PERFORMANCE OF BEEF CATTLE UNDER DIFFERENT FEEDLOT PRACTICES IN MWANZA REGION

BY

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ABSTRACT

Two studies were carried in Misungwi, Nyamagana and Magu districts of Mwanza region to investigate the performance of cattle under different feedlot practices. The specific objectives were (1) To document feedlot beef production practices in the study area, (2) To study the source, quality of feeds and type of animals used by feedlot practitioners in fattening enterprises and (3) To evaluate the performance of indigenous beef cattle under different feedlot practices. Study 1 involved survey type using both closed and open-ended questions in a structured questionnaire that were administered to 58 respondents. In study 2 four feedlotters from each district were selected for monitoring that was conducted for 56 days, the performance of 240 beef cattle using four feed types namely cotton seed hulls (CSH), mixture of cotton seed cake (CSC) and cotton seed hulls, waste brewers mash and rice polishing were monitored. Feed intake per feedlot was measured daily and body weight measurements were determined fortnightly. Feed samples were collected and subjected to chemical and an *in vitro* dry matter digestibility analysis. Results showed that source and types of animals used in the feedlots were from Mwanza, Kagera and Kigoma regions. Both females and males were used. Breeds of animals used in feedlots were Tanzania Short Horn Zebu and Ankole. The CP content and *in vitro* dry matter digestibility for the 4 feed types were different ($P<0.05$). Feed intake per animal per day (8.84kgDM/d), average daily gain (0.78kg/d) and feed conversion ratio (11.3) were significantly ($P< 0.05$) higher for animals fed the mixture of CSH and CSC than other rations. Marginal profit per animal obtained ranged between 52830/=for animals consuming RP and 78500/= for animals consuming the mixture of CSH and CSC. It was concluded that local cattle can be finished on local byproducts yet substantial profit is realized.

DECLARATION

I, MAWONA FIDELIS GALLUS, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work and that it has neither been submitted nor is it being concurrently submitted for degree award in any other Institution.

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The above declaration is confirmed

Prof. Kimambo, A. E Date

(Supervisor)

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DEDICATION

I dedicate this humble effort and fruit of my study to my affectionate Children Arnold, Erick, Mtage, Severina, Nelly and Thecla “Chaku”

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LIST OF ABBREVIATIONS

ADF	-	Acid Detergent Fibre
ADG	-	Average Daily Gain
A.O.A.C	-	Association of Official Analytical Chemists
AU	-	Animal Unit
BL	-	Body Length
BW	-	Body Weight
BM	-	Brewers mash
CF	-	Crude Fibre
CP	-	Crude Protein
CSC	-	Cotton seed cake
CSH	-	Cotton seed hulls
CRD	-	Completely Randomized Design
DM	-	Dry Matter
DMI	-	Dry Matter Intake
ECF	-	East Coast Fever
EE	-	Ether Extract
FAO	-	Food and Agriculture Organization of United Nations
FCE	-	Feed Conversion Efficiency
FCR	-	Feed Conversion Ratio
FI	-	Feed Intake
FMD	-	Foot and Mouth Disease
HG	-	Heart Girth

IVDMD	-	In vitro dry matter digestibility
IVOMD	-	In vitro organic matter digestibility
KG	-	Kilogram
MALD	-	Ministry of Agriculture and Livestock Development
ME	-	Metabolizable Energy
MJ	-	Mega Joules
MLD	-	Ministry of Livestock Development
NARCO	-	National Ranching Company
NDF	-	Neutral Detergent Fibre
NFE	-	Nitrogen Free Extract
NPN	-	Non-Protein Nitrogen
NRC	-	National Research Council
PDIFF	-	Probability levels for the difference between LSmeans
SAS	-	Statistical Analysis System
SEM	-	Standard Error of the Means
SS3	-	Sum of square type 3
STDERR	-	Standard Errors of the least square means and the probability levels for tests of the hypothesis.
TBS	-	Tanzania Bureau of Standards
TSHZ	-	Tanzania Shorthorn Zebu
UNDP	-	United Nations Developments Programme

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

A beef feedlot is a confined yard area with watering and feeding facilities where cattle are held and completely hand or mechanically fed for the purpose of meat production. This includes any adjoining or nearby area where such cattle are yarded, tended, loaded and unloaded. The animal wastes from the feedlot are accumulated or treated pending removal or disposal.

A cattle feedlot is a change of land use from farming activities to intensive animal keeping. Before entering a feedlot, cattle spend most of their life grazing on rangeland. Feedlot diets are usually dense in food energy, to encourage the deposition of fat, or marbling, in the animal's muscles; this fat is desirable as it leads to 'juiciness' in the resulting meat (Price and Berg, 1981).The animal may gain an additional 180 kg during its 3-4 months in the feedlot (Lardy, 1999). Although the majority of slaughter cattle are finished on natural grazing, this does not provide adequate nutrition to enable the large and fast growing animals to express their genetic potential for growth. Nutrition is especially limited during the long dry season and drought years, when both dry matter availability and protein content of natural pasture are very low. Therefore, it may be necessary to supplement grazing animals with suitable diets that would allow them to grow faster and attain a good carcass finish at marketing age; this is where feedlotting comes into effect. The market price for slaughter stock in Tanzania is based mainly on carcass weight, which in turn is determined by age and the finish of the animal (Creek, 2003). The advantage of using breeds with fast growth rates and high mature weights cannot be sufficiently exploited unless adequate feed resources in both quantity and quality are available to support such growth rates.

Despite the large variation in the quality and quantity of the range, feedlot fattening is not popular in Tanzania due to lack of awareness and high cost of conventional feedlot rations (MLD, 2006). Creek (2003) reported that growth rate for crossbred animals were increased during the feedlot period. However, financial benefits from the increase in live weight gains did not justify the higher cost of the feed. The use of locally available pasture, crop residues and agro-industrial by-products provides an opportunity for improving the livestock feed resources for use in feedlots. These ingredients can be utilized to formulate feedlot diets that will give the required finish for slaughter cattle (Chamatata, 1995). In their study on performance of local cattle in feedlots Norris *et al.* (2002) reported that animals fed low and medium roughage diets had average daily gains above 1.0 kg per day, except for Brahman and Santa Gertrudis crosses which had daily gains of 0.8 kg per day when fed the low roughage diet. Ballantine (1998) reported that alterations in body composition through previous nutrition could alter the net energy requirements for maintanance (NEm) of growing cattle.

Generally, as body condition score or fleshiness of cattle increases at a particular body weight, the amount of energy needed to support increased average daily gain decreases. Therefore, body condition score or fleshiness of cattle can have important effects on performance of cattle under feedlot condition. Previous nutrition that restricts cattle growth can positively affect cattle performance in the feedlot through compensatory growth (Hersom, 2005). Compensatory growth is a period of faster or more efficient growth following a period of nutritional or environmental stress (NRC, 1996). Therefore, it is hypothesized that an animal with lower body weight gain and lower body condition resulting from the grass grazing period will exhibit improved feedlot feed efficiency and daily body weight gain. The real value of a feed is obtained by the expression of the performance of animal utilizing that feed and their responses have been recorded. In view of significance of *Bos indicus* in the beef industry of Tanzania, the study focused on evaluating the performance of small scale feedlots. It was anticipated that the study would provide basic information on the performance of beef cattle in different feedlots under different types of feeds and suggest ways to improve performance.

1.2 Problem Statement and Justification

Although Tanzania is the third country in Africa after Ethiopia and Sudan to possess large numbers of cattle, it has not been able to exploit that opportunity to be a large beef producer. Livestock contribution to the National Economy is only 6.1% of the Gross Domestic Product (MLD, 2006). There is a significant potential need for quality beef in Tanzania under a market-led commercialization of the livestock sector, driven by domestic urban demand and to some extent neighbouring countries demand. There have been relatively few studies done in Tanzania with regard to cattle feedlots and fattening. Fattening is now being expanded and practiced by individual practitioners in Tanzania, although on a small scale basis, but feeds used by these enterprises are not known. Use of agro-processing byproducts for cattle fattening has been minimal although it is widely used in dairy cattle. The reasons for the low use are possibly the underdeveloped commercial beef industry and reliance of feeding on natural pasture that are of poor nutritional quality particularly in dry season. Comparative performance of different types of beef cattle under different types of feeds that in the end produce better quality meat is not known.

