MANAGEMENT, PRODUCTIVITY AND SOCIO- ECONOMIC ATTRIBUTES OF GUINEA PIGS IN NJOMBE DISTRICT

By

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN TROPICAL ANIMAL PRODUCTION OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

This study was aimed at studying management, productivity and socio- economic attributes of guinea pigs (GP) in Njombe district. Two separate studies were conducted. A survey was done among 72 households and results indicated that GP were owned by most of the households. The majority (93.1%) of farmers who keep GP practise intensive production system. GP were found to be a good source of meat (35.5%) manure (32.8%) and for income (17.5%) to farmers. The mean weights of sampled GP measured at the farmers' households were 571.3 ±8.71, 548.9 ±8.25, 233.5 ±2.19, 231.6 ±2.38, 126.4 ±3.52, 127.1 ±3.18 g for mature males, females, growing males, females, young males and females, respectively. A planned experiment was conducted involving 60 GP aged one month and fed 5g (T1), 20g (T2) and 30g (T3) of concentrates for 4 months. Data were analysed using General Linear Models of SAS for effects of sex, origin and diets. Results showed that the effect of sex on body weights at the 2nd, 3rd, 4th and 5th month and carcass traits was not significant (P>0.05). Further, effect of origin of GP on weights and carcass traits was insignificant though GP from Ramadhani had significantly higher (335.6± 9.09 g) mean initial weight and final weights (551.9± 8.59 g)compared to those from Itulike (with respective weights of 292.6± 9.09 and 508.9± 8.59 g). Dietary treatment had significant (p<0.01) effect on monthly weights and carcass weight expressed as percent of slaughter weight. Weights and weight gains increased with increase in feeding level. Daily weight gains were 1.1±0.04, 2.1±0.04 and 2.2±0.04 for T1, T2 and T3 respectively. Their corresponding final weights were 473.6±10.5, 528.7±10.5 and 588.8±10.5 g. It was concluded that experimental GP were heavier in early stage of growth than those from surveyed farms indicating that native GP can do well under good management practices.

DECLARATION

I, Lusajo Nkundwe Mwalukasa, do hereby declare to the SENATE of Sokoine University of Agriculture that this dissertation is my own original work and has not been submitted for a higher degree award in any other University.

Signature……………………………….. Date………………………….

Lusajo Nkundwe Mwalukasa

The above declaration is confirmed.

Signature……………………………….. Date………………………….

Prof. G. C. Kifaro

(Supervisor**)**

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I highly thank the Almighty God who helped me in every step of my studies. And I also thank my beloved wife and our beloved children Zeituni, Fedelis, Benson and Jacklin for prayer, love and care which have always been a source of strength and encouragement. May the Almighty God bless you.

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DEDICATION

This work is dedicated to my father Mr. Nkundwe and my mother Mrs Twitike who taught me how to have good relationship with other people. May God bless them.

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LIST OF ABBREVIATIONS AND SYMBOLS

ANOVA - Analysis of variance
CV% - Coefficient of variation in percent
DASP - Department of Animal Science and Production

DLO	-	District Livestock Office
DP	-	Dressing percentage
Fig	-	Figure
G	-	Gramm
GLM	-	General Linear Model
GP	-	Guinea pigs
HCW	-	Hot carcass weight
IU	-	International unit
Lsmeans	-	Least Squares Means
NRC	-	National Research Centre
NS	-	Not significant (P>0.05)
MLD	-	Ministry of Livestock Development
P	-	Probability
%	-	Percent
SAS	-	Statistical Analysis System
S.E	-	Standard error
SD	-	Standard deviation

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

New facts and ideas are being churned out every day from the agricultural research mills. These new facts and ideas (innovations) impact positively on the knowledge required to increase the efficiency of agricultural production, processing, preservation, distribution, marketing and family utilization of farm products in a nation (Mafimisebi *et al.,* 2006). No matter how positively a new agricultural innovation impact on production and productivity, farmers will differ in their willingness to try it.

Tanzania, like many other developing countries is facing the problems of shortage of dietary animal protein. The gravity of this problem is increasing with the growing population and urbanization. In Tanzania the daily animal protein intake is below the FAO recommendation of 50 kg of meat, 200 litres of milk, 300 eggs and 10.96/kg fish per person per year. Tanzania has 18.8 million cattle, 13.5 million goats**,** 3.6 million sheep, 1.4 million pigs, 33 million local chickens and 20 millions exotic breed of poultry. However, consumption of animal products on average is 11kg of meat, 41 litres of milk, 64 eggs and 6.9 kg of fish per person per year (MLD, 2008). Hence this rate of consumption is very low. According to the recently updated dietary reference intake guidelines, women aged 19–70 need to consume 46 grams of protein per day, while men aged 19–70 need to consume 56 grams of protein per day to avoid deficiency (IM, 2008).

Due to the acute shortage of animal protein in the diet of the average Tanzanian, there is a need to increase the production of domestic animals which are conventional sources of animal protein in Tanzania. Protein deficiency could be alleviated but several protein sources like meat from conventional animals are marketed in too high prices for penurious people to afford especially those from rural areas (UNUP, 1990). Therefore food from micro-livestock like meat and eggs could play an important role in alleviation of protein deficiency (WHO and FAO, 2007; USDA, 2007; UA, 2008).The usefulness of guinea pigs as meat producers and as a source of income in peri-urban (Ngoupayou, 1992; Ngoupayou *et al.,* 1995) and rural areas (Lukefahr, 1984; Nuwanyakpa, 1993) has been reported.

The species name *porcellus* means "little pig" in Latin (Wagner, 1976). Although guinea pigs are not members of the pig family, they do resemble suckling pigs when they are skinned and dressed for cooking. Also, some of their vocalizations sound somewhat like pig vocalizations (Wagner, 1976; Alderton, 1999).

The guinea pig (*Cavia porcellus)* is a member of the rodent which is related to the wild and semi domesticated cavia (Chauca de zaldivar, 1995) .The name guinea pig is generally thought to have originated some centuries ago as British sailors carried this curious specimen resembling a young pig from South America to Britain through the port of Guinea in West Africa. This explains how this animal got the name guinea pig in English (Morales, 1994). Guinea pigs are native to the Andean highland areas of Latin America, where many resource-poor families keep them for meat production. Guinea pigs have also some significance in West Africa and Asia such as Sierra Leone, Ghana, Togo, Cameroon, Democratic Republic of Congo and the Philippines (Morales, 1995). For example, guinea pigs are raised for food by 10% of households in Southern Nigeria. They offer an alternative to chicken or small animals hunted in the forest. They are easier to prepare than poultry because they are skinned rather than plucked. They also require shorter cooking time, consuming less fuel. Since guinea pigs require much less room than traditional livestock and reproduce extremely quickly, they are a more profitable source of food and income than many traditional stock animals, such as pigs and cows (Nuwanyakpa *et al.*, 1997). Moreover, they can be raised in an urban environment. Both rural and urban families raise guinea pigs for supplementary income, and the animals are commonly bought and sold at local markets and large-scale municipal fairs.

Guinea pig meat is high in protein content (about 21%) and low in fat and cholesterol content of about 8%, and is described as being similar to rabbit and chicken meat (Huss and Roca, 1982).Estimated dressing percentage for farm –raised guinea pigs is 65%, while under improved conditions, Cicogna *et al.* (1992) reported average dressing percentage of 75% at 15 weeks of age. They have also studied reproductive and growth performance of GP raised for meat. They reported prolificacy of 3.8 (number of born/litter) and an annual fertility of 13.6 (number born alive/breeding female/year). They also reported more impressive average GP weights at birth, weaning at 3 weeks and 15 weeks to be 99, 247 and 738 g respectively. With 20 breeding females and 2 males of guinea pigs a family of 6 members can be provided with a year round adequate supply of nutritious meat (NRC, 1991).

Guinea pigs are herbivores. They feed in groups with little competition for food (Harper, 1976; Navia and Hunt, (1976). Unlike other rodents, guinea pigs cannot manufacture vitamin C. They therefore must consume it in their diet and they are frequently used to diagnose tuberculosis, since they are easily affected by human tuberculosis bacteria (Gad, 2007). Sources of dietary vitamin C include fresh vegetable matter and supplements that are added to food or water (Ediger, 1976). To extract as much nutrition as possible from their cellulose-rich diets, guinea pigs use coprophagy. They cannot digest cellulose themselves, but bacteria in their caecum can. However, once food has reached the caecum, guinea pigs cannot absorb nutrients from it. So, they pass and eat special, soft fecal pellets containing bacteria-digested cellulose (Alderton, 1999).

Guinea pigs have been shown to play a vital role in the animal protein supply and income generation in rural areas of Cameroon (Ngoupayou *et al.* 1994; Manjeli *et al.* 1998). In these regions, production is mainly by traditional means. Traditional guinea pig farming appears to be a secondary household activity undertaken by small farmers basically women (Ngoupayou *et al.,* 1994). Such an extensive production system which shows no defined management practices, integrates very well in the agricultural systems (small livestock, food crops and natural forages production) of the Western highlands and Southern forest zones of Cameroon.

Under such a system, guinea pigs are reared in polygamous groups. This leads to a situation where mismanagement contributes to post-partum mating and inbreeding of stock (Nuwanyakpa *et al.,* 1997). Uncontrolled breeding does not only lead to some females being bred too early, but also the perpetuation of inferior genotypes resulting in low conception rate, low birth weight and kid survival (Manjeli *et al.* 1998). Essentially that leads to inbreeding depression.

Njombe district has estimated to have 44, 910, guinea pigs (DLO, 2008). Although guinea pigs contribute to the alleviation of protein deficiency in the diets of people in developing countries, they have largely been neglected as a livestock species. Thus their actual contributions to food production has been greatly ignored or underestimated by scientists, extension workers, other development agencies and policy markers in the agriculture and livestock sectors in Africa and particularly in Tanzania where there is little information on their production, marketing and consumption. Njombe district is very poor in guinea pigs performance. Therefore, this study was aimed at studying husbandry practices and performance of guinea pigs, their contribution to food security and socio – economic welfare of households in Njombe District. The specific objectives of the study were:

(i) To study the management systems practiced in the study area.

(ii) To assess the socio- economic aspects of guinea pig production.

(iii) To evaluate the effect of feeding regime on growth and carcass characteristics of guinea pigs

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Traditional values of guinea pigs

In the Andes region, for centuries guinea pigs have been a valuable source of animal protein and income for small holder farmers (Morales, 1994). The guinea pig is not only a source of protein, but also serves as an investment alternative and source of additional income especially among the women in the household expenditure, and meeting social and cultural obligations (Elizabert and Claudia, 2003; Owen *et al*., 2005; Ajala *et al*., 2006). It has been estimated that there are 36 million guinea pigs in the Andean countries (Chauca de Zeldiva, 1995) emphasizing the traditional food value of guinea pigs. About two million guinea pigs are consumed each year in Peru alone. The rearing of guinea pigs on small farms in Latin America has shown to be more profitable than rearing of either pigs or dairy cows (Huss and Roca, 1982).

Guinea pigs are excellent source of supplementary income because their meat fetches high prices. In Latin America, guinea pigs have been used as food resource for many years, but now they are spread to parts of Africa. In Southern Nigeria at least 10% of all households raise guinea pigs for food with colonies of up to 30 animals per household. However, Nuwanyakpa (1993) reported that the consumption of guinea pigs in Cameroon was still insignificant. Economic gains and low cost of guinea pig production was one of the encouraging factors for small holder farmers to engage in guinea pig production for meat (Loetz and Nova, 1983). Further more; Nuwanyakpa (1993) explains that considerable quantities of guinea pigs were used for food in some farm families and other towns and villages. Conversely Ngoupayou (1992) reported that about 58% of the respondents in Cameroon during the survey indicated to have never eaten guinea pig meat and 42%

claimed to have eaten guinea pig meat at least once. This shows that the income generation instead of nutrition improvement was their highest priority.

Guinea pig meat is used as an important source of animal protein given that it is a product of excellent quality, high biological value, is high in protein and low in fat compared to other meats (Elizabeth and Claudia, 2003; Msemwa, 2005).

2.2 Physical characteristics of guinea pigs

Guinea pigs measure 20 to 40 cm from head to rump; they do not have tails (Nowak, 1999). Like all members of Caviidae, guinea pigs have four toes on each front paw and three toes on each hind paw (Alderton, 1999; Donnelly *and* Brown 2004). Adult guinea pigs usually weigh 500 to 1500 g, but the National Agrarian Research Institute of Peru has developed a "super-cuvy that weighs up to 3 kg (Nowak, 1999; Economist, 2004). In general, females tend to weigh slightly less than males. Vanderlip (2003) and Owen *et al*. (2005) reported that guinea pigs are large rodents weighing between 600 and 1200g live weight at maturity and slow- growing with extremely high resistance to diseases and measuring between 20 and 25 cm in length. Guinea pig incisors and molars grow continuously. They wear down from the guinea pig chewing its roughage-rich diet (Navia and Hunt, 1976).

It has been pointed by Huss and Ruca (1982) and Ngoupayou (1992), that guinea pig production is least labour intensive thus can be conducted by women and young youths. They typically live an average of four to five years, but may live as long as eight years (Richardson, 2000). According to the 2006 Guinness Book of Records the longest living guinea pig survived 14 years and 10.5 months. Nuwanyakpa (1993) pointed out the constraints of rearing guinea pigs to be the relative newness of guinea production, their appearance (rate-like), small size and lack of nutrition education programs, to be the major mitigating factors that deter the consumption of guinea pigs. The relatively small and high seasonal market outlets for guinea pigs also contribute to the drawback of rearing guinea pigs by small holder farmers.

2.3 Housing of guinea pigs

The system for managing cavies for meat is of great importance in order to make it productive and economical. Unfortunately much less is known about management of cavies than chickens, rabbits, pigs and goats. Standardized systems have been developed in some instance, but have not been thoroughly tested (Franklin, 1991).The rooms in which guinea pigs are housed have to be quiet to avoid stress responses triggered by intense and/or chronic noise.

With the exception of specific short-term experimental protocols, guinea-pigs should always be kept on solid floor with bedding (NRC, 1996; North, 1999; Reinhardt, 2002; Kawakami *et al.*, 2003). When grid or perforated floors are used, a solid resting area must be provided (EC, 2000; CE, 2002; ARC, 2005), that is sufficiently large to allow all animals to lie on it simultaneously. Bedding of dust-free shavings from seasoned soft wood, supplemented daily with high-quality hay should be regarded as a basic form of environmental and feeding enrichment (Benjamin *et al.,* 2004). Regularly at least twice a week changed bedding is the best guarantee of a hygienic cage environment (Kawakami *et al.*, 2003). Apart from durability and hygiene, the economy of better housing would favour such housing in the long run (Bawa *et al.*, 2004). Guinea-pigs need the social environment to guarantee their behavioral health, safeguard their physiological well-being (Sachser and Lick, 1991; Fenske, 1992; Adrian *et al.,* 2005) and assist them to cope with circumstances of confinement (CCAC, 1993). Compatible group-housing should, therefore, be the standard arrangement for them in the research laboratory (Brain *et al.,* 1998; E C, 2000; Wewers *et al.,* 2003; Hennessy *et al.*, 2004).

