ]
c) Ancestry [  ]
d) Growth rate [  ]
e) Other (specify) [  ]………………………………………………………………

45. At what age do you breed your rabbits? (months)

Bucks……………………………… MONTHS   Does………………………… MONTHS

46. What is the average kindling interval? ........................ MONTHS

47. What is the average litter size? ............................ AT BIRTH........................ AT WEANING

48. i) How often do you replace your breeding buck (years)? ............... 

   ii) How do you replace the breeding buck?

   a) But in…….. b) Exchange with other farmer….. c) Select from own stock……
49. i) At what age do you consider your breeding stock too old to breed?

   Bucks……………………………MONTHS Does……………………………MONTHS

   ii) What is the method of disposal of the culls?

   Sell ………. b) Sell for slaughter ……….. c) Slaughter at home………………

F: HOUSING STRUCTURES AND EQUIPMENT

50. What is the type of housing? (Observation and pictures)

   a) loose group housing   [   ]
   b) caged outdoor         [   ]
   c) caged indoor          [   ]

51. If caged, is it..

   (a) one level            [   ]
   (b) tiered cages        [   ]………………………………………………No. of tiers

52. Are the rabbits reared together with other animals within the house?

   YES = 1     [   ]      NO = 2       [   ]

53. If yes, with which animals are they housed together? ……………………………………………………………

54. What factors did you consider when sitting this hatch?

55. Indicate the materials used in the rabbit house for the following structural parts on the table below.

107
<table>
<thead>
<tr>
<th>STRUCTURES</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roofing material</td>
<td></td>
</tr>
<tr>
<td>Floor</td>
<td></td>
</tr>
<tr>
<td>Walls</td>
<td></td>
</tr>
<tr>
<td>Bedding</td>
<td></td>
</tr>
<tr>
<td>Feeding troughs</td>
<td></td>
</tr>
<tr>
<td>Watering troughs</td>
<td></td>
</tr>
</tbody>
</table>

56. On a scale of 1 to 3 (1=GOOD, 2=FAIR, 3=POOR) how do you rate the sanitation in the rabbit house?

- **Ventilation**: GOOD [ ] FAIR [ ] POOR [ ]
- **Lighting**: GOOD [ ] FAIR [ ] POOR [ ]
- **Fur condition**: CLEAN [ ] FAIR [ ] DIRTY [ ]
- **Bedding**: GOOD [ ] FAIR [ ] POOR [ ]
- **Odour**: GOOD [ ] FAIR [ ] POOR [ ]

57. Make a measurement of the length and width as well as the number of rabbits in the space and enter these on the spaces provided. Do not forget to enter measurement units.

(i) TOTAL LENGTH .......... UNITS ...............

(ii) TOTAL WIDTH .......... UNITS ...............

(iii) If tiered, measure distance from highest point of cages to the roof? .......... Units

(iv) TOTAL NUMBER OF RABBITS IN THE SPACE .........................
58. How high is the rabbit house from the ground? Measure the height of rabbit house above the ground/floor? .................UNITS

**G: FEEDS AND FEEDING**

59. What do you mainly use to feed your rabbits? *Tick as appropriate*

(a) Locally available forages/weeds [ ]

(b) Purchased concentrates [ ]

(c) Homemade concentrates [ ]

(d) Combination of (a) & b [ ]

(e) Combination of (a) & (c) [ ]

60. List the local forages that are used to feed rabbits on this farm over the course of the year and their sources. Use local names if not sure of common names. Also make an indicative price per unit if these are purchased.

<table>
<thead>
<tr>
<th>FODDER NAME</th>
<th>SOURCE</th>
<th>COST/UNIT (if purchased)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

61. Of the forages mentioned, what are the two most preferred forages for rabbits in your experience?

FODDER 1……………………………………………………………

FODDER 2……………………………………………………………

62. Why do you prefer [FORAGE 1 and FORAGE 2]? *List reasons on space indicated below*

1. …………………………………………………………………………………………………………………………..

63.i) Do you wilt forage before feeding them to your rabbits?
63.ii) Why? ..............................................................

64. Are there times in the year when forage availability is a constraint? YES = 1 [ ] NO = 2 [ ]

65. During which season of the year is forage availability for rabbits constrained? ..............

66. In your experience, are there forages that are harmful to rabbits? YES = 1 [ ] NO = 2 [ ]

67.i) Which forages are harmful to rabbits?

1: ........................................................................................................

2: ........................................................................................................

67.ii) During which season do they occur? .........................

68. How do these [FORAGES] affect the rabbits if fed? .........................................................

69.i) Do you preserve forages for rabbits?

YES = 1 [ ] NO = 2 [ ]

69.ii) In what form do you preserve

Hay (harvested)

Standing hay

Other (Specify) ...............................................................
71. Do the rabbits have *ad-libitum* access to water? YES = 1 [ ]  NO = 2 [ ]

72. (IF NOT *AD-LIBITUM*) How often do you water your rabbits every day?....................