The beef industry is expanding at the times of declining supply of natural pasture, caused by more frequent droughts, lack of water, overstocking and general environmental degradation in many parts of the country. Supplementation with adequate amounts of concentrates is far from widespread. Some concentrates are purchased from distant places and this is a hindrance to their frequent use. There is now greater need for more research on utilization of agro processing byproducts and crop residues for cattle fattening in our efforts towards commercialization and modernization of the beef industry. Information on the reasons that led to the emergency of small scale fattening units in Mwanza, their performance and their profitability is lacking despite the good environment created for production of quality beef, there is lack of information (data) on which breeds would be best used to produce quality beef under proper nutrition (World bank, 1994).

This study therefore aimed at evaluating the performance of small scale feedlot enterprises in Mwanza region. Information on types of animals and feeds used in these feedlots were also collected.

1.3 Objectives

1.3.1 General objective

The overall objective of the study was to evaluate the performance of beef cattle under different feedlot practices in Mwanza region.

1.3.2 Specific objectives

The specific objectives of the study were:-

1. To document feedlot beef production practices in the study area.
2. To study the source and type of animals used by feedlot practitioners in fattening enterprises.
3. To evaluate the type and quality of feeds used by these feedlot practitioners.
4. To evaluate the performance of indigenous beef cattle animals under different feedlot practices.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 General Overview of Beef Industry

Cattle lot feeding industry in the world is an important sector of the domestic and export beef industries. It delivers all year round production of a product of consistent quality which is readily accepted by its customers, and is an important value adding component to both the beef and crop processing industries. Feedlots are important influences on country economies as well as the world economy generally.

Optimizing cattle performance in the feedlot is essential to remain competitive in the cattle feeding game. On finishing cattle, common goals are to maximize average daily gain and optimize feed efficiency. Feed intake is a powerful tool used by feedlot personnel and nutritional consultants to predict animal performance. Feeding cattle with the knowledge on historical feed conversions and the net energy content of the current ingredients one can reasonably and accurately predict average daily gain if dry matter intake on daily basis is monitored (Hersom, 2005). In general, if cattle are eating well, they should be performing well. If dry matter intake is low, animal performance is usually disappointing. Estimates of DMI expressed as a percentage of body weight on a dry matter basis are an excellent tool to monitor ongoing progress of cattle in feedlots (Norris *et al.*, 2002).

Once dry matter intake (DMI) is determined, feed efficiency is easily computed by dividing dry matter required by average daily gain (ADG). The steers' converts feed more efficiently than heifers during growing period. Steers are heavier at harvest and their body weights are key determinant in calculating a maintenance requirement, they require more feed to maintain their weight. However, the greater ADG of the steers compared to the heifers results in a lower overall feed intake relative to gain (Loy, 1999). Information on feed conversion of progeny can be used by beef herd owners in selecting for animals that use feed more efficiently, resulting in a lower cost of gain to reach a given market target.

2.2 Beef Production Systems

Beef production systems are classified according to the age at which animals emanating from a production unit are sold. The production unit could be a farm or one of the enterprises in a larger undertaking. A full description of a system includes the age, mass and carcass class at which animals are marketed, as well as the breeding, management and feeding practices followed (Mpofu, 20*0*2). In Tanzania the most common beef production systems are four or more year old (ox) systems. Buying-in systems are also commonly used, in which animals are bought, kept for a time during which they are usually fed to gain mass or condition, and then sold.

2.2.1 Extensive system

In most parts of Africa cattle farming constitutes a significant proportion of agricultural activities and contributes largely to the sustenance of rural populations. In extensive system cattle are grazed on unfenced grazing land. This system is characterized by overgrazing, low off-take rates, low technical efficiency measures in terms of calving rates, higher mortality rates and soil degradation (Mpofu *et al.*, 1998). Besides overgrazing and nutritional stress of the animals, periodic rainfall, variable droughts and diseases are important constraints to cattle production in Africa. .

Van Renen (1997) reported that in extensive system, beef supply is only determined by cattle numbers, which are not adjusted according to environmental factors. It is argued that communal farmers consider their cattle as a store of wealth, and they are only sold to meet immediate cash needs. Pastoralists have for several centuries practiced an extensive system for beef production and specialized method of livestock keeping based on the availability of virtually unlimited rangeland and the freedom to move in search of pasture, water and to avoid disease threats. They have developed a strong and enduring culture centred on livestock production, which has depended on adaptive management strategies to survive the regular cycles of unpleasant environmental conditions that make exploiting the rangeland resource so challenging. The repository and guiding hand behind these strategies rests with respected elders and age set leaders in the community, utilising traditional knowledge that has been acquired and passed on from generation to generation over the centuries that pastoralists have been occupying the rangelands (FAO, 2004).

In their study on performance of indigenous beef cattle under two management systems at Pokuase, Ghana, Baiden and Duncan (2008) reported that the performance of a mixture of N'dama x West African Shorthorn (WASH) cattle raised under an extensive management system and an improved system (cut and carry plus supplementation with agro-industrial by-products) varied considerably. Animals under extensive system had an average daily gain of 107 g/day while animals under improved system had an average of 314 g/day. Indigenous cattle under the traditional management system are slow in growth depending on level of feeding (Okantah *et al.,* 2005)

2.2.2 Semi-intensive system

Semi-intensive system is similar to zero-grazing except that cattle spend some of the time confined to stalls and grazing in paddocks at the other time. In this system there is an increase in demand for forage, which commands high prices. Smallholders who do not own beef cattle are often the source of fodder, which they grow for sale. Planted forages have grown in importance, particularly as beef cattle feeding shifts from extensive to either semi-intensive or intensive system.

The effect of natural pastures on the growth of local and crossbred bulls is variable. When the quality of the roughages is medium to high (CP levels of about 12g/kgDM) indigenous steers and cross bred bulls initially weighing about 170 kg can grow at 400 g/day on fresh fodder grass fed *ad libitum*. Supplementing with about 1 kg of a maize grain concentrate produces a growth response of about 0.5 kg/day. Mature natural grasses containing 4g/kgDM CP can meet only the maintenance requirements of yearling steers (Olayiwole and Olrunju, 1987).

2.2.3 Feedlot

A feedlot is a form of intensive system and is defined by the use of ruminant species, principally cattle, goats and sheep that are fed on feeds introduced from outside the farm system. Landless ruminant production systems (LLR) are highly concentrated in only a few regions of the world. In the case of cattle, they are almost exclusively found in Western Europe like Denmark, Holland and Switzerland and the Commonwealth Independent States member countries like New Zealand and Australia (Dicostanzo and Zehnder, 1996). The LLR system is based almost exclusively on high-producing, specialized breeds and their crosses, which, nevertheless, have not been bred specifically for performance under "landless" conditions. LLR system is highly capital-intensive, leading to substantial economies of scale (Sainz and Paulino, 2004). It is also feed-intensive and labour-intensive. Key efficiency parameters are daily weight gains and feed conversion, basically reflecting the efficient use of capital invested in infrastructure or in the form of lean animals and feeds. Weight gains are usually in the range of 1 to 1.5 kg per day, and feed conversion rates are about 8 to 10 kg of grains per kilogram of weight gain (Devendra, 1995). Different animal categories can be used for feedlotting as described in the following sections:

2.2.3.1 Steers

Feedlot production is found on principle of feed efficiency. Steers have more ability to convert grass into beef than older animals. The efficiency of feed utilization in feedlot for steers is based on high feed conversion ratio, which is the amount of feed consumed divided by the live weight gain (Arthur *et al*., 2001a, Sainz and Paulino, 2004). Variation in feed intake (FI) in steers is associated with maintenance requirements. According to Herd *et al.* (2004a), as feed intake increases the amount of energy expended to digest the feed increases due in part to the change in size of the digestive organs. The amount of energy expended by the tissues themselves also increases per unit weight of the animal hence the heat increment.