Animals living in groups should be provided a floor area of no less than 1200 cm^2 per breeding female, and no less then 750 cm^2 per weaned, non-breeding animal. There is no need for a cover because the animals are poor climbers and will normally make no serious attempts to escape over walls that are only 30 cm high (Reinhardt, 2000; 2002). Rodents appear to prefer sheltered areas of the cage, especially if those areas have decreased light and height. Providing such a confined space within a cage might be one way to enrich the environment of rodents (NRC, 1996; Hennessy *et al.*, 2004). The provision of such protected, safe space is a basic requirement to assure data collection of animals that are not unduly stressed by their living environment. Guinea pigs instinctively avoid open surfaces that expose them full view to potential predators (Young, 2003).

To minimize social tensions arising from the presence of several mature males and from overcrowding it is recommended to keep only one mature male with 3-6 females and remove the naturally weaned young at the age of three weeks (Donnelly and Brown 2004). The adolescents can then be housed in same-sex groups without risk provided that male groups have no visual and no olfactory contact with female groups. The mere exposure to the smell of female urine will turn even the most compatible males into fractious enemies who will no longer tolerate each other's presence (Reinhardt, 2000).

A major problem under traditional colony management of GP by small farmers is that GP are exposed to a high level of predation (Ngoupayou 1992; Young, 2003), generally from cats, dogs, rats and snakes. Special precautions must therefore be taken to provide adequate shelter in order to protect the GP from such predators. Inbreeding is another potential problem under traditional systems of rearing GP (Huss and Roca 1982; Ngoupayou 1992; Nuwanyakpa 1993). Most of the farmers who are raising GP in Cameroon do not know how to determine sex (ie: distinguish females from males). These animals (males and females) are housed promiscuously on the floors of bedrooms, kitchens or rabbit sheds (Ngoupayou 1992; Nuwanyakpa 1993). This polygamous or colony system enables GP to breed and run freely on the floor. Breeding records are seldom kept. The female to male ratio (3:1) is often too low and there is potentially the problem of inbreeding (Nuwanyakpa, 1993).

2.4 Breeding of guinea pigs

The guinea pig is able to breed year-round, with birth peaks usually coming in the spring. As many as five litters can be produced per year (Nowak, 1999; Paterson *et al.*, 2001). The gestation period lasts from 59 to72 days, with a range of 63 to 68 days (NRC, 1996; Paterson *et al*., 2001). Because of the long gestation period and the large size of the pups, pregnant females may become large and eggplant-shaped, although the change in size and shape varies. Newborn pups are well-developed with hair, teeth, claws and partial eyesight (Harkness, 1995). They are mobile and begin eating solid food immediately, though they continue to suckle. Litters yield 1–6 pups; with an average of three (Richardson, 2000; Paterson *et al*. 2001). The largest recorded litter size is 17. In smaller litters, difficulties may occur during labour due to over-sized pups.

Large litters result in higher incidences of stillbirth, but because the pups are delivered at an advanced stage of development, lack of access to the mother's milk has little effect on the mortality rate of newborns. Cohabitating females assist in mothering duties (Percy, 2001). Males reach sexual maturity at 3–5 weeks; females can be fertile as early as four weeks and can carry litters before they are adults (Richardson, 2000). Females that have never given birth commonly develop irreversible fusing of the pubic symphysis, a joint in

the pelvis after six months of age (NRC, 1996). If they become pregnant after this has happened, the birth canal will not widen sufficiently; this may lead to dystocia and death as they attempt to give birth. Pregnancy toxaemia appears to be most common in hot climates. Other serious complications of pregnancy can include prolapse of the uterus, hypocalcaemia and mastitis (Richardson, 2000). Breeding life is 5 years or longer for males and 4 – 5 years for females. Weaning age is 10 to 14 days at which time they would weigh 150 to 250 g and can re-bred immediately after parturition (Paterson, *et al*., 2001). Mating ratio is 1 male to 10 females. The first oestrus cycle after birth is 20 – 24 hours postpartum, and normal oestrus cycle takes 16 – 18 days (Richard, 2004). Ngoupayou (1992) reported that the sow can conceive shortly after parturition with gestation period of 65 – 70 days; thus five parturitions per year are possible. Where guinea pigs are housed in family groups, there is evidence that suggest that mating of siblings and dams can apparently increase inbreeding. Normal sexual behaviour is directed towards unrelated females (Hennessy *et al.*, 2003).

It was shown by Cheeke (1983) that rabbits could be mated 24 hours after kindling since rabbits are induced ovulators. Mc Nitt *et al.* (1996) also reported that does are fertile 24 h after kindling and can be rebred at this time. Ngoupayou (1992) also reported on the same findings in guinea pigs.

However, short re-mating intervals such as 1, 4, 9 and 10 days after kindling may not allow for adequate recovery of the body reserve of the does. As a consequence there may be a decrease of fertility, milk production, litter weight at weaning and an increase in kid mortality. This is in agreement with the reports of Hennessy *et al.* (2003) and Fonteh *et al.* (2005) who made similar observations on guinea pigs. Moreover, the practice of rebreeding 24 h (1day) after kindling was condemned by animal welfare group (Harkness, 1988).

Re-mating interval most commonly adopted by Spanish farmers is 11 days post-partum (Rafel, 2001). In most tropical and developing countries, the current practice is weaning kids at the age of 6 - 8 weeks and rabbit does are re-mated there after. Under tropical conditions, long rebreeding intervals of 30 to 60 days or more are observed to reduce the number of kids raised per doe per year (Iyeghe-Erakpotobor *et al.,* 2005). Also in the tropics, one of the problems in the management of domestic rabbits is the selection and adoption of a suitable time of mating after parturition especially under intensive system of production. A suitable re-mating interval of rabbits and guinea pigs may offer the greatest opportunity for increasing the output of rabbits per year.

Birth weights and growth depend on nutrition, litter size, gestation length and litter interval. Average weight in litter is 85 – 95g, weaning weight 180g; gaining per day 2.5 – 3.5g and adult sows weigh 700 – 850g. There is a larger number of offspring at birth that have a better weight when the female guinea pigs that are pregnant have been fed well. This in turn improves their multiplying ability (Paterson *et al*., 2001). Plate1 represents a group of animals selected for breeding. Ten to 30 guinea pigs are managed together. The food is based on harvest leftovers and kitchen waste.

Inadequate installations are frequently used in areas like the kitchen, bedrooms and other spaces shared by other species, which makes management impossible and inadequate sanitary conditions (Elizabet and Claudia 2003). Traditional family breeding insists that technical family breeding be developed in a rustic manner without improved technique applications. Management of the animals is done in open colonies where the animals are kept together in an environment without sex or age distinction, which causes premature pairing. When the guinea pigs are kept all together, the female offspring mix with their brothers and fathers causing consanguinity. This inbreeding brings a depression in productive parameters: high death rate, small number of offspring per birth, and low weights (Huss and Roca, 1982; Ngoupayou, 1992; Nuwanyakpa, 1993). A major problem under traditional colony management of guinea pigs by smallholder farmers is that guinea pigs are exposed to a high level of predation (Ngoupayou, 1992), generally from cats, dogs, and snakes. Special precaution must therefore be taken to provide adequate shelter in order to protect the guinea pigs from such predators.

Genetic selection is one instrument of choice to reduce variation in birth weight and to find an optimum balance of litter size and birth weight. Town *et al.* (2004) have demonstrated that fetal weight and semitendinosus muscle weight and fiber number increased when the number of fetuses was reduced by unilateral oviduct ligation. Furthermore, it has been shown by estimations of heritability coefficients, genetic correlations, and results of selection, that muscle fiber number and other muscle characteristics, such as the percentage of giant fibers, can be changed by selection and used in addition to traditional selection criteria for improving lean meat accretion and meat quality in pigs (Rehfeldt *et al*., 2000; 2004; Fiedler *et al.* 2004).

Plate 1: New born guinea pigs breast-feeding

2.5 Feeds and feeding of guinea pigs

Guinea pigs produce a range of vocalizations in relation to feeding, social encounters, mating and mothering (Donnelly and Brown 2004). Vocalization plays an important part in communication with up to 11 distinct calls recognized.

Guinea pigs can eat up to 30% of their body weight per day in form of green pasture or vegetable matter. Although they can live and reproduce on much poorer diets, for maximum productivity their nutrient requirements include about 18% crude protein, 10% crude fiber and 12.54 MJ ME/kg DM, together with a good supply of minerals and vitamins. Good quality leguminous pasture such as lucerne (*Medicago sativa*), tropical kudzu (*Pueraria phaseoloides*) will meet the need for protein, but will contain too much fiber and too little energy to give optimum results (Morales, 1995). To obtain the highest yield of meat, up to 40% of the diet can be provided as concentrate feed including cracked grain. The change from one major feedstuff to another should be done gradually to avoid diarrhea (Harkness, 1995). The daily requirements for water are about 30, 80, and 100 ml/day for sucklers, growing animals and adults respectively. As the proportion of dry feed in diet increases, there is a need for a constant supply of clean drinking water. Mortality rate is significantly increased when the animals are deprived of water with pregnant and lactating females being the most affected, followed by young and rapidly growing animals (Owen *et al.,* 2005).

Most grass-eating mammals are quite large and have a long digestive tract; while guinea pigs have much longer colons than most rodents, they must also supplement their diet by coprophagy, the eating of their own feces (Richardson, 2000; Donnelly *et al.,* 2004). However, they do not consume all their feces indiscriminately, but produce special soft pellets, called cecotropes, which recycle B vitamins, fiber, and bacteria required for proper digestion. The cecotropes (or caecal pellets) are eaten directly from the anus, unless the guinea pig is pregnant or obese (Terrill, 1998). They share this behaviour with rabbits. In older boars (the condition is rarer in young ones); the muscles which allow the softer pellets to be expelled from the anus for consumption can become weak. This creates a condition known as anal impaction, which prevents the boar from redigesting cecotropes, though harder pellets may pass through the impacted mass (Richardson, 2000). The condition may be temporarily alleviated by carefully expelling the impacted feces. Some pet owners and veterinary organizations have advised that, as a legume rather than a grass hay, alfalfa consumed in large amounts may lead to obesity, as well as bladder stones due to excess calcium, in any but pregnant and very young guinea pigs. However, published scientific sources mention alfalfa as a source for replenishment of protein, amino acids and fiber (ILAR, 1995; Terrill, 1998).

The guinea pigs can double their weight from the time of birth to the weaning period, that is why they should be given proper amounts of healthy food. When they are not given enough food, the guinea pigs do not have an adequate weight (Elizabet and Claudia, 2003). Supplementary feeding such as through the use of rabbit concentrates (Ngoupayou, 1992; Owen *et al*., 2005), commercial poultry layers mash or some concentrate mix specifically compounded for guinea pigs is normally needed in order to obtain maximum production potential. The feed conversional ratio of 2.8/kg of feed (on dry matter basis) per kg of meat can be achieved through feeding of green fodder alone (Huss and Roca, 1982 ; Plate 2).

Plate 2: Guinea pigs feeding on forages

2.5.1 Feeding systems of guinea pigs

The feeding systems for the guinea pigs are established according to the availability of food and the costs of these foods have throughout the year. Three systems can be implemented depending on the type of breeding (family, family-commercial, commercial), and the availability of food, which are described in the following sections.

2.5.2 Forage based diet

Forage based food consists of having forage as the only form of food. It is highly influenced by the weather, seasons and forage production. In this case, forage is a main source of nutrients and assures adequate intake of Vitamin C. Nonetheless, it is important to note that a diet based on forage does not produce the best results with the animals. It is enough in terms of quantity, but does not fulfill the nutritional requirements for example the feeding only bamboo leaves or grass hay.

2.5.3 Balanced diet

As the name indicates, a balanced diet is complete and fulfills all of the requirements. Vitamin C is not stable, but decomposes that is why it is recommended to avoid degradation, using vitamin C that is stable and protected. This system, however, cannot be used permanently, but is to be periodically supplemented by forage (Elizabeth and Claudia, 2003).

2.5.4 Influence of maternal under nutrition of guinea pigs on fetal development

Fetal growth retardation can also be induced by maternal under nutrition during pregnancy. Thus, birth weight of offspring from sows fed a low-energy diet has been found to be lower than the birth weight of offspring from sows fed a high-energy diet throughout gestation (Kunkele, 2000; Bee, 2004). Likewise, maternal protein restriction has detrimental effects on fetal growth when either applied transitionally or throughout gestation. Restrictive maternal feeding has been reported to cause decreases in muscle fiber number and myonuclear number in rats and in guinea pigs (Ward and Stickland, 1991; Dwyer and Stickland, 1992; Dwyer *et al.,* 1995).

2.6 Health management

When guinea pigs receive a consistent, plentiful variety of palatable foods, and when their immediate surroundings are kept clean, disease outbreaks can be controlled. Good management practices include the regular sweeping of manure and feed wastes, and adding these materials as compost for later use in gardening and other crop production activities. The optimum temperature for young animals is over 12^0C. Adults can generally tolerate cooler temperatures better than extremely high ones, the optimum for breeding animals being 18^0C. Temperatures outside the range from 30^0 -34^0C can adversely affect breeding or lactating females. Although guinea pigs are susceptible to draughts, good ventilation and natural lighting are important to maintain heath (Terrill, 1998). Diseases are not usually an issue with the rustic common types as with other livestock, the more productive lines and selections show less resistance to health problems. Common infectious diseases include salmonella and pneumonia, while fungal attacks can cause skin problems (Richard, 2000; Owen *et al*., 2005). Hay or straw dust can also cause sneezing. While it is normal for guinea pigs to sneeze periodically, frequent sneezing may be a symptom of pneumonia, especially in response to atmospheric changes. Pneumonia can be fatal (Richardson, 2000). Because the guinea pig has a stout, compact body, the animal tolerates more easily excessive cold than excessive heat (Wagner, 1976). Guinea pigs are not well suited to environments that feature wind or frequent drafts, and respond poorly to extremes of humidity outside of the range of 30–70% (Terrill, 1998).

2.7 Growth rate

Growth is defined as an increase in weight and body size associated with biosynthesis of body tissues. Growth can be measured by the actual weight change of the animal at particular period intervals using growth curve and weight per unit time. The rate of growth is one of the most important traits in meat production as it has implications in the amount of meat output obtained and age at target weights viz puberty and slaughter weight (Malole, 2002). Different growth rates for guinea pigs have been reported under field conditions in various parts of West Africa and America. Richard (2004) reported that birth weight and growth depend on nutrition, litter size, gestation length and litter interval. Average weight in litter is 85-95g, weaning weight 180g and gaining per day 2.5 -3.5g.

Birth weight is an important economic trait in pig production. It is commonly recognized that low birth weight in piglets correlates with decreased survival and low postnatal growth rates (Milligan *et al.*, 2002; Quiniou *et al.*, 2002; Town *et al.*, 2005). Usually so called runts that fall short of certain limit in birth weight are excluded from rearing. Prenatal growth is mainly dependent on the nutritional supply to the embryo/fetus and its ability to use the available substrates. In turn, nutritional partitioning and utilization are under the control of hormones and growth factors but, conversely, nutrition may also influence the hormonal status (Brameld *et al.*, 1998; Breier, 1999; Robbinson *et al.*, 1999). Maternal features that are determined by genetic (breed, genotype) and environmental (e.g., feeding, housing) factors further modify these interactions.