E. DISEASES

73. Are rabbit diseases a problem on your farm? YES = 1 [ ]  NO = 2 [ ]

74. Please list for me in order of importance, the diseases that occur frequently among your rabbits. *(copy this list of diseases as mentioned on the first column of table immediately below)*

DISEASE/SYMPOTM 1.................................................................

DISEASE/SYMPOTM 2.................................................................

75. In your assessment, which of the [DISEASES/SYMPOTMS] you have listed above is the most serious?.................................................................

76. Quickly copy the diseases/symptoms listed by the respondent in Q.75. above and then fill out the table with the appropriate responses. You might want to ask, “what age does [DISEASE/SYMPOTM] affect; what sex does [DISEASE/SYMPOTM] affect, etc moving from column to column or from row to row, whichever you feel is more comfortable for the respondent.
<table>
<thead>
<tr>
<th>i) Disease / symptom</th>
<th>ii) Age affected(kits, weaners, adult)</th>
<th>iii) Sex (male, female or both)</th>
<th>iv) Numbers affected(few or many)</th>
<th>v) out of 10 rabbits, how many actually die from this disease? (%)</th>
<th>vi) Season when the disease commonly occurs (wet, dry or both)</th>
<th>vii) which is the breed commonly affected by this disease/symptom</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

77. What do you do when there is a disease problem among your rabbits?

PERSONALLY ADMINISTER TREATMENT [ ]

CALL AN ANIMAL HEALTH PROFESSIONAL [ ]

DO NOTHING [ ]

SLAUGHTER [ ]

ANY OTHER (specify)………………………………………………………………………………………...“Is there any other action you take save from those above”?

78. What determines your course of action?

79. Have you practiced disease treatment/control in the last 6 months? YES = 1  [ ] NO = 2 [ ]

80. i)What methods of disease treatment/control did you use?

(a) Modern drugs [ ]
80.ii) Please the common types of indigenous treatments used *(If answer if (b) above, ask this question)*

81. From where did you get information on the appropriate drugs to administer for the diseases/symptoms?

<table>
<thead>
<tr>
<th>Source</th>
<th>[ ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fellow farmer</td>
<td>[ ]</td>
</tr>
<tr>
<td>Media (Radio, TV, print)</td>
<td>[ ]</td>
</tr>
<tr>
<td>Veterinarians</td>
<td>[ ]</td>
</tr>
<tr>
<td>GoK extension officers</td>
<td>[ ]</td>
</tr>
<tr>
<td>NGO representative</td>
<td>[ ]</td>
</tr>
<tr>
<td>Field days</td>
<td>[ ]</td>
</tr>
<tr>
<td>Field schools</td>
<td>[ ]</td>
</tr>
<tr>
<td>Internet</td>
<td>[ ]</td>
</tr>
<tr>
<td>Other (specify)</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

82. IN THIS SET OF QUESTIONS YOU ARE REQUIRED TO ASK THE RESPONDENT TO RESPOND WITH A YES OR NO ANSWER TO;

<table>
<thead>
<tr>
<th>Question</th>
<th>YES [ ] NO [ ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Are veterinary services available?</td>
<td>YES [ ] NO [ ]</td>
</tr>
<tr>
<td>b. Are drugs to treat rabbit diseases readily available?</td>
<td>YES [ ] NO [ ]</td>
</tr>
<tr>
<td>c. Is information to farmers on rabbit diseases readily available?</td>
<td>YES [ ] NO [ ]</td>
</tr>
<tr>
<td>d. Is the cost of drugs and/or veterinary services too high</td>
<td>YES [ ] NO [ ]</td>
</tr>
</tbody>
</table>
CONSUMPTION & MARKETING

83. Do you or members of your household consume rabbit meat?  

1 YES [ ] 2 NO [ ]

84. How frequently do you or your household consume rabbit meat? (Tick as appropriate)  

(a) once every week [ ]  
(b) once a month [ ]  
(c) once a year [ ]  
(d) other frequency………………………………………….[specify frequency on space]

85. What is the usual source of the rabbits (MEAT) that you or your household consumes?  

a) own stock [ ]  
(b) neighbors [ ]  
(c) market [ ]  
(d) hotel (meat) [ ]

86. Have you or members of your household sold rabbits in the last 3 months? YES[ ]NO[ ]

87. Please tell me, how many [BUCKS, DOES, WEANERS] were sold at the [FARM GATE, LOCAL MARKET, HOTEL, COLLECTION CENTRE, INSTITUTION, OTHER OUTLET] in the past 3 months (Indicate numbers sold in table below)
88. Please tell me, what were the prices of [bucks, does, weaners] that were sold at the [FARMGATE, LOCAL MARKET, HOTEL, COLLECTION CENTRE, INSTITUTION, OTHER OUTLET] in the past 3 months? (Indicate prices in table below)