2.2.3.2 Finishing cull cows

Mature cows are usually culled from the beef herd after failing to deliver a live calf. These cows are often in moderate to thin body condition. Finishing cull cows on feedlot diets offers considerable potential to improve carcass composition and net return. Feedlot performance will decrease as time on feed and body condition increases. Thin healthy cows have excellent gains, perhaps greater than 1.80 kg per day on high grain diets, especially for the first 30 to 50 days (Pritchard, 1998). In their trial, Price and Berg (1981) reported that where cull cows were fed from 59 to 116 days, overall gains were 1.45 ± 0.27 kg daily. This level of gain occurred in thin cows exhibiting compensatory growth. Fleshier cows would not gain as fast. Older cows gained slower than cows 4 years old and younger. Feed conversion can vary from 3.17 to 3.63 kg of dry matter per kg of gain in the early stages of the feeding period and greater than 12.5 kg DM/kg of gain during later stages. There is no reported effect of breed on gain or feed conversion for cull cows. The high weight gain early in the feeding period is partially due to an increase in gut fill. The poorer feed conversion at later stages is likely the result of a higher maintenance requirement due to increased weight and an increased portion of the weight gain as fat.

2.2.4 Breeds

There is still no generally accepted definition-scientific or otherwise of a breed (Maule, 1990; Hammack, 2003). In the 1940's a breed was defined as "a race of animals which have some distinctive qualities in common". At the end of twentieth century the definition of a breed changed to "a stock of animals within a species having similar appearance, usually by deliberate selection" (Hammack, 2003). To date a "breed" is known as a group of animals having definable and identifiable external characters that distinguish it visually from other similar groups within the same species (Maule, 1990; Hammack, 2003). Several breeds that have been used for feedlotting under different production systems in most of the tropical countries are indigenous *Bos indicus* cattle and beef producer's looks to the introduction of *Bos Taurus* to improve productivity. Although there is a tendency for zebu crosses to have slightly higher digestive efficiency than British breeds (Mpofu, 2002). Brahmans, Hereford and Santa Gertrudis, are some of the breeds in the United States used in feedlotting while Sindhis and Sahiwals are used in Pakistan. Tuli, Tswana, Barotse and Boran are found in East and Southern African countries. The breeds that have been evaluated recently on performance include the Afrikaner (a breed developed in South Africa), Nkone, Mashona, Brahman, Charolais, Hereford, Simmental, Aberdeen Angus and Sussex (Tawonezvi, 1993).

In Tanzania the Zebu is the dominant breed used in feedlots. Body weight of an adult Zebu ranges from 300 to 445 kg in males and from 275 to 385 kg in females; height at the withers ranges from 118 to 140 cm in males and from 110 to 135 cm in females (Rege and Tawah, 1999). Although quite a lot is known on the performance of several breeds as stated above, there is still more work to be done to collect information on Tanzania's indigenous breeds. On-farm evaluations and breed comparisons have been limited by lack of field records, particularly records from the smallholder and communal production systems. A number of smallholder and communal farmers keep both local breeds and their crosses alongside foreign breeds. If data were available from such sectors, on-farm breed comparisons would be possible, and enable selection for an ideal beef cattle type with higher performance. It is not known whether there are subtypes within each breed or if the breeds differ genetically. Breed comparisons have tended to concentrate on biological traits. However, evaluations should also focus on economic possibilities of indigenous livestock taking into account both biological and economic data.

2.3 Factors to Consider in Deciding on a Production System

2.3.1 Profitability

There is still controversy as to which is the most profitable beef production system although a number of studies have been undertaken in an attempt to determine this. In his study on feed bunk management in USA, Loy (1999) reported that specific circumstances favour one or more production systems e.g. when feedlots are making a profit, feeders achieve good prices. When the animals are transferred to the feedlot the accent changes from growth to *finishing*. The steers gain in weight at a rate of about one kilogram per day, although this growth alone would not pay for the expense of confining them in a feedlot; but in a remarkably short time the animals also begin to finish by laying down a layer of fat. This has the effect of increasing the market value of the meat. It is this increase in grade, coupled with the live-weight gain of the animals, which makes the feedlot an economic proposition. Using unimproved pastoral cattle it is possible profitably to increase the yield of edible carcass from one animal by between 30 and 50 percent during 10 weeks in the feedlot (Loy, 1999).

When the circumstances under which a system is functioning change, profitability changes. Profitability of the feedlot is dependent on both inputs and outputs. Providing feed to the animals is a major input cost in most animal production systems. This has long been recognized in feedlot enterprises of developed countries. Although the cost of providing feed to grazing animals is more difficult to quantify, it is still a major cost of production in the extensive grazing system. It is therefore important that the efficiency of feed utilisation of the whole production system is considered in order to improve feedlot profitability

(Okantah *et al*., 2005). Here in Tanzania people fatten the animals in dry season because it is profitable at that time as they buy animals cheap and feeds are also cheap.

2.3.2 Fodder flow

Beef farming can be run under intensive conditions, but low returns and relatively stagnant beef prices during the early part of the nineties has favoured beef farming enterprises run under extensive conditions where natural grazing lands is the main source of feed for the cattle. Whether the beef production system is run under intensive or extensive conditions, matching the fodder requirements of herds on a farm to the fodder produced reduces input costs (Mpofu, 2002).

2.3.3 Climate

In very hot or excessively cold climates, breeds adapted to the relevant environments have an advantage over cattle not accustomed to extremes of temperature (Kuhl, 1992). Under moderate environmental conditions, assuming suitable management, most breeds of cattle are able to cope with the climate (Van Renen, 1997). Weaner systems of beef production contain a high percentage of breeding cows. This makes these systems relatively inflexible and poorly suited to areas prone to periodic droughts, in these systems, when numbers must be reduced, breeding cows must be sold and buying in good quality breeding cows after a drought is difficult and very expensive. But with ox system cattle only surplus animals need to be sold to reduce feed requirements. Where rainfall is low and erratic, it could be advisable to commit a part of the farm to a buying and selling system. During years when rainfall is poor, cattle are not bought and the relevant part of the farm can be used to graze home-bred cattle (Berger and Merchen, 1995).

2.3.4 Available markets and transport

Market prices and distance to market must be taken into account when deciding on a beef production system for a specific farm. Unfortunately, fluctuations in market price are difficult to follow by changing production system, and reliance must be placed on evaluating the market over past long term periods with the aim of developing a system which will provide the best average profit over future long term periods. The periods evaluated should stretch over years and not months. Chance therefore plays a significant role and luck in addition to experience and a thorough knowledge of beef markets is necessary to provide the correct solution (Thomson and Patricia, 2008). Transporting cattle over long distances to markets increases input costs. Where cattle are transported to abattoirs for slaughter, bruising of carcasses, stress and diseases like transit fever result in financial losses which can be reduced by good management, but cannot be eliminated. An argument often raised is that it is cheaper to transport carcasses than live animals and it has been demonstrated in developed countries that it is more profitable to erect abattoirs in beef producing areas rather than in consumer areas, which are often far away from the beef farming areas (Moll *et al*., 2001).