Continuous inadequate nutrition may have serious consequences on fetal development. Furthermore, nutrition during fetal life may affect adult animal performance, which is also termed “fetal programming” according to previous research in humans (Barker, 1998). This seems to be especially important when fetal muscle development (myogenesis) is adversely affected (Kuhn *et al.,* 2002). An important phenomenon is that the number of prenatal formed muscle fibers determine, at least in part, the rate of postnatal fiber hypertrophy. During postnatal development, the individual muscle fibers generally grow more slowly when the number of fibers is high, and conversely, fibers grow rapidly when the number of fibers is low (Rehfeldt *et al.,* 2000). This has been shown for several species such as pigs (Fiedler *et al*., 1997) by negative phenotypic and genetic correlation coefficients ranging from – 0.3 to -0.8.

Under such circumstances, females are faced with high reproduction pressure, as well as demands for their maintenance needs and lactation for the newborn. The application of better management strategies such as improved feeding, elimination of precocious breeding and early weaning could reduce these pressures on the females. Early weaning of kids is likely to permit adequate feeding for kids (improving growth and survival) as well as reducing the demand on the body reserves of dams although Piattoni *et al*. (1999) and Xiccatto *et al*. (2000) did not observe any significant influence of early weaning on the subsequent viability of rabbits.

Fortun *et al.* (2001) showed that early weaning provided higher viability and fastest growth in weaned rabbits. Gidenne and Fortun (2002) also reported that the composition of the diet given to young rabbits (18 - 30 days of age) influenced the development of their digestive capacity, performance and later viability. They further stressed that although the development of the digestive capacity of the young rabbit is essentially under the control of ontogenetic factors, the nutritional composition of the diet consumed around weaning could affect the development of intestinal digestive capacities and more particularly microbial activity in the caecum.

Diet composition in early weaning therefore influences digestion and growth performance. The guinea pigs being pseudo-ruminants with essentially the same digestive system and physiology like rabbits would have the same response (Ngoupayou, 1992; Tchoumboue *et al*. 2001).

2.8 Butchering and cooking cavies

Slaughter age for GP under traditional management system ranges between 16 to 20 weeks and 10 weeks for commercial management with the slaughter weight of 0.8 to 2 kg (Paterson *et al*., 2001). Cavies are killed by three techniques; by strong blow at the base of the head and neck with a pipe as presented in Plate 3, by twisting and dislocating the neck, or by holding the body of the animal in one hand, placing a thumb at the junction of head and neck, then simultaneous stretching the body and pushing down with the thumb.

All techniques require some practice to perfect. Once killed, cavies are prepared for eating by two techniques. In the first, the hair of the cavies is softened by immersion in hot but not boiling water, followed by scraping. The abdomen is then opened and the animal is cleaned conventionally as represented on Plate 4. In the second technique the animal is killed and immediately hung by its hind legs and the throat is cut and blood is drained. The skin of the abdomen is pulled forward and slit with knife or scissors. The animal is skinned conventionally and then cleaned. The cleaned animal can be mounted on a spit and cooked in rotisserie fashion or can be cut into pieces and fried. However, because of its small size and the desirability of making maximum use, it is recommended that the meat be cut into several large pieces and boiled until soft (Morales, 1995). The meat can then be shredded and the small bones are removed. The meat is then included in soups, stews or fricassees, which are seasoned conventionally. The meat is dark, flavorful and especially low in fat. The small intestines (tripe) of the cavy is often cut up, washed and boiled to eat. The heart, kidneys, and liver are relished (Franklin, 1991). Plate 5 represents fried guinea pig meat. Guinea pigs are also a source of meat in Nigeria and other parts of Africa, as well as in the Philippines (NRC, 1991).

Plate 3: Killing by hitting at the base of the head

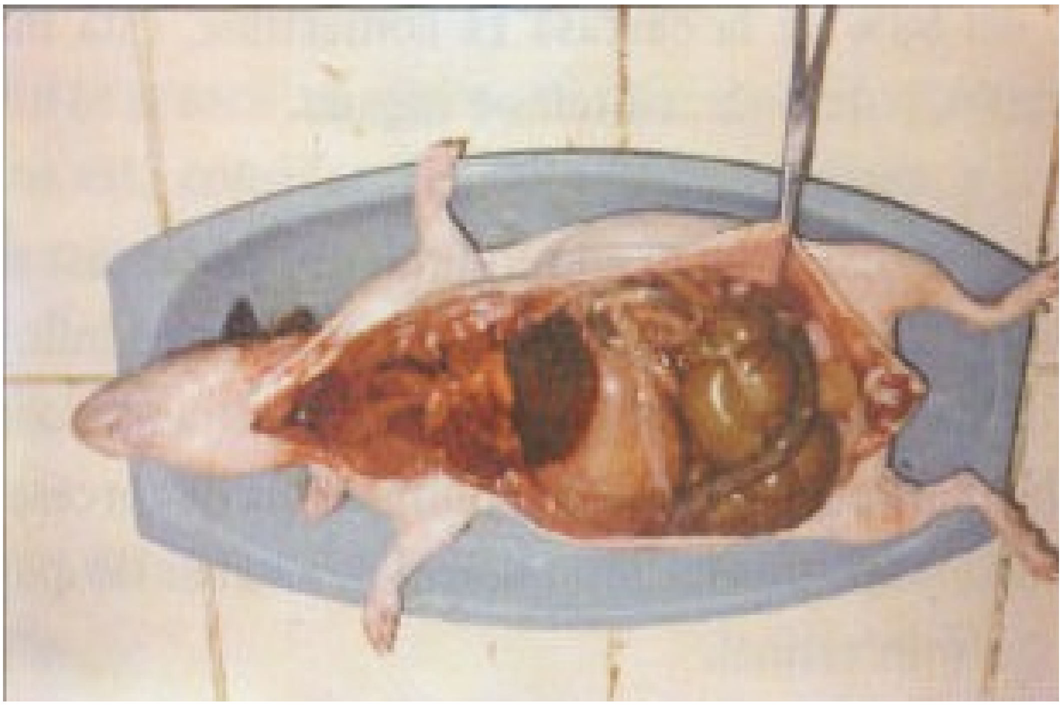

Plate 4: Cut and extraction of entrails

Plate 5: Fried guinea pig meat

2.9 Dressing percentage

Dressing percentage (DP) for an individual animal is defined as carcass weight divided by live weight (Owens *et al.,* 1995). Dressing percent is both a yield and value-determining factor and is therefore an important parameter in assessing performance of meat producing animals (Hango, 2005). It predicts the expected value of slaughtered animal because it indicates the expected yield of the carcass. It has been stated that feeding, breed, sex, slaughter weight, age, gut fill and method of dressing the animal affect dressing percentage. The higher the gut fills, the lower the DP (Hango, 2005). However, since it is expressed as a ratio of carcass weight to live weight and that many factors influence weighing of these fractions e.g. skin weight, size of gastro intestinal tract (GIT), gut fill, slaughtering procedures and partitioning of body fat, dressing percentage must be interpreted carefully. Under either method of softening by immersing in hot water there is little waste since the skin, head, bone, lungs, liver, and intestines are all consumed with the meat (Huss and Roca, 1982). Estimated dressing percentage for farm raised guinea pigs is 65%, while under improved conditions, Cicogna *et al.* (1992) reported average dressing percentage of 75% at 15 weeks of age.

2.10 Uses of guinea pigs

2.10.1Culture

Guinea pigs have been an important part of South American culture in the Andean region (in Colombia, Ecuador, Peru, and Bolivia) for thousands of years. Incans used them in religious ceremonies, and they also mummified them (Morales, 1995; Alderton, 1999). The Spanish Conquest introduced Roman Catholicism to South America, and traditional beliefs and practices combined with the new religion. For example, people in Peru use guinea pigs in the celebration of patron saint days. Also, Andean traditional medicine uses guinea pigs for diagnosis and healing (Morales, 1995).

2.10.2 Meat

In South America, guinea pigs are eaten on special occasions and are considered a delicacy. Today, there are commercial guinea pig farms in South America, but many Andeans still raise them in the traditional manner. The animals run loose in kitchens where they feed on kitchen vegetable scraps (Morales, 1995). Guinea pigs are also a source of meat in Nigeria and other parts of Africa, as well as in the Philippines (NRC, 1991; Elizabert and Claudia, 2003).

2.10.3 Pets

Guinea pigs are kept as family pets and bred for showing. Cavy breeding clubs in Europe and North America, such as the American cavy breeders association, set breed standards and organize shows and competitions.

2.10.4 Scientific research

Guinea pigs have been used in scientific research since the mid-1800s for studying pathology, nutrition, heredity and toxicology, and for the development of serums (NRC, 1991; Nowak, 1999). Various aspects of their physiology and anatomy make them ideal labaratory animals. For example: Guinea pig gestation is long enough to permit easy differentiation between stages of embryological and fetal development (Hoar, 1976).

Guinea pigs are useful for studying collagen biosynthesis, as they do not produce their own vitamin C, unlike other small labaratory animals such as mice, rats and hamsters (Navia and Hunt, 1976). Collagen biosynthesis requires vitamin C. Compared to that of other small lab animals, the guinea pig electrocardiogram waveform is more similar to the human waveform. Also, guinea pigs generally are calm animals, so it is possible to obtain continuous and stable readouts (Sisk, 1976). Hearing studies use guinea pigs since their inner ear is readily accessible (McCormick and Nuttal, 1976). Guinea pigs are ideal candidates for germ-free research, since their precocial young have a good chance at surviving from birth on solid food. Scientists surgically remove the pups from the pregnant guinea pig in a sterile environment, and then raise them on sterile food in a germ-free environment (Wagner and Foster, 1976).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 The study area

Njombe District is one of the seven district of Iringa Region. Others are Iringa rural, Iringa Urban, Kilolo, Mufindi, Makete and Ludewa. Njombe District is bordered by Mufindi District on the North, Mahenge District in the east, Songea District in the South and Makete and Ludewa Districts in the west. It lies between latitude 7° and 9° South and longitude 25° and 30° East of Greenwich Meridian. The area lies between 1600-2700m above sea level. It has a temperate like climate with rainfall distribution throughout the year. Average annual rainfall is 1600 mm with temperatures ranging from 15^0 to 20^0C.

Small scale agricultural production includes crop and livestock production. Types of cropping systems are subsistence and commercial crop production (vegetable and perennial horticulture production). Subsistence crops include maize, beans and Irish potatoes, while cash crops grown are sunflower, cabbages, tomatoes, onions and beans. Perennial horticultural crops are fruits, such as peaches, plums, pears and apples. Forest trees are also grown largely to provide fire wood and timber. The livestock reared are mainly cattle, pigs, goats, sheep, local chicken, ducks and guinea pigs. The study was conducted in Imalinyi, Igominyi and Njombe town divisions, in Njombe district, Iringa region, Tanzania. These areas were chosen because they are actively engaged in guinea pigs production.

3.2 Survey study

3.2.1 Sampling procedure

Three divisions were selected at random out of six divisions. One ward was selected from each of the three divisions within the district to form representative ward samples. Two villages were selected at random from each ward and four households were selected from each village. In Imalinyi ward the survey study was carried out in Igagala and Ulembwe villages while in Uwemba ward which is in Igominyi division also two villages Kifanya and Magoda were selected. In Njombe ward, Wikichi and Itulike villages were involved. A multistage sampling technique was employed to select the respondents in the following technique.

DV1	DV2	DV3
1WD	1WD	1WD
2VLG	2VLG	2VLG

4HH 4HH 4HH

(3X3X2) X4 = 72HH

Where:

DV = Division, WD = Ward, VLG = Village and HH = Household.

The respondents were chosen by simple random sampling at the household level. Pre-testing of the questionnaire involving 10 respondents was conducted in Njombe urban for six days during the last week of August, 2008, before the actual survey. This was undertaken in order to determine the correctness of the questions and the expected responses from guinea pigs keepers and also to check whether the questionnaire was comprehensive enough to collect the required information.

3.2.2 Data collection

A structured questionnaire was used to obtain the required qualitative and quantitative data (Appendix 1). Heads of households were interviewed. A sample of 72 farmers was interviewed. The data collected included background information, occupation, land use, animal rearing, and management of guinea pigs, feeds and feeding, sources of labour, diseases, animal preference, processing and consumption. The study further included data on monetary input and output relationship of various activities and how they complement or compete with each other. Different classes of guinea pigs were weighed during the survey.

3.2.3 Data handling and statistical analysis

Data from questionnaires was coded and entered into a spread sheet for analysis. The frequency procedure of Statistical Package for Social Science- SPSS version 12.0 for windows was used. Averages, percentages and frequencies were used to summarize the information obtained from the questionnaire.

Simple frequency procedure was used to analyze cases where respondents had to give only one answer for instance yes or no, while multiple response procedure was employed where respondents gave more than one answer.

3.3 The feeding experiment

3.3.1 Source of experimental animals

A total of 60 Tanzanian local guinea pigs (GP) with mean initial body weight of 312.5g for females and 315.7g for males and aging approximately one month were purchased from farmers of Itulike and Ramadhani villages in Njombe district. From each village 30 GP were purchased, half of them being males and the other half being females. The animals were identified to enable recording to be done**.**

3.3.2 Experimental lay-out

The intention of the study was to evaluate the effect of the supplementing GP on growth rate and carcass characteristics. There were two origins (Itulike and Ramadhani villages) and two sexes (males and females). There were three dietary feeding levels and each treatment had GP from both locations and sexes to make a 2^2x3 feeding experiment as shown in Table 1.

Table 1 : Treatments allocations

	Location 1		**Location 2**	
Treatments	**Females**	**Males**	**Females**	**Males**
T1	5	5	5	5
T2	5	5	5	5
T3	5	5	5	5

GP were weighed and thereafter randomly allocated into the three feeding diets.

T1 = Basal forage of bamboo leaves plus 5g of concentrates; T2 = Basal forage of bamboo leaves plus 20g of concentrates and T3 = Basal forage of bamboo leaves plus 30g of concentrates. The concentrate was composed of maize bran, sunflower seed cake and mineral mixture. Each group of 5 guinea pigs was placed into a separate raised wood type compartment of 540 cm^2 (i.e. 90 cm long and 60 cm wide) with a height of 180 cm. The experiment was designed to compare the traditional management practiced by farmers with higher levels of feeding. The lowest level of T1= 5g was meant to imitate the traditional system of management whereby little or no concentrate is offered. The experiment lasted for 4 months (From 8th September to 30th December 2008). The feeding experiment was conducted at chosen site in Njombe.

3.3.3 Feeding management

Piglets were fed *adlib* with fresh bamboo leaves collected from the field and supplemented with concentrates. During the experimental period, 55g of concentrates were weighed daily into a dish. Feeding was performed two times a day in the morning at 08.30 and in the evening at 16.30 hours, with small amount of concentrate placed in the feeders. Each morning at 07.30 hours before feeding, spilt feeds were collected from the trays and thrown into composite pit since the refusals were contaminated with pelleted feaces. Clean water was provided in clean drinkers every day at 13.00 hours.