<table>
<thead>
<tr>
<th></th>
<th>Bucks</th>
<th>Does</th>
<th>Weaners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm gate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local market</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collection centres</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutions (e.g. schools, Research institutions)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

89. Do you maintain any written records for your rabbit enterprise?

1  YES [ ]  2  NO [ ]

90. Which records do you keep? (Indicate what kind of records respondent has been keeping by ticking against the correct options provided)
91. Do you or does anybody in this household belong to a rabbit producer group or association?
1 YES [ ] 2 NO [ ]

92. What is the name of this group/association that you are (or the member of your household is) a member of?

93. What benefits have you derived from this membership? 

94. Would you like to belong to one such association?
1 YES [ ] 2 NO [ ]

95. If Yes/No, why?

96. Are you aware of the National Rabbit Development Stakeholders Forum?
1 YES [ ] 2 NO [ ]

97. Considering this time last year, would you say that your rabbit enterprise has maintained, lost or gained in terms of turnover?
(a) Worsened [ ]
(b) No change [ ]
(c) Improved [ ]
E Closing remarks

98. In your opinion, what do you think needs to be done to make the rabbit industry more successful in Kenya? ........................................................................................................

99. (FOR NON-RABBIT KEEPERS) Do you think the rabbit industry has a future in Kenya?

Give reasons. ..............................................................................................................

Thank You!

Time ended interview ................................................................................................
**Appendix B:**

**Table 6.1: Frequency of feeds and fodders used to feed rabbits**

<table>
<thead>
<tr>
<th>TYPE OF FEED/FODDER</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KALES ((Brassica oleracea\text{ var} acephala))</td>
<td>63</td>
</tr>
<tr>
<td>CABBAGES ((Brassica oleracea\text{ var} capitata))</td>
<td>60</td>
</tr>
<tr>
<td>SWEET POTATO VINES ((Ipomoea batatas))</td>
<td>51</td>
</tr>
<tr>
<td>GALLANT SOLDIER ((Galinsoga parviflora))</td>
<td>50</td>
</tr>
<tr>
<td>BLACK JACK ((Bidens pilosa))</td>
<td>50</td>
</tr>
<tr>
<td>MUTHUNGA ((Commelina ensifolia))</td>
<td>29</td>
</tr>
<tr>
<td>RABBIT PELLETS</td>
<td>29</td>
</tr>
<tr>
<td>RHODES GRASS ((Chloris gayana))</td>
<td>28</td>
</tr>
<tr>
<td>MAIZE STALKS ((Zea mays))</td>
<td>17</td>
</tr>
<tr>
<td>NAPIER ((Pennisetum purpureum))</td>
<td>12</td>
</tr>
<tr>
<td>CARROTS ((Daucus carota))</td>
<td>9</td>
</tr>
<tr>
<td>MSISINA ((Albizia harveyi E. Fourn))</td>
<td>7</td>
</tr>
<tr>
<td>KIKUYU GRASS ((Pennisetum clandestinum))</td>
<td>6</td>
</tr>
<tr>
<td>BANANA LEAVES ((Musa spp.))</td>
<td>6</td>
</tr>
<tr>
<td>MAIZE ((Zea mays)) BRAN</td>
<td>5.7</td>
</tr>
<tr>
<td>DAIRY MEAL</td>
<td>5</td>
</tr>
<tr>
<td>AMARANTHUS ((Amaranthus spp.))</td>
<td>4</td>
</tr>
<tr>
<td>TYPE OF FEED/FODDER</td>
<td>Frequency (%)</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>MAIZE (Zea mays) GERM</td>
<td>4</td>
</tr>
<tr>
<td>BEAN (Phaseolus vulgaris) STALKS</td>
<td>4</td>
</tr>
<tr>
<td>MAIZE (Zea mays) POLLARD</td>
<td>3.7</td>
</tr>
<tr>
<td>MAIZE (Zea mays) GRAINS</td>
<td>3.3</td>
</tr>
<tr>
<td>MULBERRY (Morus spp.)</td>
<td>2.7</td>
</tr>
<tr>
<td>IRISH POTTO (Solanum tuberosum) PEALS</td>
<td>2.7</td>
</tr>
<tr>
<td>CALLIANDRA (Calliandra spp.)</td>
<td>2.4</td>
</tr>
<tr>
<td>LEUCANEA (Leucaena leucocephala)</td>
<td>1.7</td>
</tr>
<tr>
<td>AVOCADO (Persea Americana) FRUITS</td>
<td>1.7</td>
</tr>
<tr>
<td>PIGOEN PEAS (Cajan cajan)</td>
<td>1.7</td>
</tr>
<tr>
<td>DESMODIUM (Desmodium spp.)</td>
<td>1.4</td>
</tr>
<tr>
<td>CALF PELLETS</td>
<td>2.7</td>
</tr>
<tr>
<td>MNYINYA (Launea cornuta)</td>
<td>1.3</td>
</tr>
</tbody>
</table>