2.3.5 Efficiency of production

The whole rationale of introducing a feedlot system to small holder beef producers is not as a method of producing beef from crops. Instead it is a method of preparing the live animal produced from the range so that, at slaughter, its carcass has the correct specifications to meet market requirements (Klopfenstein and Owen, 1988). Conception rates are often taken by feed otters as an indicator of efficiency; since some animals that are fattened are bred in the feedlot operator farm and some are bought at auctions. However conception rates are based on pregnancy diagnosis, which can be inaccurate. Calf mortalities from birth to weaning render birth rate a less efficient indicator of production efficiency than weaning rate (Ruíz-Flores, 2006) Thus birth rate and weaning rates are important. Weaner systems are known to be very prone to depressed profit margins when the number of weaners produced per annum is low. Unless at least a 75% weaning rate is achieved without excessive feeding. It is doubtful if any system can make a profit with weaning percentages below 65 % (Hetzel, 1988).

2.3.6 Other enterprises on the farm

Where the beef unit is a secondary enterprise, efficient management of the feedlot cattle could be limited by a lack of time due to engaging in other activities. The semi-intensive system would then be inadvisable. On the other hand, where grain crops are produced, the grain could be a source of cheap feed for a feedlotting enterprise, time permitting. The availability of relatively cheap cattle feeds, either bought-in or home-produced, for growing out and fattening livestock could provide the means for cost-effective on-farm feedlotting (Abate, 1990).

2.4 Nutritional Needs of Feedlot Cattle

2.4.1 Energy supplementation

Feedlot cattle are typically fed high energy diets that contain a lot of grain. Feeding high grain diets reduces the time cattle spend in the feedlot, as well as reduces the need for feedlots to maintain large inventories of stored feeds. Sunvold *et al.* (1991) reported that grains are an excellent source of energy and a good source of protein. However, cattle are not like pigs, they need some fiber in the diet to maintain healthy rumen function. High energy diets that contain a lot of grain are rapidly digested in the cow's stomach which causes acidosis. When this happens, feed intake is erratic from day-to-day and digestion of feed is inefficient. Thus, the main reason for including forage in the diet of feedlot cattle is as a source of physically effective fiber for maintaining healthy rumen (Klopfenstein and Owen 1988). If the proportion of forage in finishing cattle diets is low, then the function of the forage to promote rumen health will be impaired, forage quality is less important in feedlot diets than in dairy diets (Sainz and Paulino, 2004). For example, chopped straw can be used effectively in feedlot finishing diets.

Feeding management of finishing cattle is efficiency driven, and cost of gain is the primary target. From a commodity standpoint, one of the costly activities associated with confinement feeding of cattle is purchasing and handling of roughage, which is an inexpensive source of energy compared with cereal grains. It is hypothesized that feeding grain to cattle early in life may stimulate greater daily gain. The cattle which are too emaciated and unfit for slaughter markets can at least gain weight in feedlots where they are raised primarily on supplementation to excellent body condition within an average 3.5 months. Intake by cattle of feed rations high in forage is generally limited by ruminal fill (Mpofu, 2002). However, cattle fed high levels of concentrates can and do overeat. This can result in a wide variety of disturbances such as acidosis and bloat Moore *et al.* (1990).

It also can be costly because of reductions in performance from reduced average daily gain and poor feed conversion efficiency. Underfeeding cattle on high concentrate rations also can result in reduced performance (Lardy, 1999). Feed intake is the only performance characteristic that is routinely measured in commercial feedlots on a daily basis and is highly related to both gain and efficiency. Under most circumstances, average daily gain can be predicted from feed intake. Obtaining maximum, consistent feed intake is a goal of cattle feeders. Both age (steers vs. yearlings) and starting weight have dramatic, predictable effects on dry matter intake of feedlot cattle (Grimaud *et al.,* 2006). Most predictions of feed intake are based on equations that anticipate a curvilinear increase in feed intake as weight increases. That is, as cattle get heavier, feed intake increases, but intake as a percent of body weight decreases.

Description of muscling may or may not improve prediction. In the work of Stanton *et al*. (1988), the Net Energy/g (NE/g) predicted average daily gain (ADG) of muscular steers more accurately than ADG of average steers. These steers consumed diets containing 0.61 Mcal NEg/kg and grew at relatively rapid rates (grand mean 1.5 kg/d). Perhaps genotype, endocrine manipulation, and dietary energy density and the interactions between these variables must be considered for accurate prediction of energy requirements.

2.4.2 Effect of protein supplementation on feed intake and digestion in ruminants

Mature forage from grasses such as cereal and pasture, have an ME content rarely more than 5 MJ ME/kg dry matter. The requirement tables (NRC, 2000) predict that such feed will probably maintain young animals, providing nitrogen and mineral deficiencies are corrected. The idea that straw is too low in ME to support growth often leads to a recommendation to replace it with a more energy-dense feed and/or increase the ME content by treating it with an alkali such as ammonia. Treatment with urea or ammonia to increase straw digestibility is a highly recommended procedure, as it increases the use of the basal low cost resource. In addition, it also corrects N deficiency in the rumen. The increased digestibility of straw consumed often increases growth of cattle by up to 300 g/day. The value of this additional growth is often less than the cost of treatment (Holloway *et al*. 2002). By providing more protein for digestion in the intestines through supplementation with an escape protein source, the overall efficiency of use of absorbed nutrients is improved.

Protein supplementation to feedlot cattle ensures an efficient digestion of forage in the rumen usually improves digestibility and intake and increases performance, whereby average daily gain and feed conversion efficiency are major factors that are taken into consideration (Bowman and Sanson, 1996). This is the first step in combating low productivity when cattle are fed on forage. Improving protein nutrition is the second strategy for increasing production to the feedlot cattle with a high protein requirement (Berger and Merchen, 1995). These include young animals following weaning, draught animals and drought stricken animals or cattle recovering from massive body loss from diseases. It is important that the diet contain a significant amount of rumen degradable protein since this is the fraction of protein used directly by the rumen microorganisms as they grow and multiply. Higher levels of protein are required for growing animals in order to synthesize body tissues. Kimambo *et al.* (1999) reported that crude protein content of some feedstuffs can be as low as 20 g/kg DM implying that animals consuming these feeds will involuntarily start to deplete stores in body tissues such as liver, blood and muscles. This will predispose the animal to retarded growth and several fatal ailments if not supplemented. Cochran *et al*. (1986) fed either cubed alfalfa hay or cottonseed meal-barley cake supplements to cattle grazing in the range and found that the type of supplement did not influence weight. However, supplemented animals were able to gain weight and maintain body condition more effectively than non-supplemented animals.

In their work on dormant tall grass prairie, Del Curto *et al.* (1990) reported that feeding cattle a supplement that was less than 0.6% body weight and containing at least 220 g/kg DM crude protein increased both intake and utilization of that low-quality forage. Dry matter digestibility in ruminants is highly affected by the protein content of the ration due to the increased supply of N, which is required to support different microorganism involved in digestion of different feed components (Grimaud *et al.*, 2006; Arthington and Kalmbacher, 2003).

2.4.3 Performance Responses to energy supplementation

There have been mixed results regarding energy supplementation and weight gain in feedlot cattle. Oliveros *et al*. (1989) found that daily gain increased with corn or wet-corn bran supplement when fed with a high-roughage, low quality diet of corn cobs and alfalfa haylage. Moll *et al*. (2001) observed that energy supplements tended to increase daily gain in steers grazing brome grass (a higher quality feed) in the fall, with no difference between soybean hulls or corn. Animals fed under *ad libitum* conditions will have fluctuations in feed intake. These fluctuations may result in decreased feed utilization due to digestive disturbances. As feed moves through the gastrointestinal tract faster, digestibility is reduced because the feed is exposed to digestive processes for a shorter time. It is possible that a reduction in feed intake will improve digestibility. The improvement in digestibility with limited feeding has been observed in several experiments and has resulted in better than predicted animal performance (Stanton *et al*., 1988).