(a) Maize bran (MB)

A product of MB from local milling machine in Njombe was used. It was sun-dried to reduce moisture content before storage and feeding.

(b) Sunflower seed cake

Sunflower seed cake was produced by Njodeco Company and purchased from a trading shop in Njombe. Before mixing the clumps were crushed using hammer mill to allow easy mixing.

(c) Bamboo leaves

Bamboo is a vernacular or common term for members of a particular taxonomic group of larger woody grasses (family Andropogoneae/ poaceae, subfamily Bambosoideae) (*Gratani et al., 2008)*. Bamboo is believed to have originated in Asia (Bystriakova *et al.,* 2003). The tree grows in wild all around most parts of India and in Tanzania particularly in Iringa region. Bamboo leaves were cut with branches and fed in that form because guinea pigs tend to eat in an up right manner like goats.

(d) Vitamins and mineral supplement

Mineral premix was purchased from an Agro-vet shop in Njombe and included in the concentrate mixture according to manufacturer's (Cooper Kenya LTD) instructions. It was mixed with concentrates in a ratio of 5 table spoons to 15 kilogram of concentrates. Composition of vitamins, minerals and growth promoter (pig booster) was given as follows:

Vitamins:-A = 10 000 000 IU**,** D = 100 000**,** E = 2000 mg**,** B6 = 3000 mg**,** B1 = 2000 mg**,** B2 = 5000 mg**,** B3 = 1500 000 mg**,** Pantothermic acid = 30 000**,** B12 = 20 mg and Betaine = 40 000 mg.

Amino acids (AAs):- Lysine = 500 mg and Methionine = 500 mg

Trace minerals Manganese = 50 000 mg**,** Zinc = 50 000 mg**,** Iron = 40 000**,** Copper = 6000**,** Cobalt = 4 000 and Iodine = 2000.

The composition of concentrate used in this study was comprised of maize bran (67%) and sunflower seedcake (33%) dry matter basis. The formulated diet contained 12.54 ME MJ/kg DM and approximately 18% crude protein.

The proximate chemical compositions of bamboo leaves, maize bran and sunflower seed cake were determined at the Department of Animal Science and Production (DASP) laboratory. Samples were ground to pass through a sieve of 1mm. Dry matter (DM), Crude Protein (CP), Crude Fiber (CF), Ether Extract (EE) and Ash were determined according to the method described by AOAC (1990). Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) were determined according to procedure of Van Soest *et al.* (1991).

3.3.4 Variables studied

3.3.4.1 Growth rates

The actual age at start of experiment was not known but were approximately one month old and piglets were weighed to get initial weights. The piglets were weighed on monthly basis by using a spring balance and from monthly weights growth rates were computed.

Monthly weight gains at different ages were obtained as the difference between the second month and first month weight, third month and second, fourth month and third month, fifth month and fourth (Appendix 7). The difference between fifth month and first month body weights were indicating the total gain for the whole period of the experiment.

3.3.4.2 Killing out characteristics

The feeding experiment lasted for 120 days. Before slaughter, they were starved for 24 hours and then weighed so as to minimize variation due to gut fill. Slaughtering was done by hitting them at the base of the head and immediately by cutting the carotid artery and jugular vein on the neck region using a sharp knife followed by bleeding. Thereafter, the carcasses were immersed in hot water and scrupted by using a dull knife. The head and feet were cut off. Hot dressed carcass weights (HCW) were taken after removing all internal organs (viscera) and the following hot carcass measurements were recorded: weights of the carcass, head, feet and empty intestines.

3.3.5 Data analysis

The General Linear Models (GLM) procedure of Statistical Analytical System (SAS, 2000) was used to analyse weights at different ages, growth rates, slaughter weight, carcass weight, head weight, feet weight, weight of intestines and dressing percentage. Dressing percentages of guinea pigs were calculated as hot carcass weight divided by slaughter weight times 100.

In analyzing body weights, initial body weights were used as a covariate so as to control the influence of live weight on response to treatments, although there was an oversight in balancing the weights between treatments during the start of the trial, and slaughter weight was used as a covariate on carcass characteristics. Fixed effects fitted in the model were sex of piglets, treatments and origin of the animals. The following statistical model was used:

$Y_{ijkl}=\mu + D_i + S_j + L_k + (D*S)_{ij} + (D*L)_{ik} + (S*L)_{jk} + b(x_{ijkl} - \bar{x}) + E_{ijkl}$

Where:

Yijkl = Dependant variables (weights, growth rates, carcass weights, head weights, feet weights, dressing percentages, etc.) µ= General mean

Di= Effect of i^{th} experimental diet (T1, T2 and T3)

Sj= Effect of j^{th} sex (1=males, 2= females)

Lk=Effect of k^{th} origin (1= Itulike, 2= Ramadhani)

D*S, D*L, S*L = Effect of interactions as described above

Xijkl = Individual observation for each dependent variable

$\bar{X}$ = mean initial body weight in analyzing body weights and mean slaughter weight in analyzing carcass traits.

Eijkl=Random error. (N, $0,\delta^2_e$)

Treatment means were compared using the pdiff procedure at P<0.05 (SAS, 2000).

CHAPTER FOUR

4.0 RESULTS

4.1 Survey results

4.1.1 Views by guinea pig keepers

Results on socio- economic characteristics of the households surveyed are presented in Table 2. The majority (63.9%) of households were male headed. About 22.2% of the interviewed people were between 46 and 55 years of age.

Further, the majority (73.6 %) of respondents had primary education while 13.9 % had informal education and those with secondary education made only 8.3%. The family sizes of the selected households below 3 were 52.1 % and 4 to 6 were 32.4%. The major economic activity of the people in the surveyed area was farming as it involved 81.9% of respondents.

Table 2: Households' socio – economic characteristics (N=72)

Variables	Frequency	Percent (%)
Age (years)		
15 - 25	13	18.1
26 -35	13	18.1
36 - 45	12	16.7
46 - 55	16	22.2
56 – 65	11	15.2
66 – 75	7	9.7
Sex of respondent		
Male	46	63.9
Female	26	36.1
Education level		
Primary school	53	73.6
Secondary school	6	8.3
College	2	2.8
University	1	1.4
No formal education	10	13.9
House hold size		
Below 3	37	52.1
4 – 6	23	32.4
9 – 12	8	11.3
9 – 10	2	2.8
Above 10	1	1.4
Activities		
Farming	59	81.9
Livestock keeping only	5	6.9
Employment only	6	8.3
Business	2	2.8

About 51.4% of the households interviewed raised guinea pigs ranging between 9 to 16 and very few people kept below 5 and above 20 animals (Table 3).

Table 3: Number of guinea pigs kept by households

Number of guinea pigs	Frequency	Percent (%)
< 5	8	11.1
5 – 8	12	16.7
9 – 16	37	51.4
17 - 20	9	12.5
>20	6	8.3

The majority (93.1%) of farmers who keep guinea pigs practise intensive production system. About 45.8% of farmers used mud as building material for constructing houses meant for keeping guinea pigs, while 34.7% used wood. Further, 50% of respondents keep 10-25 GP/ m^2 and a good number of them (44.3%) keep less than 10 GP/ m^2 as presented in Table 4.

Table 4: Production systems of guinea pigs keeping and number of livestock

System practiced	Number of farmers	Percentage
Free range system	4	5.6
Indoor system	67	93.1
Semi – intensive system	1	1.4
Material		
Wood	25	34.7
Bricks	14	19.4
Mud	33	45.8
Number of GP per m^2		
< 10	31	44.3
10 – 25	35	50.0
26 – 41	3	4.3
58 -73	1	1.4

Results on the distribution of farmers by years they started keeping guinea pigs are presented in Table 5. Over half (57.4%) of the respondents started keeping guinea pigs from year 2000. However, the historical background shows that one farmer started keeping guinea pigs between 1966 and 1970. Popularity of keeping guinea pigs has been increasing with time as shown by the increase in number of people raising them.

Table 5: Distribution of farmers by years they started keeping guinea pigs

Years	Frequency	Percentage
1966 – 1970	1	1.5
1971 – 1980	7	10.3
1981 – 1990	8	11.8
1991 – 2000	13	19.1
2001 – 2008	39	57.3
Total	68	100.0

The main reasons for keeping guinea pigs were to provide meat as a source of protein (35.5%), manure (32.8%), and income generation (17.5%) and as pet animals (14.2%) (Table 6). Most of the respondents (90.3%) expressed their desire to increase their number of guinea pigs. However, the majority of the respondents involved in this study expressed their views that they lack awareness of how to manage these animals (40.3%), others do not prefer to keep and buy them (9.7%) and in addition some feel the activity of keeping GP is labourious especially when it comes to the task of feeding them as indicated on Table 6.

Table 6: Reasons for keeping and not keeping guinea pigs

Aspect	Frequency	Percentage
Reason for keeping GP [1])		
Pet animals	26	14.2
Manure	60	32.8
Meat as source of protein	65	35.5
Income	32	17.5
Decision on herd size		
Increase herd size	65	90.3
Decrease herd size	1	1.4
Maintain present herd	6	8.3
Reasons for not keeping GP		
They feel laborious to look for their feeds	9	12.5
Not aware of these animals	29	40.3
Predators	3	4.2
Dirtiness	2	2.8
Do not like them	7	9.7
Lack of time to keep them	8	11.1
They can not buy them	7	9.7
They are not attractive	2	2.8
Don’t see any benefits of keeping GP	5	6.9

1) Total frequency > 100% due to multiple responses

Data on ranking of importance of different livestock species are shown in Table 7.

Cattle were ranked as the most important livestock species in the three wards followed by pigs and local chickens. Local sheep were ranked least by two wards.

Table 7: Ranking of different livestock species according to their importance

Location	**Species**		**Percentage**		**Overall**
		First	**Second**	**Third**	**Rank**
Uwemba ward	Local cattle	100	0	0	1
	Local goat	0	0	10	4
	Local sheep	0	0	4	6
	Pigs	10	70	10	2
	Local chickens	0	65	20	3
	Rabbits	0	0	7	6
	Guinea pigs	0	0	10	4
Imalinyi ward	Local cattle	100	0	0	1
	Local goat	0	40	0	4
	Local sheep	0	30	0	5
	Pigs	0	65	20	2
	Local chickens	0	50	16	3
	Rabbits	0	0	2	7
	Guinea pigs	0	0	7	6
Njombe town	Local cattle	100	70	0	1
	Local goat	0	0	5	5
	Local sheep	0	0	5	5
	Pigs	0	65	10	3
	Local chickens	0	65	15	2
	Rabbits	0	0	5	5
	Guinea pigs	0	0	8	4

Total frequency > 100% due to multiple responses

4.1.2 Type of feeds

Feeding was the most frequently mentioned limiting factor in increasing herd size of guinea pigs. Bamboo leaves (39.3%) and vegetables (25.1%) were the major feed resource of guinea pigs. There was a very low awareness on the use of commercial feeds (Table 8).

Table 8: Types of feeds locally used to feed guinea pigs

Type of feed	Frequency	Percentage
Grasses	5	2.7
Bamboo leaves	72	39.3
Maize brain	32	17.5
Kitchen waste	28	15.3
Vegetables	46	25.1
Source of supplement		
Own preparation	3	75.0
Commercially prepared	1	25.0

Total observation > 100% due to multiple responses.

4.1.3 Labour division

Survey results showed that all members of the families were involved in providing water (65.3%), cleaning (36.1%) and feeding (63.9%) while slaughtering and selling were done by the mother or father (Table 9).

Table 9: Distribution of labour division and decision making by household members

Household members	Watering		Cleaning		Feeding		Slaughtering		Selling	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Father	-	-	1	1.4	-	-	9	12.7	3	4.4
Mother	10	13..9	15	20. 8	11	15..3	20	28..2	14	20.6
Children	8	11.1	24	33. 3	7	9.7	3	4.2	1	1.5
Father and Mother	6	8.3	5	6.9	7	9.7	24	33.8	31	45.6
All members of the family	47	65..3	26	36.1	46	63..9	15	21.1	19	27..9
Hired labour	1	1.4	1	1.4	1	1.4	-	-	-	-

4.1.4 Number of guinea pigs

The average flock sizes were 14.8, 11.7 and 13.2 for Uwemba, Imalinyi and Njombe wards, respectively. The overall mean was 13.2 GP per household. The average number of breeding males, mature females, young males and young females were 2.4, 5.4, 3.9, and 5.3 respectively (Table 10).

Table 10: Number of guinea pigs kept per household by age classes

Location	Number of GP	Breeding males	Mature females	Young males	Young females
Uwemba ward	14.8	2.3	8.0	6.9	9.7
Imalinyi ward	11.7	2.1	4.3	2.6	3.3
Njombe town	13.2	2.7	4.1	2.8	3.9
Overall mean	13.2	2.4	5.4	3.9	5.3

4.1.5 Performance of guinea pigs

During the survey different classes of GP were weighed whose means are given in Table 11 and Appendix 6. Mature GP were slightly above half a kilogram. The mean weights (± s.e) were 571.3 ± 8.71, 548.9 ± 8.25, 233.5 ± 2.19, 231.6 ± 2.38, 126.4 ± 3.52, and 127.1 ± 3.18 for mature boars, mature females, growing males, growing females, young males and young females respectively.

Table 11: Mean weights of various classes of guinea pigs in Njombe district

Variable	Frequency	Mean	sd	CV %
Age category of GP	**(N)**			

Mature boars	162	571.3	110.9	19.4
Mature female (sows)	191	548.9	114.1	20.8
Growing males	127	233.5	24.7	10.6
Growing females	132	231.6	27.3	11.8
Young males	76	126.4	30.8	24.3
Young females	106	127.1	32.8	25.8

Sd = standard deviation

CV% = Coefficient of variation in percent

4.1.6 Factor affecting reproduction

The reproductive traits of guinea pigs according to farmers' experience are presented in Table 12. A half of the respondents (51.4%) weaned their guinea pigs at 3 to 4 months of age. About 94.4% of the respondents mentioned that they didn't know signs of farrowing, whereby cases of parturition problems were very few (2.8%). About 73.6% of the replacement stock was obtained from their own flocks. Further, 77.8% of the respondents mate their animals once per conception. Few cases of abortion were reported to occur and 77.8% of guinea pig keepers did not know the causes of abortion.

Table 12: Factor associated with reproductive performance of GP

Variable	Frequency	Percentage
Weaning age (month)		
1 to 3	35	48.6
3 to 4	37	51.4
Signs of furrowing		
Yes	4	5.6
No	68	94.4
Parturition problems		
Yes	2	2.8
No	70	97.2
Replacement stock		

Hired	4	5.6
Own	53	73.6
From all source	15	20.8
Frequency of mating		
Once	56	77.8
Twice	10	13.9
Three times	5	6.9
Four times	1	1.4
Problems of abortion to GP		
Yes	9	12.5
No	63	87.5
Causes of abortion		
Not known	7	77.8
In-breeding	2	22.2

4.1.7 Sex of guinea pigs disposed

According to the report given by 72 respondents, 9 of them disposed male guinea pigs, while 57 respondents disposed both male and female guinea pigs. Among the 72 respondents, 29 slaughtered GP in the households once per month, 19 farmers twice per month, while one reported very often and 21 interviewees were not used to guinea pig meat and 53 out of 72 respondents offered guinea pigs as presents to other people (Table 13). No taboos related to eating GP meat were mentioned.