Feedlot cattle are normally fed under *ad libitum* conditions (allowed to eat according to appetite). This allows maximum weight gain because any energy above that for maintenance goes for gain. However, recent feedlot work suggests that small limitations in feed intake may improve feed efficiency. In several studies where feed intake was restricted from 5-20 percent (mean 11.4 percent), the gain response was 5.5 percent lower than *ad libitum* fed cattle and quite variable from -20 -7 percent (Murphy and Loerch, 1993; Hicks *et al*., 1990; Plegge, 1987). Feed efficiency was improved (mean 3.5 percent, range -1-9 percent) in all the studies. The greatest improvement in performance from limit feeding appears to be when feed restriction was 4- 8 percent of *ad libitum*. These results indicate that slight restrictions in intake in finishing diets may be beneficial in improving efficiency, but when feed intake has been limited to less than 87 percent of *ad libitum*, cattle performance will be reduced. The difference in animal performance between veldlot and feedlot has been well reported by Bowman and Sanson, (1996). Veldlot is similar to semi–grazing where animals graze in rangeland they are then supplemented later with concentrates.

2.5 Feed Resources that can be used in Feedlots in Mwanza

2.5.1 Cottonseed hulls

2.5.1.1 Physical composition of Cotton seed hulls (CSH)

Cottonseed hulls are the outside portion of the whole cottonseed. They are separated from the whole seed during the processing and production of cottonseed oil. The total digestible nutrients (TDN) level is around 45 percent, and the protein content is approximately 4 percent (Hsu *et al*., 1984). One tonne of cotton fiber yields 0.3 tonnes of cotton seed hulls (Jagadi *et al*., 1987). Therefore out of 480 600 tonnes produced in Tanzania in year 2007 yielded 144 800 tonnes of Cotton seed hulls. Cotton seed hulls are high in fiber and are available as intact hulls or ground and pelleted. They are poorly digested feedstuff used primarily as a roughage source in grain-based diets. The low bulk density of cottonseed hulls usually confines the use of this feedstuff to areas surrounding production plants or for special uses, such as a roughage source in rations for beef cattle. Cottonseed hulls are very palatable to cattle and have been shown to stimulate intake in young cattle fed grain-based diets. Intake tends to increase with addition of CSH to rations for beef cattle (Morales *et al*., 1989) and steers (Moore *et al*., 1990).

2.5.1.2 Chemical composition of Cotton seed hulls (CSH)

CSH are low in CP (40-120g/kg DM) varying with the amount of cotton seed meal or kernel present (Hsu *et al.,* 1984). The main component of CSH is Neutral Detergent Fibre (NDF) which is between 735g/kg DM and 890 g/kg DM as reported by Hsu (1984), Garleb (1988) and Mertens (1994) which includes a relatively large portion of acid detergent lignin.

Table 1: Chemical composition of cotton seed hulls obtained by different authors (g/kg DM)

Authors name	DM g/kgfeed	CP	EE	CF	ASH g/kg DM	NFE	NDF	ADF
Church and Pond (1982)	910	41.0	-	480	-	-	-	-
Rao *et al.* (1984)	-	31.0	4.00	411	94.0	460	-	-
Hsu *et al*. (1984)	884	124	92.0	-	-	-	-	-
Garleb *et al* (1988)	896	67.0	-	-	28.0	-	-	-
Chamatata (1995)	929	88.5	42.0	408	41.7	348	624	463
Calhoun *et al.* (1995)	899	50.0	19.0	486	28.0	-	869	670
Hall *et al.* (2000)	889	64.0	32.0	470	36.0	426	782	530
Blasi and Drouillard (2002)	900	41.0	19.0	480	30.0	-	870	680
Ramachandran and Singhal (2008)	937	79.1	30.8	-	32.0	-	655	437

2.5.1.3 Digestibility and animal performance

The NDF and NDL fractions tend to be negatively correlated with digestibility. Torrent *et al.* (1994(and Moore *et al*. (1990) reported the proportion of between 320 and 380g/kg DM for NDF while dry matter was (327g/kg DM Torrent *et al*., 1994 and 343g/kg DM, Garleb *et al*., 1988). In their study on influence of roughage source on kinetic of digestion and passage rate in beef steers, Moore *et al*. (1990) found that dry matter intake by steers was higher (P< 0.10) for cotton seed hulls than that for the alfalfa diets. Cottonseed hulls are usually fed at 25 to 50 percent of the diet, depending on desired performance level (Ruiz-Flores *et al.*, 2006).

The digestion of CSH and their effect on digestibility of other ration components is likely affected by their physical form as well as composition. CSH are composed of a lignified seed coat and attached cellulosic lint. Little of the lignin disappears after in situ or in vivo fermentation and the remaining cellulose is rather crystalline (Garleb *et al*., 1988). CSH have been reported to decrease the digestibility of other dietary components. With steers on a milo diet, apparent digestion of DM and NDF were lower when CSH replaced half of the alfalfa hay (Moore *et al.*, 1990). In their study to compare the feeding value of wheat straw (WS) and cottonseed hulls (CSH) based complete diets in mash and flaked forms (CSH-M and CSH-F) Ramachandran and Singhal (2008) reported that Average daily body weight gain and feed conversion ratio of crossbred steers was higher ($P < 0.05$) for CSH- F 586 g and 8.49 kg.while CSH-M had 533g and 9.29 kg than in WS-M 245 g and 15.6 kg respectively.

Lignin encrustation and cellulose crystallinity are among the factors that affects cotton seed hull fermentation (Harris *et al*., 1983). Also cotton seed hulls have high passage rate affecting fermentation process in the rumen compared to forage (Moore *et al*., 1990). Norbaev (1989) reported on problems of hepatosis associated with the feeding of cottonseed hulls in Russia.

2.5.2 Brewers mash

2.5.2.1 Physical composition of Brewers mash

Brewer's mash is the residue produced as a by-product of the mashing operation in the brewing process and as such is a water cooked product. Being a water cooked product, the physical characteristics of the brewer's mash differ from uncooked natural protein sources, and dry cooked products, because during the cooking, water soluble constituents are leached from the grain resulting in a depletion of the mineral content. Furthermore, the cellular structure of brewer's mash is broken down during malting and brewering resulting in a product that is less retentive of moisture than uncooked products. It has also been found that wet brewer's grain, is deficient in minerals like calcium, phosphorus, magnesium and sodium necessary for nutrient balance in the overall feed (Blasi and Drouillard, 2002). Brewers mash (BM) is one of the industrial wastes in Tanzania that for years has not been utilized effectively.

2.5.2.2 Chemical composition of Brewers mash (BM)

Brewers' mash is a lignocellulosic material containing about 170 g/kg DM cellulose, 280 g/kg DM non-cellulosic polysaccharides and lignin, chiefly arabinoxylans (Aines *et al.*, 1987). Nevertheless, it has high content of protein and fibre (around 200 g/kg DM and 700 g/kg DM respectively). Two-thirds of the original grain DM (corn and grain barley only) consists of starch. After fermentation, approximately one-third of the original grain DM is recovered in the whole stillage (grain drying frame). Because only the starch is removed during the fermentative process, the other nutrients associated with the grain become more concentrated. For example, CP increases from approximately 90 g/kg DM in the original corn grain to 270 g/kg DM in the whole stillage (DM basis) (Afshar and Maheri, 2008).

Brewers mash as animal feed falls into a group of single cell protein resource, rich in high quality protein and vitamins of B – group (McDonald *et al.*, 1995) Distiller's solubles are valued for their growth factors. It is doubtful whether distiller's solubles promote growth in cattle, but it has been claimed that they contain a rumen-stimulating factor that increases cellulose digestion. The CP content in the table below ranges from 235 g/kg DM to 525 g/kg DM, this variation may be caused by unclear separation of brewers byproducts like brewers grains (wet or dried) and brewers dried yeast. The brewering plant also can vary depending upon the type of substrate being used (barley, wheat, corn, etc.), proportions being fermented and fermentative process being used. Some plants will dry the brewer’s grain and sell it as dried brewer's grain, while others will have it available as wet brewer's grain.