Table 13: Sex of guinea pigs disposed, frequency of slaughtering, offer as present and taboos related to GP

Variable	Frequency	Percentage
Sex of GP disposed		
Male	9	13.4
Female	1	1.5
Male and female	57	85.1
Frequency of slaughter		
Once/per month	29	41.4
Twice/per month	19	27.1
Very often	1	1.4
Not used	21	30.0

Offer as present to other		
Yes	53	73.6
No	19	26.4
Taboos related to GP eating		
None	72	100.0

4.1.8 Type of livestock kept

Large numbers of guinea pigs were kept in Uwemba ward followed by Njombe and Imalinyi wards with an overall mean of 13.2, while poultry, pigs, cattle, goats, sheep and donkeys had overall means of 12.3, 2.4, 7.2, 13.0, 5.5, and 4.0 respectively as presented in Table 14.

Table 14: Number of different types of livestock kept by households

Ward	Guinea pigs	Poultry	Pigs	Cattle	Goats	Sheep	Donkeys
Uwemba	14.8	10.7	2.8	7.4	17.5	0	2.0
Imalinyi	11.6	12.2	1.9	12.0	10.7	0	6.0
Njombe	13.2	13.9	2.6	5.5	8.0	5.5	0
Overall mean	13.2	12.3	2.4	7.2	13.0	5.5	4.0

4.1.9 Methods and reasons for disposal of GP

The most common methods used to dispose guinea pigs were through selling of live guinea pigs and slaughtering as reported by 68 out of 72 respondents for the purposes of income generation. The age of disposal varied according to producer's interest; however 36 farmers out of 68 preferred to dispose guinea pigs in their adult stage. The main reason for disposing GP given by 36 farmers out of 72 respondents was to get money. Most of the respondents (92.5%) indicated that the common method used to slaughter guinea pigs was through stunning by knocking on their heads then dehairing with warm water (Table 15).

Table 15: Methods and reasons for disposing GP

Variable	Frequency	Percentage
Methods		
Sale	23	33.8
Slaughter	22	32.4
Sale and slaughter	23	33.8
Age at disposal		
Adult	36	52.9
Old age	22	32.4
Young	10	14.7
Reasons for disposal [1])		
Lack of feed	3	2.8
To control in breeding	9	8.3
Fighting	24	22.0
Old age	11	10.1
To get meat	20	18.3
To get money	36	33.0
Normal culling	6	6.0
Methods of slaughter		

Stunning by knocking	62	92.5
Slaughtering by knife	4	6.0
Stunning by knocking then use fire for dehairing	1	1.5

Total frequency > 100% due to multiple responses

4.1.10 Prices of GP sold at different ages

Mature male and female guinea pigs were sold at 2000/= Tshs and young piglets were sold at 1500/= Tshs each. The maximum income per month was 20,000/=Tshs (Table 16). Farmers experienced high prices for these animals in dry seasons. Farming activity associated with food shortages during the dry season lead the producers to sell most of their guinea pigs as source of meat.

Table 16: Prices of GP sold at different ages

Prices of GP sold	Price	Maximum income per month
Males	2000/=	20,000/=
Females	2500/=	20,000/=
Young males	1500/=	10,000/=
Young females	1500/=	10,000/=

4.1.11 Guinea pigs meat consumption

Results on processing, consumption and social functions of guinea pigs are presented in Table 17. Sixty two out of 72 farmers who were interviewed stated to prefer fried meat to cooked one. Guinea pigs are used for various social functions such as weddings, rituals and traditional dances.

Table 17: Aspects related to consumption of guinea pig meat

Meat processed	**Frequency**	**Percentage**
How meat is processed		

Fried/roosted	62	86.1
Cooked	10	13.9
Carcass consumption		
Carcass	62	86.1
Whole GP	5	6.9
Throw away intestine	5	6.9
Social function		
Local belief (adolescence stage)	29	40.3
Wedding	31	43.0
Traditional dance	10	13.9
Christmas festivals	1	1.4
Provided during group work(*migowe*)	1	1.4

4.1.12 Production constraints

Animal health related problems were the general concern of livestock keepers. Many farmers (29.4%) mentioned worms as the major constraint to guinea pigs production followed by mange (23.5%). Other constraints were skin related diseases (17.6%) and other diseases (11.8%). Regarding management constraints it was reported by 35.5% of farmers that, in-breeding was the major problem (Table 18).

Table 18: Production constraints associated with the raising of guinea pigs

Constraint	Frequency	Percentage
Other diseases	4	11.8
Abscesses	2	5.9
Diarrhoea	2	5.9
Pneumonia	2	5.8
Mange (alopecia)	8	23.5
Worms	10	29.4
Skin diseases	6	17.6
Predators		
Cats	70	43.8
Dogs	58	36.4
Rats	32	20.0
Management constraints		
Laborious	28	24.1
Poor extension services	5	4.3
Many activities at home	1	9.0
Lack of education	13	11.2
Lack of improved breed	8	6.9
Lack of markets	1	9.0
Inbreeding	7	35.5

Total frequency > 72% due to multiple responses

4.1.13 Control measures used for some of the constraints

Control measures for some of the constraints are given in Table 19. To control in-breeding in their flocks, farmers use different methods including cross breeding (83.9%), castration of boars (6.4%), slaughtering (6.4%) and selling (3.2 %) of boars. In order to control predators farmers use different techniques such as building strong rooms (49.4%), poisoning them (31.3%) and use of traps (10.8%).

Table 19: Control measures used for some of the constraints

Methods used	Frequency	Percentage
To control in breeding		
Castration of boars	2	6.4
Selling of boars	1	3.2
Slaughtering of boars	2	6.4
Cross breeding	26	83.9
To control predators		
Use of traps	9	10.8
Poisoning them	26	31.3
Strong rooms	41	49.4
Making strong doors	7	8.4

Total frequency > 72% or < 72% due to multiple responses

4.2 Experiment results

4.2.1 Health of experimental guinea pigs

During the adaptation period all animals were in good condition with quite encouraging appetite. Initially, animals on concentrate supplementation succumbed to minor diarrhea as they were not used to concentrate feed. Two guinea pigs developed signs of alopecia (i.e. shedding of hair together with skin bud). The shedding started from peripheral parts of the body and back bone (Plate 6).The first animals to show signs were from T2 and the signs were observed 2 weeks after the commencement of the experiment and were treated immediately by using ivormectin drug which controls external and internal parasites.

Plate 6: Guinea pig with dermatitis

4.2.2 Chemical composition of feeds

Chemical composition of bamboo leaves, maize bran (MB) and sunflower seed cake (SSC) are shown in Table 20. The results show that sunflower seed cake had higher CP content (36.8%) compared to MB (10.0 %). Furthermore, bamboo leaves had the highest CF content (38.4%) as compared to other feeds, followed by sunflower seed cake (25.8%). The highest NDF content (72.6%) was observed in bamboo leaves followed by sunflower seed cake (37.9%) and maize bran (27.4%). Results of in-vitro digestibility showed that maize bran had the highest degradability (73.0%) followed by sunflower seed cake (55.7%).

Table 20: Proximate composition of maize bran, sunflower seedcake and bamboo leaves (on % DM basis)

Composition	Maize bran	Sunflower seedcake	Bamboo leaves
%DM	46.0	47.3	46.4
OM	45.0	44.4	40.2
CP	10.0	36.8	21.0
CF	6.4	25.8	38.4
EE	9.2	9.9	4.8
ASH	4.9	5.6	1.9
NDF	27.4	37.9	72.6
ADF	16.9	30.7	35.3
In-vitro digestibility	73.0	55.7	49.2
Minerals	%Ca 1.5, %P 1.5	%Ca 0.8,%P 1.5	%Ca 0.9, %P 2.5

4.2.3 Effect of sex on growth and carcass traits

Least squares means for effect of sex on body weights and carcass traits showed that there was no significant difference between male and female guinea pigs (Table 21). Sex did not significantly influence (P>0.05) carcass components as % of slaughter weight**.** The overall mean weight at 5 months was 530.4± 3.17g. At this age female guinea pigs were heavier than males by 5.2 g. However, the effect of sex on growth rate (Figure 1) shows that males were slightly heavier than females at the start of experiment but females had higher weight at the end of experiment. There were no sex differences in initial weight, final weight, weight change and daily weight gain (Table 22).

Table 21: Lsmeans (± s.e) for weights at different ages and carcass components of guinea pigs (g)

Variable	Sex		Significance level
	Females	Males	
Number of guinea pigs	30	30	
Weight in 2nd month	366.4 ± 0. 86	368.0 ±0.86	NS
Weight in 3rd month	419.3 ±1.55	420.1 ±1.55	NS
Weight in 4th month	470.7 ±2.26	473.7 ±2.26	NS

Weight in 5th month	533.0 ±4.47	527.8 ±4.47	NS
Carcass components as % of slaughter weight			
Head weight	16.6 ± 0.29	16.6 ± 0.29	NS
Feet weight	4.5 ± 0.06	4.5 ± 0.06	NS
Weight of intestines	10.7 ± 0.14	10.4 ± 0.14	NS
Dressing %	68.1 ±0.33	68.5 ±0.33	NS
Weight of different carcass components(in g)			
Head weight (g)	86.9 ±1.44	87.7 ± 1.44	NS
Feet weight (g)	23.8 ± 0.17	23.8 ± 0.17	NS
Weight of intestines (g)	56.5 ± 0.72	54.9 ± 0.72	NS
Carcass weight (g)	363.2 ± 1.62	364.0 ± 1.62	NS

NS = Not significant (P>0.05)

* = Significant at (P<0.05),

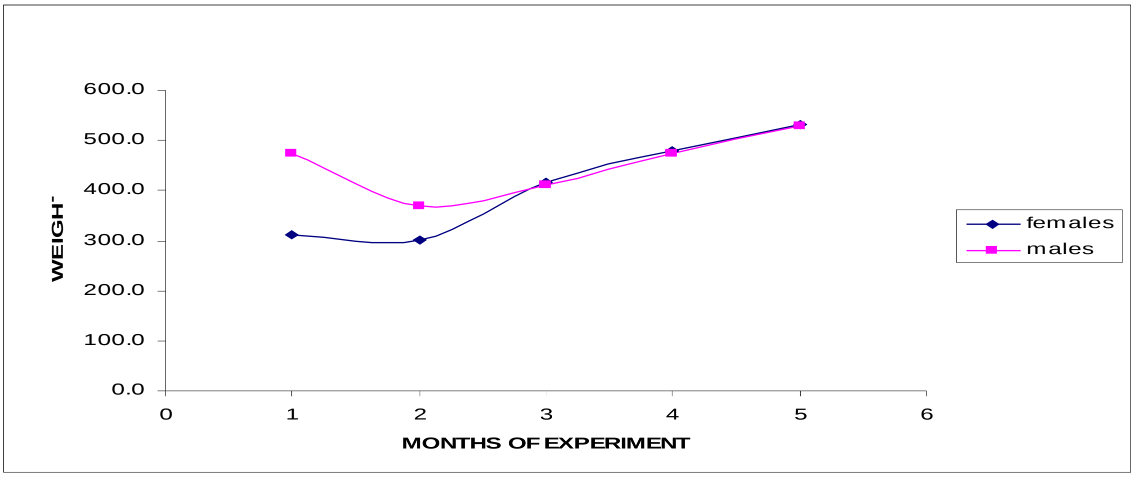

Figure 1: Effect of sex on growth rate of guinea pigs

Table 22: Lsmeans (± s.e) for effect of sex on growth performance of guinea pigs (g)

Variable	Sex		Significance level
	Females	Males	
Number of guinea pigs	30	30	
Initial weight	312.5 ± 9.09	315.7 ±9.09	NS
Final weight	531.7 ±8.59	529.1 ±8.59	NS
Weight change	219.2 ±4.76	213.4 ±4.76	NS
Daily weight gains	1.8 ±0.04	1.8 ±0.04	NS

4.2.4 Effect of origin of guinea pigs

Table 23 presents least squares means for weights and carcass traits of guinea pigs by place of origin. The results reveal that effect of origin on weights at different ages were not significantly (P>0.05). There was no significant difference (P>0.05) in carcass components as % of slaughter weight. There was highly significant difference (P<0.001, Appendix 4.2) in mean feet weights of guinea pigs from the two origins whereby guinea pigs from Ramadhani were 4% higher.

With regard to place of origin, at the start of experiment, guinea pigs from Ramadhani were significantly (P<0.01) heavier (335.6g) compared to those from Itulike (292.6 g). This difference was also reflected in the final weights where GP from Ramadhani were 8% heavier (p<0.001) than those from Itulike (Appendix 5.2). Origin had no significant effect on neither total weight gain or on daily weight gains (Table 24).

Table 23: Lsmeans (± s.e) for the effect of origin of guinea pigs on weights at different ages and carcass traits

Variable	Origin		Significance level
	Itulike	Ramadhani	
Number of guinea pigs	30	30	
Weight in 2nd month	366.9 ± 0.91	367.6 ± 0.19	NS
Weight in 3rd month	419.3 ± 1.63	419.1 ± 1.63	NS
Weight in 4th month	472.0 ± 2.38	472.4 ± 2.38	NS
Weight in 5th month	526.2 ± 4.72	526.2 ± 4.72	NS
Carcass components as % of slaughter weight			
Head weight	16.8±0.29	16.4±0.29	NS
Feet weight	4.6±0.06	4.5±0.06	NS
Weight of intestines	10.7±0.14	10.3±0.14	NS
Dressing %	68.4± 0.32	68.9± 0.32	NS
Weight of different carcass components			
Head weight	86.4 ± 1.53	88.2 ± 1.53	NS
Feet weight	23.3 ± 0.19^a	24.4 ± 0.19^b	***
Weight of intestines	56.4 ± 0.76	55.0 ± 0.76	NS
Carcass weight	364.3±1.72	362.9±1.72	NS

NS = Not- significant (P>0.05)

*** Significant different (P<0. 001).

Table 24: Lsmeans (± s.e) for the effect of origin on growth performance of guinea pigs

Variable	Origin		Significance level
	Itulike	Ramadhani	
Number of guinea pigs	30	30	
Initial weight	292.6 ± 9.09 [b]	335.6 ± 9.09 [a]	**
Final weights	508.9 ± 8.59 [b]	551.9 ± 8.59 [a]	***
Weight changes	216.2 a ± 4.76	216.3 a ± 4.76	NS
Daily weight gains	1.8 ± 0.04	1.8 ± 0.04	NS

4.2.5 Effect of dietary treatments

Body weight changes at different ages as influenced by treatment diets are shown in Table 25 and Fig. 2. T1 had the highest mean weight in the 1st month (start of experiment) but least in the 5th month while T2 and T3 had linear increase in weights. From the 2nd month, T3 excelled other treatments. There was no significant difference between T2 and T3 but the two differed significantly (P<0.05) from T1. All carcass traits were not significantly (P>0.05) influenced by plane of nutrition. However, slaughter weight significantly (P<0.001) determined all carcass traits analyzed in this study. In absolute terms, guinea pigs in T1 slightly exceeded their T2 and T3 counterparts in the weight as percentage of slaughter weights of head, weight of feet and weight of intestines by margins of 0.9g, 0.2g and 0.6g respectively.

Table 26 shows effect of concentrates supplementation on growth rate of guinea pigs. Dietary treatments had significant (P<0.001) effects on final weights, total weight gain and daily weight gains. T2 guinea pigs had lowest initial weights (280.0g) compared to the other treatments. T3 guinea pigs excelled the other treatments in final weights, total weight gain and daily weight while T1 guinea pigs were the least.

Table 25: Lsmeans (± s.e) for effect of level of supplementation on weights at different ages and carcass traits

Variable	Overall mean	Treatments		
		T1	**T2**	**T3**
2nd month	367.2±0.61	347.4±1.13 [b]	375.7±1.15 [a]	378.6±1.06[a]
3rd month	419.2±1.10	380.2±2.02[b]	436.4±2.07 [a]	441.1±1.90[a]
4th month	472.2±1.60	413.5 ±2.95[b]	498.1±3.02[a]	505.1±2.78 [a]
5th month	530.4± 3.17	450.2±5.84 [b]	556.3±5.97 [a]	584.6±5.49 [a]
Carcass components as % of slaughter weight				
Head weight	16.6±0.03	17.5±0.35[a]	16.6±0.35[b]	15.8±0.35[b]
Feet weight	4.5±5.5.55	4.8±0.07[a]	4.6±0.07[b]	4.2±0.07[c]
Weight of intestine	10.5±0.01	10.9±0.17[a]	10.3±0.17[b]	10.3±0.17[b]
Dressing %	68.3± 0.21	68.1±0.46	68.5±0.37	68.3±0.47
Weight of different carcass components				
Head weight	87.3±1.02	87.6±2.22	86.6±1.70	87.6±2.24
Feet weight	23.8± 0.13	23.9±0.27	24.0±0.21	23.6±0.27
Intestine wt	55.7± 0.51	57.2±1.10	54.7±0.88	55.3±1.12
Carcass weight	363.6± 1.15	361.7±2.49	365.1±2.98	363.9±2.52

T1 = Low concentrates; T2 = medium concentrates; T3 = high concentrate

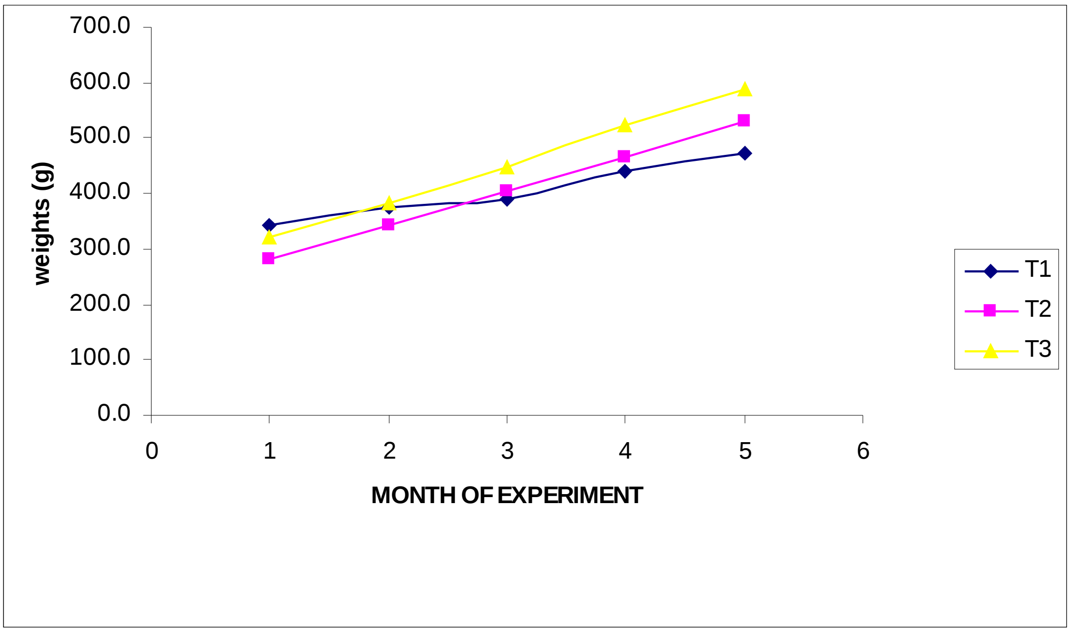

Figure 2: Effect of treatment diets on weights at different ages

Table 26: Lsmeans (± s.e) for effect of level of supplementation on growth performance of guinea pigs

Variable	Overall mean	Treatments		
		T1	T2	T3
Initial weight	314.1±0.83	343.0 ±11.13[a]	280.0 ±11.13[b]	319.3 ±11.13[a]
Final weights	530.4±0.78	473.6±10.51[c]	528.7±10.51[b]	588.8±10.51[a]
Weight changes	216.3±0.43	130.6±5.83 [c]	248.7±5.83[b]	269.5 ±5.83[a]
Daily weight gains	1.8±3.63	1.1±0.04[c]	2.1±0.04[a]	2.2±0.04[a]

CHAPTER FIVE

5.0 DISCUSSION

5.1 Socio – economic characteristics of respondents

The majority of the households visited in the present study were male-headed. About two thirds of respondents were aged between 25 and 55 years. This implies that most of the respondents were in the active working group and could make decisions regarding management of guinea pigs in their localities.

The ability to read and write is an important personal asset which enables women and men to increase economic opportunities in life. Knowing the distribution of the literate population can help program managers especially in agricultural activities to know how to send messages to the people (Mafimisebi *et al.,* 2006). The study results showed that most of the respondents had finished primary education which implies that the literacy level of the respondents was sufficient to enable them adopt agricultural and livestock innovations. A high number of respondents with primary education were attributed to the governments' deliberate effort since 1977 when universal primary education (UPE) was introduced to all children.

The results in this study revealed that decision making for slaughter or selling were equally distributed among all members of the families. These findings imply that if all members of the families participate in labour division and decision making they will have various ways of improving their household incomes and hence they will be economically better- off. The study found that crop farming was the major economic activity. This suggests that there is a high level of crop- livestock integration among the guinea pigs owning households. Variation in ranking orders of livestock species according to their importance in the households was observed whereby in the three wards in the study area farmers ranked cattle as the most important animals followed by pigs and local chickens, despite the fact that local guinea pigs were kept by many households. However, it is convenient to slaughter a small non-ruminant for family consumption or during special family occasions rather than cattle and therefore their important role in supply of protein in the rural communities. Similar observations were reported by NRC (1991; 1996), Elizabet and Claudia (2003), WHO and FAO (2007), USD (2007) and UA (2008) on the important role of micro-livestock could play in alleviation of protein deficiency.

The benefit obtained from raising guinea pigs contributes to the farmers' income through sale of guinea pigs which helps them to purchase some of the household needs and different contributions needed in the villages was also reported by Nuwanyakpa (1993), Ngoupayou *et al*. (1994) and Menjeli *et al*. (1998). Further, guinea pig raising provides manure which is used in the farms and home gardens to increase soil fertility and consequently this leads to higher yields per unit area.

The poor families in the rural areas need market to sell their guinea pigs freely (Bawa *et al.*, 2004). The study findings showed that due to lack of market access, farmers rely on their fellow farmers in selling guinea pigs and this situation leads to some difficulties in improving their household income. The study results showed that guinea pig production has some social functions. For instance, in Peru, the annual ceremonial ritual of slaughtering guinea pigs and distributing the meat among all society members is believed to have an evolutionary basis in the prevention of protein deficiency (WHO and FAO, 2007). The meat is offered to important visitors and eaten in social or religious feasts, since it is considered absolutely the best (Morales, 1995; Aldorton, 1999). The animals are also used for sacrifices and also as ethno medicine. Guinea pigs are more eaten than sold, thus contributing well to nutritional welfare of poor populations.

Large numbers of adult male and female guinea pigs in the study area were disposed off through selling and farmers tended to retain female guinea pigs in the herd. Only a small number of female guinea pigs were disposed off, which is a common phenomenon among traditional livestock keepers. Selling of adult female guinea pigs is not popular to most traditional livestock keepers due to the fact that their main role is to generate replacement stock in the flock.

The tendency of guinea pigs keepers in Njombe district to be reluctant to dispose their guinea pigs could also is attributed to poor market. According to Bawa *et al*. (2004), the absence of effective marketing channel in the tropics is a major constraint to growing guinea pigs and off takes. Where there is no market, guinea pigs are frequently sold to middlemen who profit from farmers who have need of finance. Therefore, the establishment of a more efficient marketing system is an important part of livestock development programme.

5.2 Guinea pigs management

Traditional guinea pigs keeping in the study area was found to be a secondary household activity undertaken by small farmers basically women. Huss and Roca (1982) and Msemwa (2005) reported the same results in their studies. The study findings showed that under such a system, guinea pigs were reared in polygamous groups. This leads to a situation where mismanagement contributes to early post-partum mating and in-breeding of the guinea pigs (Ngoupayou, 1992; Nuwanyakpa *et al.*, 1997). However, such an extensive production system which shows no defined management practices integrates very well in the agricultural systems (small livestock, food crops and natural forages production).

Most of the respondents expressed the desire to increase their number of guinea pigs. This perception by the farmers that the number of guinea pigs should increase in their herds suggests that the breed is not under risk of extinction. It is difficult to make solid statements about the estimated population size of GP since there is no comprehensive survey which has been carried out to establish their population. It is unfortunate that all indigenous GP strains are considered as one group of GP; hence, there is no population data specific for each GP strain.

Feeding was the major limiting factor in coping with guinea pig keeping. Shortages of feeds occur because the majority of the respondents engaged in guinea pigs production do not cultivate bamboo trees which are the main source of guinea pigs feed. However, the main use of bamboo tree plants in Iringa Region is to produce bamboo juice, a local beverage. In the present study the dominant system was an intensive system of management whereby cut bamboo leaves, grass, vegetables and household wastes such as peels of round potatoes were used to feed the guinea pigs. In fact most of the respondents confined their animals year around and yet they were faced with unavailability of green forage especially bamboo leaves and others during the dry season. This justifies the use of crop by- products such as maize bran and household wastes. In addition root crops residues available within households which are unsuitable for marketing and family use are used for feeding guinea pigs.

The results of the study have shown that guinea pigs management is faced with some production constraints such as diseases, predators and management aspects which hinder the growth and improvement of guinea pigs. Animals' health related problems seemed to be the main production constraints to farmers. Most farmers had no strategies for disease and parasite control such as routine deworming and dusting. This may be attributed probably to lack of proper management skills and insufficient agricultural extension services. Nuwanyakpa (1993) pointed out the constraints of rearing guinea pigs which were associated with the relative newness of guinea pigs production, their appearance (rate-like), small size and lack of nutrition education programs. It is therefore suggested that awareness should be created to traditional guinea pig keepers to adopt better feeding strategies and disease control measures.

This study has shown some of the control measures for the constraints in the rearing of guinea pigs. Results according to Hennessy *et al*. (2003) have indicated that normal sexual behaviour is directed towards unrelated females. The male can be removed immediately after the females have farrowed. Another technique for avoiding in- breeding is to house 10-15 females and 1 male in low cost pens as a polygamous group.

During the study weights were taken from various age classes of guinea pigs. The weights of GP taken from farmers' homesteads varied from mature to young guinea pigs. In terms of comparison with on-farm experiment the mean final weight of four months GP was 530.4±3.17g, where by mature GP of more than 6 to7 months of age weighed at farmers households between 548.9±8.25 and 571.3±8.71g. This shows that guinea pigs which were raised in the experiment with improved management could attain more weight since they were still growing as compared to those kept by farmers. There was probably in-breeding, as there was no selection to improve genetic potential of breeding stocks as well as culling of inferior stocks (Huss and Roca, 1982; Ngoupayou, 1992; Nuwanyakpa, 1993). This situation may lead to dilution of purity of guinea pigs strain as farmers admitted that the problem of interbreeding was increasing nowadays.

The majority of guinea pigs keepers were disposing their guinea pigs when they are adult and very old. However, when there is a critical financial need in the household, farmers have a tendency to select guinea pigs in good condition for selling in order to secure better prices. As a result, the prices of guinea pigs are set through bargaining, and depend on circumstances and pressure to get cash. Generally, the prices often fluctuate, taking into account the sex, age, health and condition of the animals. In order to promote guinea pigs marketing and its consumption in the study area, organized formal marketing venues and channels should be established whereby prices of guinea pigs would be set and controlled by organized bodies. Likewise, the organization could be a body which protect the guinea pigs through promotion of sustainable utilization.

5.3 Housing and disease control

The study results showed that all respondents interviewed kept guinea pigs in houses. Various materials were used by the respondents in building houses for keeping guinea pigs depending on the scale of income and production (size of holding). Poorly constructed houses can predispose guinea pigs to diseases, predators and possibly trigger off the spread of contagious diseases especially where animals have been over crowded in a place (Ngoupayou, 1992; Young, 2003). Worms and mange were observed to be the commonest parasites in the herds. Mange and worms can cause considerable production losses and competition for food nutrients in the body. Richard (2000), Richardson (2000), Elizabet and claudia (2003) and Owen *et al.* (2005) reported on the different causes of diseases in the herd. Although there were high incidences of worms in the study area, respondents noted that it was common in young piglets and was observed to be probably responsible for their mortalities. The burnt brick walls and concrete floor had been advocated because of their durability and high level of hygiene. The advantage of better houses would favour the keeping of guinea pigs in the long run (Terrill, 1998; Bawa *et al.,* 2004).

5.4 Performance of experiment GP

5.4.1 Chemical composition of feed ingredients and diet

Following proximate analysis, the diet used in the present study was found to have satisfactory concentrations of the different chemical constituents to meet requirements for the growing guinea pigs. The diet of the present study was in agreement with standard requirements of growing, pregnant and lactating guinea pigs recommended by Elizabet and Claudia (2003).

5.4.2 Health of the experimental guinea pigs

The shedding of hair together with skin bud seen in the back bone region of the growing guinea pigs and the response to treatment by ivormectin suggests high probability of fungal infection. The source might probably be the poor living rooms where they originated which had bad ventilation, draught and inadequate light. Dust has been found to be associated with fungal infection in guinea pigs (Richardson, 2000; Owen *et al*., 2005). In the study results few cases of diarrhea were observed. This might be due to the change from one major feedstuff to another. Harkness (1995) recommended that changing of diet in guinea pig should be done gradually to avoid diarrhea.

5.4.3 Effect of sex on growth and carcass traits

Based on the findings of the present study, effect of sex had no significant influence ($P>0.05$) on weights at different ages and carcass traits. The weights for the last month of experiment for females and males were 533.0±4.47 and 527.8 ±4.47g respectively. However, Nowak (1999), Venderlip (2003) and Economist (2004) reported that adult guinea pigs weigh 500 to 1500 g, although generally females tend to weigh slightly less than males. Another reason could be in-breeding which could bring a depression in reproductive parameters for instance low weight at birth as reported by Huss and Roca (1982), Ngoupayou (1992) and Nuwanyakpa (1993). The decrease in weight between first and second months of experiment (Fig. 1) might have been caused by new environmental conditions, such as housing, type of feed and feeding system and fighting to create social dominance.