Table 2: Chemical composition of Brewers mash by different authors (g/kg DM)

Authors	DM	CP	CF	EE	NDF	ADF	NFE	Ash
	g/kgfeed	g/kg DM						
Göhl (1981)	891	499	15.0	13.0	-	-	388	85.0
Preston *et al.* (1987)	931	282	172	71.0	538	201	545	-
Sekin and Akbulut (1987)	910	525	35.0	30.0	-	-	250	70.0
McDonald *et al* (1995)	900	443	2.00	11.0	-	-	342	102
Preston R.L (2002)	920	240	140	92.0	500	240	-	400
Mussato *et al*, (2006)	928	235	167	73.0	523	264	-	750
Mirzaei and Maheri (2008)	933	243	159	88.0	542	257	-	680
Afshar and Maheri (2008)	931	284	174	78.0	498	246	-	730

2.5.2.3 Digestibility and performance of animals fed Brewers mash

In their evaluation of brewers' mash (BM) and palm kernel meal (PKM) as major sources of nitrogen for growing cattle Umunna *et al.* (1980) found average daily gain of 0.86 kg, average feed intake of 7.59 kg and feed conversion ratio of 9.48 kg feed/kg gain. The results between steers supplemented with BM or PKM were not significantly ($P > 0.05$) different. Both dry matter (DM) and nitrogen (N) digestibilities were not significantly ($P > 0.05$) affected by the treatments but there was a tendency towards reduced DM digestibility for the BM treatment. Those results of the BM study on digestibility were similar to that of Klopfenstein and Rounds (2005) that were 889 g/kg DM and 905 g/kg DM which was later confirmed by Oster *et al.* (2007). Oster and co-workers (2007) demonstrated no significant differences in average daily gain, feed intake and feed conversion of growing cattle from 80-240 kg fed two levels of BM at 17 or 36% of the concentrate mixture versus soybean meal (SBM) as protein source. Klopfenstein and Rounds (2005) showed that cattle fed a corncob-based ration gained faster and more efficiently with BM as protein source than with SBM, urea or a BM-urea combination.

Limitation on its use is that Brewers mash normally contains 80 to 90 percent moisture when the brewery mashing process is completed (Klopfenstein and Rounds, 2005). This moisture content is too high for efficient utilization as livestock feed, and the high moisture renders the feed unsuitable for efficient and satisfactory preservation beyond a few days storage. Brewers mash preserved with high moisture content (80 to 90 percent) tend to become excessively sour in storage, losses nutritional value through leaching and run-off, and undergoes spoilage and loss of quality and palatability as livestock feed. Drying the Brewers mash is an art employed to preserve perishable wet grains from time of production until time of use as livestock feed. This method of preserving and using brewers mash as feed has the problems of adding cost to the feed product, and failing to correct nutritional imbalance and deficiencies which exist in untreated brewers grains. To lengthen the time of storage the wet brewer’s mash are distributed evenly on the floor covering the surface with plastic or some other covering material to minimize surface spoilage.

2.5.3 Cotton seed cake (CSC)

2.5.3.1 Physical properties of CSC

The cotton plant, *Gossypium spp*, is grown primarily for its fibre. After harvest from the fields the cotton is ginned to remove the greater part of the fibre, called cotton lint, for use in the fibre industry. On average the lint constitutes 360 g/kg by weight of the cotton and the rest 640 g/kg are by products. Cottonseed cake is the second most valuable product of cottonseed, usually accounting for over one-third of total product value (Calhoun *et al.*, 1995). It may be sold in the form of meal, cake, flakes, or pellets. Cottonseed cake is used principally as feed for livestock and is usually sold at between 250- 410 g/kg protein level. Its major value is as a protein concentrate (Coppock, 1991).

2.5.3.2 Chemical properties of CSC

Crude protein ranges from 231 to 457 g/kg DM for undecorticated and decorticated respectively (McDonald *et al*., 1995). Crude fibre of 300 and 150 g/kg DM were reported for the undecorticated and decorticated cotton seedcake respectively (NRC, 1996). Cottonseed cake, a leading protein supplement, provides the protein necessary to overcome the low protein content available in grain and roughages. It furnishes 3 to 6 times the protein of most grains and 10 to 20 times that of the lower quality roughages. In addition to its high protein content and high energy value, cottonseed cake is higher in phosphorous than any of the other vegetable proteins.

Table 3: Chemical composition of Cottonseed cake in g/kg DM from various authors

Reference	DM	CP	CF	EE	NDF	ADF	ADL	OM	ASH
	g/kgfeed				g/kg DM				
Davis,(1982)	943	206	215	200	-	-	-	-	49.0
NRC, (1996)	910	452	133	16.0	-	170	-	-	71.0
Coppock (1991)	920	230	208	175	400	175	-	-	50.0
Calhoun *et al.*, (1995a)	857	237	-	-	414	358	67.0	916	84.0
Forster *et al*. (1995)	877	230	247	55.0	-	-	-	-	66.0
Chamatata, (1995)	968	356	140	77.5	-	-	-	-	55.0
McDonald, (1995)	900	457	87.0	89.0	-	-	-	-	74.0
Machibula (2000)	929	268	-	-	488	299	84.9	885	57.4
Ayo, (2002)	899	363	231	83.2	324	-	-	935	64.2
Hango, (2005)	940	371	347	71.8	643	308	-	-	60.7

DM: Dry matter, OM: Organic matter, CP: Crude protein, ash, NDF: Neutral detergent fibre,

ADF: Acid-detergent fibre , ADL: acid-detergent lignin, CF: Crude fibre, EE: Ether extract

2.5.3.3 Digestibility and performance of animals fed Cottonseed cake

In the study of Pham *et al*. (2008) on effects of different levels and sources of cotton seed cake protein supplementation on feed intake, digestibility and nitrogen retention in local cattle compared to Charolais crosses in Vietnam they reported that DM intake did not differ between cottonseed cake and sesbania/urea supplementation; but was higher for the 200g CP level than the 150 g level. There were no differences between breeds when DM intake was expressed on the basis of metabolic live weight but daily weight gain was higher for Charolais crosses. The apparent digestibilities of DM and NDF were higher in local cattle than in Charolais crosses (530 g/kg DM vs. 499 g/kg DM and 579 g/kg DM vs. 540 g/kg DM). Cotton seed cake apparent digestibility did not differ between breeds but was higher for the higher level of CP supplementation. The ADG for local cattle and Charolais crosses were 220g/d and 335g/d. In another study by Pires *et al*. (1997) who studied the effects of heat treatment and physical processing of CSC on nutrient digestibility of Holstein cows, Basal diets consisted 553 g/kg of corn silage and 447 g/kg concentrates on a DM basis. Calculated total tract digestibility was higher ($P < 0.05$) for the control diet than for the diet containing CSC; values were 671 g/kg to 622 g/kg for the control and CSC diets, respectively. Total tract digestibility of Nitrogen was also increased ($P < 0.05$) in animals fed the control diet. Cottonseed cake supplementation decreased ($P < 0.05$) total tract N digestibility by 58 g/kg as the value decreased from 728 g/kg for the control to 670 g/kg for the CSC-supplemented treatment**.** Results of these studies indicate that relative differences in the digestibility of high-roughage, CSC-supplemented diets can be quite variable. In high-roughage diets, the main source of roughage most likely determines the effects of CSC addition on intake, as well as effects on fiber, protein, and DM digestibilities.

Limitations on its use is that cottonseed cake contains gossypol, a naturally occurring plant pigment found most commonly in cotton (*Gossypium Spp.*) and okra, as well as in most plants in the family *Malvaceae*. Gossypol is a polyphenolic compound that, in cotton, is localized in pigment glands found throughout the plant. These glands are especially concentrated in the seed. Cottonseed has been shown to contain from 4 g/kg to 20 g/kg free gossypol. The level of gossypol is affected by species, variety, fertilization, growing conditions, and insect pressure. The presence of gossypol affords the plant some protection against predators such as insects, field mice, and raccoons that might otherwise feed on these plants and/or their seeds (Blasi and Drouillard, 2002) Gossypol exists as two stereo isomers, or mirror images of each other, which are designated as (+) and (-) isomers. The minus or "(-)" isomer has been shown to be more detrimental biologically within the animal. Gossypol causes toxicity to animals. Clinical signs of gossypol toxicity in mature cattle can include decreased dry matter intake, panting, elevated heart rate, ruminal stasis, severe abomasitis, haemoglobinuria and sudden death. Other signs have included abdominal distension and pulmonary oedema. Clearly these symptoms indicate a number of disorders, and the intake of excess levels of gossypol should be the important factor. (Calhoun *et al.*, 1995a)

2.5.4 Rice polishing

2.5.4.1 Physical properties of Rice polishing

Rice polishing is a byproduct of rice milling and is the cheapest source of energy and protein for beef cattle feeding. According to Nadeem (1998) rice polishings come from the fine inner layer covering the grain. It constitutes about 100 g/kg of paddy and is available in large quantities in major rice growing areas of the world (Ambreen *et al.*, 2006). Rice polishing has great potential as an ingredient in beef cattle feed; with inclusion level varying from 250 to 400 g/kg feed (Singh and Panda, 1988).

2.5.4.2 Chemical composition of rice polishing

It is a good source of proteins, energy, vitamins and minerals (Saunders, 1990). It also contains 120-140 g/kg DM protein and has better assortment of amino acids, particularly lysine and methionine, compared to other cereal grains, including corn and wheat (Khalique *et al.*, 2004). Rice polishing supplies as much total digestible nutrients as maize (Singh and Panda, 1988). Rice polish has been reported to improve dry-matter intake, stimulate volatile fatty acid concentration, microbial numbers and efficiency of rumen synthesis (Elliot *et al.*, 1978; Cardenas et *al.*, 1992).

Table 4: Mean reference values of rice polishing in g/kgDM by different researchers

Reference	DM	CP	CF	EE	ASH	NDF	ADF
	g/kgfeed	g/kg DM					
Pond and Maner,(1974)	900	111	33.0	147	89.0	-	-
Malik and Chughtai, (1979)	926	114	38.5	146	108	-	-
Allen, (1980)	898	122	44.5	133	122	-	-
Choo and Sadiq, (1982)	-	110	120	-	98.0	-	-
Rao and Reddy,(1984)	-	120	76.0	-	174	236	125
Ghazi, (1992)	927	129	157	-	171	-	-
Chamatata, (1995)	921	116	279	21.8	68.0	-	-
Nadeem, (1998)	149	149	118	-	107	-	-
Leeson and Summers, (2001)	934	110	24.0	-	-	-	-
Ambreen *et al.*, (2006)	920	130	151	173	105	256	122

2.5.4.3 Digestibility and performance of animals fed rice polishings

A digestibility trial by Lamba *et al*. (2002) of Rice polishing as an economical substitute to wheat bran as a supplement to wheat straw diet for feedlot cattle in Northern Plains of India reported that the digestibility coefficient of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), neutral and acid detergent fibre (NDF and ADF) did not differ significantly between treatments. Those results were in agreement with the earlier findings which indicated no significant change in OM digestibility, nitrogen-retention, DM disappearance and effective degradability of grass hay with increasing level of rice polish (Cardenas *et al.,* 1992). However, contrary to reports that indicate toxic effect of increased amount of dietary fat on cellulolytic bacteria and inhibition of fiber degradation (Khalique *et al.,* 2004), the digestibility of fiber fractions (NDF and ADF) in that study was not adversely affected due to inclusion of rice polish and the fat level of RP (34 g/kg) remained below the toxic level to rumen bacteria. It is significant to note that CP and DCP intake (g/day) of all the feedlot cattle was 12-23 and 24-30 percent lower than the recommended value of 1.2-1.3 kg for CP and 0.73 - 0.77 kg for DCP, respectively. However, the animals could maintain the body condition during the experiment, which gives an indication that indigenous cattle may require moderately lower level of dietary protein than the recommended values.

Limitation on its use is that high fibre content in rice polishing limits its use by monogastric animals, but it can be utilized by ruminants. The major constraint is the high oil content which limits its storage life; stabilizing is required, further adding to costs. High fat content in the rice polishing, which is of unsaturated nature tends to develop rancidity quite readily (Singh and Panda, 1988). Ambreen *et al.* (2006) reported that Thiobarbituric acid (TBA) at certain level (5.5 ± 2 g/kg) of oxidative rancidity of fat lowers percentage of EE in the feedstuff. According to Malik and Chughtai (1979), the range of EE in rice polishing is 130-160 g/kg.

2.6 Feeding of Feedlot Cattle

Intensive production in the beef sector refers to systems that are based on complete confinement of animals. They are given a variety of feeds, including forage crops, crop residues and concentrates. When the animals are transferred to the feedlot the accent changes from growth to finishing. The steers gain in weight at a rate of about 1 kg per day, although this growth alone would not pay for the expense of confining them in a feedlot; but in a remarkably short time the animals also begin to finish by laying down a layer of fat, this has an effect of increasing the market value of the meat. It is this increase in grade, coupled with the live-weight gain of the animals, which makes the feedlot an economic proposition. Using unimproved pastoral cattle, it is possible to increase profitably the yield of edible carcass from one animal by between 30 and 50% during 10 weeks in the feedlot (Sainz and Paulino, 2004). Most research and feedlot experiences suggest that two or more feedings a day result in better trough and cattle management and reduce the amount of stale, wasted feed (Kuhl, 1992). This is particularly true for high moisture feeds offered during hot weather and periods of precipitation.

It is usually advised to feed a mixture of hay and grain *ad libitum* particularly animals with loss of condition. It is suggested that a cereal grain and legume hay at ratio of 70:30 (cereals grain: hay) can be used for rapid growth of feedlot animals, Therefore, feedlot ration should consist of DM 900 g/kg, NDF 300-350 g/kg, with CP 150-170 g/kg DM and energy 9-12 MEMJ/Kg (Maule, 1990). Growth and development on feedlot cattle can be indicated as a percentage of live weight gain. Intensive finishing systems should utilize cattle that are capable of efficiently converting concentrates to live weight or carcass weight. The greater the live weight gain, the quicker the animal reaches slaughter weight (Aines *et al.*, 1987).

2.6.1 Factors affecting feedlot performance

2.6.1.1 Feed intake

The generally accepted theory relative to feed intake in ruminants is that cattle on high roughage rations limit their intake by physical means; they simply cannot fit any more feed in the rumen due to stomach capacity limitation. On the other hand cattle consuming a finishing ration do not stop eating because they can no longer fit any more feed in the rumen. Feed intake of cattle fed a high energy ration is limited by total energy intake. The brain says, “Do not consume any more energy” It is important to be familiar with these basic concepts so that one can readily understand and help correct problems with low dry matter intake in cattle consuming high roughage and high concentrate rations. For example, if long chopped silage is fed one may run into dry matter intake problems in cattle fed a high roughage diet but it probably will not significantly influence dry matter intake in finishers (Kuhl, 1992 and Lardy, 1999)

2.6.1.2 Weather

Seasonal, long-term weather patterns as well as day-to-day weather changes can influence cattle performance and feed intake (Pritchard, 1992; Holloway *et al*., 2002). Cattle consume the majority of their feed during the comfortable period of the day. In hot weather, cattle eat primarily during the late evening, night, and early morning. Therefore, 60% of the ration should be fed at the late afternoon feeding to reduce feed spoilage. In cold weather, most eating occurs from mid-morning to late afternoon (Holloway *et al*., 2002), so the largest amount of feed offered should be at the morning feeding. Day-to-day weather changes such as rain can influence palatability of a ration, especially in warm weather. Wet feed should be cleaned out of the troughs and replaced with a fresh mix of the ration to reduce intake fluctuations (Whitlock, 1999). Rain can also affect feed consumption because of the secondary effects of muddy lots.