Generally, with regards to sex, males were heavier (315.7 g/month) than females (312.5 g/month) on initial weights. Ngoupayou *et al.* (1995) in a study involving GP production on the subsistence farms, reported similar mean body weight at 12 weeks to be 314 g. The higher initial weight of male than female GP could be associated with the higher forage intake by males than females. Forage intake regardless of breed and sex has a direct effect on growth performance of the animals (Morales, 1995).The higher weight gained by females on final weight (Table 23) is probably attributed to sex hormones. Sex hormones such as testosterones and oestrogen are determinants of the differences between males and females in growth rates as animals increase in age.

Another reason for higher growth rates in males than females especially in GP could be explained by the fact that males are more efficient in converting feed to live weight gain than females (Nowak 1999; Venderlip, 2003; Economist, 2004) and due to difference in muscle fibre cell number in favour of males at birth (Rehfeldt et al., 2000; 2004; Fiedler et al., 2004; Owen et al., 2004). Normally growth rate decreases with the age of the animal. Therefore, the factor of age during the onset of the experiment should be accounted also for the difference as one of the sources of variation.

5.4.4 Effect of origin

Effect of origin of guinea pigs had no significant effect on all traits studied except feet weight ($P<0.001$). The similar performance of guinea pigs from both locations might be due to small variation in genetic make up and weight or age at the start of experiment. Results on effect of origin of GP on final weights shows that guinea pigs from Ramadhani were heavier ($P<0.001$) compared to those from Itulike. However the origin had no significant effect on neither total weight gain nor on daily weight gains.

5.4.5 Effect of dietary treatments

The effect of dietary treatment on weights at different ages and carcass traits showed significant effect on body weight of guinea pigs. The results showed T3 excelled other treatments. This implies that if guinea pigs are supplied with improved diet they might increase in body weight in early stages of growth and as a result they will be slaughtered early. Nowak (1999) and Elizabert and Claudia (2003) and Owen *et al*. (2005) reported that when guinea pigs are provided with enough nutrients, they will attain good weight.

Studies by Morales (1995) also reported that concentrate supplementation to intensive system fed GP particularly to tropical forages is essential to improve growth performance of GP. Similar results were observed by Cicogna *et al*. (1992) in West Africa who supplemented GP with mixed hay.

They found that supplemented GP grew faster than non-supplemented and had higher dressing percentages. Further more, improved growth performance with concentrates supplementation has been reported by Elizabet and Claudia (2003). During the fifth month of the experiment all GP gained weight however the GP on T1 had relatively low weights compared to those in T2 and T3. This could be explained that animals under low plane of nutrition are more susceptible to gastrointestinal parasites than the supplemented ones (Richard, 2000; Owen et al., 2005) which can impair animal performance.

The overall mean weight gained from first to fifth months was significantly ($P<0.05$) influenced by treatment diets. This means that as live weight increases the weights of all components also increase but the percentage of lean and bones decreases as may be attributed to the increased high nutrient level intake in those animals. Since slaughtered guinea pigs were below six months old and were under moderate plane of nutrition, it is likely that these factors had an influence on the observed proportions of weight of different carcass components. The mean dressing percentages observed in the present study ranged between 68.3 and 68.5% which were lower than the mean dressing percentage of 75% reported by Cicogna *et al.* (1992). This gives the impression that in order to get large quantities of meat at slaughter, farmers should keep animals that are fast growers and are able to attain higher weights at maturity.

The reason for the difference between the dressing percentages on what had been reported by Cicogna *et al*. (1992) and the results of this study might be due to breed difference, slaughter age/ weights, method of slaughter and management in terms of feeding and hygienic conditions. Furthermore, Paterson *et al*. (2001) reported that for better carcass yield slaughter age should be 16 to 20 weeks under traditional management system and 10 weeks under commercial management system and should weigh between 0.8 and 2kg live weights at slaughter. Cicogna *et al*. (1992) have also studied reproductive and growth rate performance of GP raised for meat with impressive average weights at birth, weaning at 3weeks and at 15 weeks of age to be 99, 247 and 738 g respectively. This can be only achieved by better feeding strategies for GP production especially at farm level.

The study findings revealed that dietary treatment had significant (P<0.001) effect on growth rates. It is apparent from Table 25 that guinea pigs fed diet T3 consumed the highest amount of concentrates which might have resulted in the higher growth rates to guinea pigs fed this diet. However, T2 had the lowest initial weight compared to the others. This might be caused by the oversight in balancing weights of GP between treatments during the start of the trial. The daily weight gains obtained in this study of 2.2 g/day was lower than the results of Richard (2004) who reported daily gain to be 2.5-3.5 g/ day.

These variations could be still explained by the differences in management, the relative occurrence of litter types or the significant difference variability in the genetic pool.

The increase in cumulative live weights throughout the experimental period in all treatments observed in the present study was expected. This was due to the growth effect and change in weight at different ages of GP.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

- The results of this study suggest that GP play a major role in the supply of animals' protein in rural areas. They also provide small carcasses that can be consumed within a family in one meal eliminating the need for meat storage and refrigeration.
- However, variability in GP live weight between the household was due to difference in management practices among the farmers.
- Experimental GP were heavier than those from surveyed farms indicating that native GP can do well under good management practices.
- Better feeding strategies for GP at the farm level in Njombe district could bring outstanding contribution to GP productivity. This will contribute to substantially to the animal production intake of rural dwellers in Njombe. Also GP contribute significantly in the socio- economic welfare as livestock banking, meat and other reasons like manure and conducting traditional rituals. However, improvements and disease control are required for sustainable increase in productivity of kids and adults.

6.2 Recommendations

a) It is therefore recommended that if farmers are adviced to better feed their GP, they will grow and reproduce faster than they are doing now.

b) There should be extension packages/ messages for improved production of GP especially on housing, breeding and disease control.

c) There is a need to carry out further studies on performance of GP on various locally formulated rations.

d) Sensory and organoleptic evaluation of GP meat be done in order to determine the acceptability of meat to other community which does not raise GP.

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APPENDICES

Appendix 1: Questionnaire used for the survey study

Respondents name …………………………….. Date …………………………

District ……………………………… Division ……………………………….

Ward ……………………………. Village …………………………………….

1. Back ground information

(a)Sex of the household head ……………….. 1 male 2. Female

(a) Age of the farmer ……………………..... (years)

(b) Marital status

1. Single 2. Married 3. Divorced 4. Widow (er).

(d)Have you ever been to school?

Yes / No

(e)If yes, what is your highest education?

1. Primary

2. Secondary

3. College

4. University

(f) What is the size of your family …………………. Members

(g). How many members are in each group

Years	Number
1. Under 5 years	……………………
2. 5 to 10 years	……………………
3. 11 to 20 years	……………………
4. 21 and above	……………………

2. Occupation

(a) What is your main income earning activity?

1. farming
2. livestock keeping only
3. employment + livestock keeping + business
4. employment only
5. employment and farming
6. Others

(b) What is the main source of your income?

3. Land use

(a) How many farm plots do you have? ………………….

(b) What is the total farm acreage?..........................and how much is (i) cultivated ………..(ii) uncultivated …………………..

(c) Do you sell any of your crop harvest?

Yes /No.

(d) If yes, indicate the crops amount sold and prices received in 2007/ 2008.

Year	Crop harvest	Amount sold	Proportion sold	Price per kg.
2007				
2008				

4 Animal rearing

(a) Do you keep animals? Yes / no

If yes list in order of preference the type and number of animals kept.

Type of Animals	Number
1	
2	
3	
4	

5. Management

a)Where do you keep guinea pig (housing)

1. Raised floor 2. Not raised.

b) What type of guinea pig production system do you practice

1. Free range system
2. Intensive system

c). What is the building material used? 1. Wood 2. Bricks 3 Mud

d) What was the cost in house construction? ………………………………………………

e) How many guinea pigs per area ……………………………………………………...

f) What is the pen size ……………………………………………………………….

e) Frequency of cleaning 1. Once 2. Twice 3. Thrice

6. Guinea pig keeping

(a) When did you start keeping guinea pigs? Year ………………………………………

(b) Why are you keeping guinea pigs (in order of importance)

1. ……………………………………………………………………………………….

2……………………………..

3……………………………..

7. Feeds and feeding

(a) Give details of feeds used, in your guinea pigs

Type of feeds	Frequency of use

1= once 2 = twice 3= adlib.

b) At what season of the year feeds are available / scarce ?

1= wet season 2= dry season 3= both

(c) Do you supplement your guinea pig?

Yes /no

(d) If yes, what type of supplement feed do you use? ……………… i) where do you get the concentrates?

1. Own preparation
2. Commercially prepared.

(e) If own preparation, which ingredients do you use?……………………………………

(f.) What ratio do you mix ……………………………………………………………...

(g). What is the price of each ingredients per unit

Ingredients	Price per unit
1.	
2.	
3	

8 Source of labour

(a) Who does what in raising your guinea pigs

Activity	Responsible	Total (hours)
1.Feeding		
2.watering		
3. cleaning		
4. slaughter		
5. selling		

1. Father 2. Mother 3. Children 4. Father and mother 5. All members of the family 6. Hired labour

(b) How many guinea pig do you keep?....................................structure by age classes.

Class	Number
1Breeding males	
2.Mature females	
3.Young males	
4.Young females	

(c) What are your future expectations on guinea pigs production?

1. Increase herd size …………………………………………………………………
2. Decrease herd size …………………………………………………………………
3. Maintain present herd ……………………………………………………………

(d) What is the influence of guinea pig keeping on your other farm activities……….

…………………………………………………………………

9. Animal performance

Reproduction performance:-

(a) What is the average piglet's litter size at birth?

1. Single 2 Two 3 Three 4 Four 5 Five 6 Six

(b) Do your piglets born in your flock reach the weaning period? Yes / No. and what is the weaning age …... are they separated after weaning ? yes/no

(c) What is the litter size at weaning? Average ………………………………………….

(d) Do you know signs of furrowing of the pregnancy sow? Yes /No

(e) If yes do you experience any parturition problems in your flock? Yes / no

(f) If yes what are the problems and what are the causes of the problems?

Problem	Causes
1	
2	
3	
4	
5	

(g) At what age do mate your guinea pig for first time? (Average)………….. Months.

(h) How long is the period between two consecutive farrowings (Farrowing interval)

………………………………………………………………………………

(i) These animals reproduce very fast: where do you get replacement males? 1. Hired 2. Own, 3 all sources.

(j) If hired do you pay for services? Yes /No

(k)If yes how much do you pay per service

(l)How many times do you serve the female guinea pigs before they conceive? On average).

(m)1. Once 2. Twice 3. Thrice 4. Four times.

(n) How do you control in breeding …………………………………………………

(o)Do guinea pigs sometimes abort ?

Yes /No

(p) If yes what are the most probable causes of the abortions?

1. 2. 3 4.

10. Preference, processing and consumption

(a) At what age do you dispose your guinea pigs?.

Method of disposal	Age at disposal	No	Sex		Reasons f or disposal
			Male	Female	

1=Sale 2. Slaughter

(b) If by sale at what prices do you sell?

Mature female T.shs …………………………

Mature female Tshs …………………………

Young female Tshs ……………………………

Young females Tshs ………………………..

(c) How much are you earning /month from sale of guinea pigs? Tshs ……………..

(c) How do you slaughter your guinea pigs (Explain)…………………………………

(d) What is eaten …………………….. and what is thrown away ……………………

(e) What is the frequency of slaughtering guinea pigs in your house hold?/month

1. Once 2. Twice 3. Adlib 4. Not used.

(f) How is the meat processed before consumption 1. Fried/ roosted. 2 Cooked.

(g) Explain the number of guinea pig sufficient to a family …………………………

(h) In which form are the animals sold?

1. Live animal 2. Slaughtered as meat

(i) Do you offer guinea pigs as presents to other people yes / no

(j) If yes to whom ………………………………………………………………………

(k) If not why not ………………………………………………………………………

(l) Do guinea pigs have any other social function? yes /no

(m) If yes which are the social functions ……………………………………………..

(n) Are there any taboos related to keeping or eating guinea pigs ? Yes /No

(o) If yes which are the taboos……………………...

11. Diseases

(a) Do guinea pigs get disease problems? Yes /No.

(b) If yes which common disease problems are facing your guinea pigs

Problem	How it is solved
1	
2	

(c) Who treats your animals?

Treatment: - 1= non 2. My self 3. Extension officer (EO)

Prevention 1= vaccination 2. De-worming

(d) Is predation a problem? Yes /no

(e) If yes, by which animals ………………………………………………………………

(f)How do you control this/……………………………………………………..................

(g)Do you experience death of guinea pigs? Yes /no

(h)If yes what are the causes of death in order of importance (i) ……………………………

ii)…………….iii)………………….iv)……………

(i) Are veterinary drugs easily available? Yes /No

(j)Where do you get the drugs? 1. Place ………. 2. Distance (k)Nature of cost 1. Very high 2. High 3. Average

(l)Can you list out constraints that you face in keeping guinea pigs.

…………………………………………………………………………………………

……………………………………………………………………………………

(m)How much are you spending in a month to raise these guinea pigs ?

Tshs……………………………………………………………………………………

(n) Is this project of guinea pig beneficial? Yes /No

(o)Explain the benefits you obtain from guinea pigs keeping

…………………………………………………………………………………………

….……………………………………………………………………………………

11. Non-Guinea pig keepers

(a) If No, why are you not keeping guinea pigs? Give reasons.

………………………………………………………………………………………...

(b)Are there any taboos related to keeping guinea pigs? Yes/no

If yes which are the taboos…………………………………………………………

Appendix 2: ANOVA for weights at different ages of guinea pigs

Appendix 2.1: Weights in 2nd month

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	203599.6690	20359.9669	901.43	<.0001
Error	49	1106.7250	22.5862		

Corrected Total	59	204706.3940

R-Square	Coeff Var	Root MSE	wt2 Mean
0.994594	1.294218	4.752497	367.2100

Source	DF	Type III SS	Mean Square	F Value	Pr > F
sex	1	41.5170	41.5170	1.84	0.1814
Location	1	5.7152	5.7152	0.25	0.6172
Treat	2	10326.5951	5163.2976	228.60	<.000
inwt	1	117243.5373	117243.5373	5190.93	<.0001
sex*Location	1	16.9449	16.9449	0.75	0.390
Location*Treat	2	111.1699	55.5849	2.46	0.0958
sex*Treat	2	20.8798	10.4399	0.46	0.6326

Appendix 2.2: Weights in 3rd month

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	200447.8843	20044.7884	276.95	<.0001
Error	49	3546.4122	72.3758		
Corrected Total	59	203994.2965			

R-Square	Coeff Var	Root MSE	wt3 Mean

0.982615	2.029363	8.507394	419.2150

Source	DF	Type III SS	Mean Square	F Value	Pr > F
sex	1	51.6246	51.6246	0.71	0.4025
Location	1	0.7407	0.7407	0.01	0.9198
Treat	2	39751.9803	19875.9902	274.62	<.0001
inwt	1	112602.7731	112602.7731	1555.81	<.0001
sex*Location	1	110.0398	110.0398	1.52	0.2234
Location*Treat	2	148.1829	74.0915	1.02	0.3668
sex*Treat	2	96.9849	48.4925	0.67	0.5163

Appendix 2.3: Weights in 4th month

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	224007.2453	22400.7245	145.37	<.0001
Error	49	7550.8580	154.0991		
Corrected Total	59	231558.1033			

R-Square	Coeff Var	Root MSE	wt4 Mean
0.967391	2.628808	12.41367	472.2167

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	138.2086	138.2086	0.90	0.3483
Location	1	1.4451	1.4451	0.01	0.9232
Treat	2	90005.2739	45002.6370	292.04	<.0001
inwt	1	106886.7103	106886.7103	693.62	<.0001
Sex*Location	1	221.5936	221.5936	1.44	0.2362
Location*Treat	2	448.9747	224.4874	1.46	0.2429
Sex*Treat	2	200.9952	100.4976	0.65	0.5254

Appendix 2.4: Slaughter weights in 5th month

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	294409.6742	29440.9674	48.93	<.0001
Error	49	29484.3143	601.7207		
Corrected Total	59	323893.9885			

R-Square	Coeff Var	Root MSE	wt5 Mean
0.908969	4.624854	24.53000	530.3950

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	395.9005	395.9005	0.66	0.4212
Location	1	843.4479	843.4479	1.40	0.2421
Treat	2	180066.6469	90033.3235	149.63	<.0001
Into	1	81139.0967	81139.0967	134.85	<.0001
Sex*Location	1	1281.4843	1281.4843	2.13	0.1509
Location*Treat	2	2412.1278	1206.0639	2.00	0.1456

Appendix 3: ANOVA for carcass component as % of slaughter weight

APPENDIX 3.1: Slaughter weight (wt5)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	213270.5775	23696.7308	10.71	<.0001
Error	50	110623.4110	2212.4682		
Corrected Total	59	323893.9885			

R-Square	Coeff Var	Root MSE	wt5 Mean
0.658458	8.868274	47.03688	530.3950

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	99.5882	99.5882	0.05	0.8328
Loc	1	27782.3202	27782.3202	12.56	0.0009
treat	2	132896.2710	66448.1355	30.03	<.0001
Sex*treat	2	9019.0223	4509.5112	2.04	0.1409
Loc*treat	2	34681.5143	17340.7572	7.84	0.0011
Sex*Loc	1	8791.8615	8791.8615	3.97	0.0517

APPENDIX 3.2: Head weight %

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	65.6153400	7.2905933	2.87	0.0083

Error	50	127.0715333	2.5414307
Corrected Total	59	192.6868733	

R-Square	Coeff Var	Root MSE	hdwtA Mean
0.340528	9.594478	1.594187	16.61567

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	0.04592667	0.04592667	0.02	0.8936
Loc	1	1.96566000	1.96566000	0.77	0.3834
treat	2	29.47857333	14.73928667	5.80	0.0054
Sex*treat	2	0.11025333	0.05512667	0.02	0.9786
Loc*treat	2	24.39892000	12.19946000	4.80	0.0124
Sex*Loc	1	9.61600667	9.61600667	3.78	0.0574

APPENDIX 3.3: Feet weight %

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	6.50852167	0.72316907	6.51	<.0001
Error	50	5.55256333	0.11105127		
Corrected Total	59	12.06108500			

R-Square	Coeff Var	Root MSE	ftwtA Mean

0.539630	7.331285	0.333244	4.545500

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	0.00088167	0.00088167	0.01	0.9294
Loc	1	0.02204167	0.02204167	0.20	0.6579
treat	2	4.27527000	2.13763500	19.25	<.0001
Sex*treat	2	0.37550333	0.18775167	1.69	0.1948
Loc*treat	2	1.52234333	0.76117167	6.85	0.0023
Sex*Loc	1	0.31248167	0.31248167	2.81	0.0997

APPENDIX 3.4: Weight of intestines

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	20.37871000	2.26430111	3.72	0.0012
Error	50	30.40676333	0.60813527		
Corrected Total	59	50.78547333			

R-Square	Coeff Var	Root MSE	instwtA Mean
0.401270	7.400408	0.779830	10.53767

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	1.49784000	1.49784000	2.46	0.1229
Loc	1	2.34432667	2.34432667	3.85	0.0552

treat	2	4.96672333	2.48336167	4.08	0.0228
Sex*treat	2	1.83883000	0.91941500	1.51	0.2304
Loc*treat	2	8.76832333	4.38416167	7.21	0.0018
Sex*Loc	1	0.96266667	0.96266667	1.58	0.2142

Appendix 4: ANOVA for weights of different carcass components

APPENDIX 4.1: Head weight

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	2915.195949	291.519595	4.67	0.0001
Error	49	3057.131384	62.390436		
Corrected Total	59	5972.327333			

R-Square	Coeff Var	Root MSE	hdwt Mean
0.488117	9.050256	7.898762	87.27667

Source	DF	Type III SS	Mean Square	F Value	Pr > F
sex	1	9.3766830	9.3766830	0.15	0.6999
Location	1	37.1293203	37.1293203	0.60	0.4442
Treat	2	14.7979682	7.3989841	0.12	0.8884
slwt	1	838.5006161	838.5006161	13.44	0.0006
sex*Location	1	59.4131204	59.4131204	0.95	0.3339
Location*Treat	2	178.1787831	89.0893915	1.43	0.2496
sex*Treat	2	116.2143510	58.1071755	0.93	0.4009

APPENDIX 4.2: Feet weight

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	128.1274314	12.8127431	13.55	<.0001
Error	49	46.3285686	0.9454810		
Corrected Total	59	174.4560000			

R-Square	Coeff Var	Root MSE	fwt Mean
0.734440	4.082109	0.972358	23.82000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	0.03002264	0.03002264	0.03	0.8593
Location	1	13.61764422	13.61764422	14.40	0.0004
Treat	2	1.49527407	0.74763704	0.79	0.4592
slwt	1	33.37943141	33.37943141	35.30	<.0001
Sex*Location	1	0.04912243	0.04912243	0.05	0.8206
Location*Treat	2	2.30670209	1.15335105	1.22	0.3041
Sex*Treat	2	1.30908259	0.65454129	0.69	0.5053

APPENDIX 4.3: Weight of Intestines

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	3055.673971	305.567397	19.63	<.0001

Source	DF	Sum of Squares	Mean Square
Error	49	762.591862	15.563099
Corrected Total	59	3818.265833	

R-Square	Coeff Var	Root MSE	instwt Mean
0.800278	7.081543	3.945009	55.70833

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	41.615187	41.615187	2.67	0.1084
Location	1	22.511976	22.511976	1.45	0.2349
Treat	2	51.189374	25.594687	1.64	0.2036
slwt	1	1043.720138	1043.720138	67.06	<.0001
Sex*Location	1	12.848919	12.848919	0.83	0.3680
Location*Treat	2	213.387922	106.693961	6.86	0.0024
Sex*Treat	2	35.643481	17.821740	1.15	0.3266

APPENDIX 4.4: Carcass weight

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	210412.0772	21041.2077	267.46	<.0001
Error	49	3854.8368	78.6701		
Corrected Total	59	214266.9140			

R-Square	Coeff Var	Root MSE	carcwt Mean
0.982009	2.439456	8.869619	363.5900

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	10.33993	10.33993	0.13	0.7185
Location	1	25.39065	25.39065	0.32	0.5726
Treat	2	95.83590	47.91795	0.61	0.5479
slwt	1	70522.08822	70522.08822	896.43	<.0001
Sex*Location	1	122.56469	122.56469	1.56	0.2179
Location*Treat	2	509.40515	254.70258	3.24	0.0478
Sex*Treat	2	64.19682	32.09841	0.41	0.6672

APPENDIX 4.5: Dressing percentage

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	224.9285992	22.4928599	8.19	<.0001
Error	49	134.6138741	2.7472219		
Corrected Total	59	359.5424733			

R-Square	Coeff Var	Root MSE	dress Mean
0.625597	2.426673	1.657475	68.30233

Source	DF	Type III SS	Mean Square	F Value	Pr >
Sex	1	1.63864663	1.63864663	0.60	0.4436
Location	1	0.68431702	0.68431702	0.25	0.6199
Treat	2	1.80034887	0.90017443	0.33	0.7222
slwt	1	64.05238919	64.05238919	23.32	<.0001
Sex*Location	1	5.28606953	5.28606953	1.92	0.1717
Location*Treat	2	19.98324985	9.99162492	3.64	0.0337
Sex*Treat	2	1.31215359	0.65607679	0.24	0.7885

Appendix 5: ANOVA for growth rate performance

APPENDIX 5.1: Initial weights

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	107337.6575	11926.4064	4.81	0.0001
Error	50	124035.5043	2480.7101		
Corrected Total	59	231373.1618			

R-Square	Coeff Var	Root MSE	inwt Mean
0.463916	15.85587	49.80673	314.1217

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	150.73350	150.73350	0.06	0.8063
Loc	1	27679.12817	27679.12817	11.16	0.0016
Treat	2	40462.84233	20231.42117	8.16	0.0009
Sex*Loc	1	5010.54817	5010.54817	2.02	0.1615
Loc*Treat	2	32032.60633	16016.30317	6.46	0.0032
Sex*Treat	2	2001.79900	1000.89950	0.40	0.6702

APPENDIX 5.2: Final weights (wt5)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	213270.5775	23696.7308	10.71	<.0001
Error	50	110623.4110	2212.4682		

Corrected Total	59	323893.9885

R-Square	Coeff Var	Root MSE	wt5 Mean
0.658458	8.868274	47.03688	530.3950

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	99.5882	99.5882	0.05	0.8328
Loc	1	27782.3202	27782.3202	12.56	0.0009
Treat	2	132896.2710	66448.1355	30.03	<.0001
Sex*Loc	1	8791.8615	8791.8615	3.97	0.0517
Loc*Treat	2	34681.5143	17340.7572	7.84	0.0011
Sex*Treat	2	9019.0223	4509.5112	2.04	0.1409

APPENDIX 5.3: Weight changes

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	230928.3450	25658.7050	37.71	<.0001
Error	50	34018.6523	680.3730		
Corrected Total	59	264946.9973			

R-Square	Coeff Var	Root MSE	WC Mean
0.871602	12.06065	26.08396	216.2733

Source	DF	Type III SS	Mean Square	F Value	Pr > F

Sex	1	495.3627	495.3627	0.73	0.3976
Loc	1	0.0960	0.0960	0.00	0.9906
Treat	2	224496.2203	112248.1102	164.98	<.0001
Sex*Loc	1	528.0667	528.0667	0.78	0.3825
Loc*Treat	2	1275.8410	637.9205	0.94	0.3983
Sex*Treat	2	4132.7583	2066.3792	3.04	0.0569

APPENDIX 5.4: Average daily gains

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	16.05414333	1.78379370	37.61	<.0001
Error	50	2.37129000	0.04742580		
Corrected Total	59	18.42543333			

R-Square	Coeff Var	Root MSE	ADG Mean
0.871303	12.08740	0.217775	1.801667

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	0.03360667	0.03360667	0.71	0.4039
Loc	1	0.00000667	0.00000667	0.00	0.9906
Treat	2	15.59858333	7.79929167	164.45	<.0001
Sex*Loc	1	0.03750000	0.03750000	0.79	0.3781

Loc*Treat	2	0.09044333	0.04522167	0.95	0.3923
Sex*Treat	2	0.29400333	0.14700167	3.10	0.0538

Appendix 6: Mean weights of GP from farmers' households

	N	Mean	Std. Deviation	Std. Error Mean	CV %
Mature boar	162	571.3	110.9	8.7	19.4
Mature sow	191	548.9	114.1	8.3	20.8
Growing male	127	233.5	24.7	2.2	10.6
Growing female	132	231.6	27.3	2.4	11.8
Young male	76	126.4	30.8	3.5	24.3
Young female	106	127.1	32.8	3.2	25.8

Appendix 7: ANOVA for monthly weight gains

APPENDIX 7.1: **Dependent Variable: W3-w2**

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	12496.80007	1249.68001	134.46	<.0001
Error	49	455.41643	9.29421		
Corrected Total	59	12952.21650			

R-Square	Coeff Var	Root MSE	W2 Mean
0.964839	5.825243	3.048641	52.33500

Source	DF	Type III SS	Mean Square	F Value	Pr > F
W1	1	818.9890605	818.9890605	88.12	<.0001
sex	1	2.2280484	2.2280484	0.24	0.6266
loc	1	4.6056336	4.6056336	0.50	0.4848
treat	2	0.3614750	0.1807375	0.02	0.9807
sex*loc	1	0.8740420	0.8740420	0.09	0.7604
sex*treat	2	19.4115883	9.7057942	1.04	0.3596
loc*treat	2	15.3501427	7.6750713	0.83	0.4439

APPENDIX 7.2: **Dependent Variable: W4-w3**

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	13431.10076	1343.11008	488.87	<.0001
Error	49	134.62108	2.74737		
Corrected Total	59	13565.72183			

R-Square	Coeff Var	Root MSE	W3 Mean
0.990076	3.126116	1.657519	53.02167

Source	DF	Type III SS	Mean Square	F Value	Pr > F
W1	1	793.7990499	793.7990499	288.93	<.0001
sex	1	0.7503513	0.7503513	0.27	0.6036
loc	1	5.1710487	5.1710487	1.88	0.1763
treat	2	4.1385472	2.0692736	0.75	0.4762
sex*loc	1	1.1491879	1.1491879	0.42	0.5208
sex*treat	2	4.2080374	2.1040187	0.77	0.4704
loc*treat	2	0.6870210	0.3435105	0.13	0.8827

APPENDIX 7.3: **Dependent Variable: W5-w4**

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	12635.31551	1263.53155	162.05	<.0001
Error	49	382.07299	7.79741		
Corrected Total	59	13017.38850			

R-Square	Coeff Var	Root MSE	W4 Mean
0.970649	5.249335	2.792384	53.19500

Source	DF	Type III SS	Mean Square	F Value	Pr > F
W1	1	678.8208255	678.8208255	87.06	<.0001
sex	1	6.0036555	6.0036555	0.77	0.3845
loc	1	3.6516238	3.6516238	0.47	0.4970
treat	2	9.8719584	4.9359792	0.63	0.5353
sex*loc	1	12.5365904	12.5365904	1.61	0.2108
sex*treat	2	0.7936815	0.3968408	0.05	0.9504
loc*treat	2	0.6758409	0.3379205	0.04	0.9576

APPENDIX 7.4: **Dependent Variable: W5-w1**

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	244492.7039	24449.2704	58.57	<.0001
Error	49	20454.2934	417.4346		
Corrected Total	59	264946.9973			

R-Square	Coeff Var	Root MSE	W5 Mean
0.922799	9.446942	20.43122	216.2733

Source	DF	Type III SS	Mean Square	F Value	Pr > F
W1	1	13164.35694	13164.35694	31.54	<.0001
sex	1	1481.43795	1481.43795	3.55	0.0655
loc	1	181.99703	181.99703	0.44	0.5122
treat	2	3450.61204	1725.30602	4.13	0.0219
sex*loc	1	0.19425	0.19425	0.00	0.9829
sex*treat	2	3323.68477	1661.84238	3.98	0.0250
loc*treat	2	213.78521	106.89261	0.26	0.7751