2.6.1.3 Ration ingredients and characteristics

Rations that are too wet can limit DM intake (Miller, 1998a). To minimize Total Mixed Ration (TMR) variability it is important to minimize ingredient variation. One has to develop an easy way to adapt the ration to whatever changes are required, by making a premix of dry, non forage ingredients, setting a mixing procedure (e.g., proper mixing time), sequence for adding ingredients, and monitor the quality of the ration after mixing (Schoonmaker, 1999a). Putting a fresh feed in a clean trough is also a good management practice. Old feed remaining in the feed trough can shorten trough life of new feed and reduce DM intake (Ballantine, 1998). Trough management also varies with ingredients and types of rations being fed. Some ingredients have less trough stability than others, e.g. rations containing high-moisture grains deteriorate rapidly (Grimaud *et al.*, 2006).

2.6.1.4 Water supply

Many producers overlook the importance of water availability as it relates to trough management, including the amount of water, space provided, and the location of water sources. Problems that limit water intake also can limit feed intake, and this, in turn, can reduce overall cattle performance (Abate, 1990). Poor water quality or lack of water can cause cattle to go off feed quickly. Practitioners need to recognize this problem before making any drastic changes in the amount of feed offered. In free-stall barns, 7.5 cm of linear space per cow and one watering space (or 2 feet of tank perimeter) for each 15 to 20 cows are recommended (Brett, 1999). A water depth of 6 to 8 inches is suggested to help keep the water fresh and easier to clean, because less debris accumulates (Miller, 1998a).

As temperature and humidity go up, more water is required. During months of hot weather, water supply in the feedlot becomes an important issue. Feedlot cattle drink most of their daily water requirements after feeding. They should have access to water in their holding pens (Ballantine, 1998). Adding water tanks for the summer can help in both feedlot operations (Miller, 1998a).

2.6.1.5 Feed trough design

Good feed trough design is also essential to optimize DM intake. Beef cattle should have 61 to 76 cm of trough space each to allow all of them to eat at the sametime. Some designs such as 3-row and 6-row barns limit the space per animal. The feed trough should be 10 to 15 cm higher than the alley, so the animal can have a natural grazing position when eating (Miller, 1998a). Cattle consuming feed at ground level waste less feed and this position also helps the animal to produce more saliva and improves the buffering capacity in the rumen (Ballantine, 1998).

In addition, the condition of the feeding surface can affect DM intake. Feed troughs must have smooth surfaces. Surfaces without grooves or holes that can trap feed are easier to clean and help reduce buildup of waste feed, mold growth and odour (Ballantine, 1998; Miller, 1998). Avoiding muddy conditions and manure buildup on trough aprons is also important (Arthington and Kalmbacher, 2003). These conditions can decrease palatability of the ration as well as increase disease transmission.

2.6.2 Animal factors affecting feedlot performance

It is well known that there are several animal-related factors that affect feedlot performance, including breed type, age, body weight, sex, stage and general health. At a young age and low level of nutrition an animal grows only bone and muscle, but after maturity, when growth stops, fat may be laid down. When fat is laid down at this stage of maturity it tends to be an energy store, and it grows in large blobs over the back and in the pelvic channel (Kuhl, 1992).

2.6.2.1 Breed type

Performance of beef cattle to attain higher mature size, higher feed conversion efficiency, as well as growth rate and carcass characteristics after feedlotting is influenced by breed type (Cundiff *et al*., 2004). Nutritional requirements and production costs are also related to breed. Therefore selecting appropriate breeds to be used in a breeding program is an important decision for beef cattle producers.

2.6.2.2 Age

Researchers at Michigan State University (as cited by Miller, 1998a) found that first-calf steers ate more meals, spent less time at each meal, and ate less at each meal than older ones. Thus, in large herds, separating first-calf steers from older cattle might reduce competition and improve performance (Ballantine, 1998; Schoonmaker, 1999a, b).

2.6.2.3 Body weight and sex

Body weight and sex also affect DM intake. The average intake per unit body weight is between 3 and 5%. Typically, calves consume 8 to 12% less than yearlings of the same weight, although younger calves eat a higher percentage of their body weight. Heifers often eat 4 to 5% less than steers of a similar weight (Kuhl, 1992).

2.6.2.4 Health

Health also affects performance, and thus, affects feedlot management. For example, deworming calves increases feed intake by about 3% (Cundiff *et al*., 2004). Conversely, feedlot management observations can aid in detecting large-scale health problems. Another factor is cattle appetite. Hungry cattle are more aggressive at the feedlot, which leads to over consumption and related digestive problems in aggressive cattle, whereas timid cattle remain underfed (Lardy, 1999).

2.7 Economics of Feedlots

Estimates of total costs of production, revenues accruing from sales of feedlot animals and gross margins from feedlots have to be estimated. Average gross margin per animal per month can be calculated. Analysis of the effect or impact of the type of ration can be the profit or loss which the feedlotter makes as a result of an increase or decrease in price from the time the animal is bought (the purchasing price) to the time the animal is sold (sale price). This is called the price margin and is calculated as initial live mass X (sale price/kg - cost price/kg).

Price margin includes the difference between purchase price and selling price resulting from beef price fluctuations as well as improvement in carcass quality due to feeding. The feedlotter cannot control price fluctuations and must therefore rely on a prediction of what prices will be when stock are sold at a future date. Making use of a positive price margin is what is commonly called speculation. A positive feed margin can only be realized with high mass gains and a relatively low cost of feed. The cost of the feedlot ration relative to the beef price and live mass gain exerts a major influence on the cost of gain. Because of the high proportion of energy required to ensure good feedlot performance, the cost of proteins and grains which are usually included in most feedlot rations in the form of concentrate is a significant factor deciding profitability of a feedlot enterprise. Feedlots operators in Mwanza region reported net profits on average between Tshs. 50 000 and 70 000 per animal (Mkonyi *et al*., 2006). Quick growth and spread of feedlots was reported to be a result of easy source of cattle at low prices, especially during the dry season, relatively cheap cotton seed hulls and attractive profits of the business within a relatively short period of operations.

2.8 Feedlot Practices in Tanzania

Currently the majority of Tanzanian cattle offered at cattle markets for slaughtering are held using the extensive grazing system meaning each animal has 4 to 5 hectares to graze, without receiving any additional feed or medical treatment. Disadvantage of this system is that the animals get fat during the rainy season and thin again during the dry season having a deteriorating effect on the quality of the meat designated for consumption. Due to this system of grazing it takes on average 5 to 6 years before an animal has reached the optimal weight to be slaughtered and even then the carcass weight is often relatively limited. However, like one of the molasses project in Mtibwa which was showing promising results in fattening cattle using the feedlot system came to a standstill (Creek, 2003).

The development of modern feedlots under intensive feeding system will depend on government proposing, implementing and enforcing legislation on animal production, slaughtering and food processing. It is anticipated that such legislation will become effective in the medium term. Despite the current lack of enforcement on legislation, investment projects in modernizing the feedlots, animal slaughtering and meat processing sector are emerging. In Morogoro, Dodoma and Sumbawanga, new smaller sized, slaughterhouses have been constructed. The one in Dodoma has been commissioned and is demonstrating positive results, but is located at a far distance from the main consumer market in Dar- es- salaam (Creek, 2003). The stage has now reached whereby proposals have been recently made to extend the feedlot approach to areas where milling by products are abundant like Vingunguti proposed project that will utilize the Pugu animal market. It has been further reported that Ruvu ranch is in the threshold of starting feedlot operation soon.

2.8.1 Feedlot Practices in Mwanza region

There exist two supply channels for terminal domestic beef markets in Mwanza. The first involves a direct channel where traders buy cattle from producers (pastoralists and farmers) and sell at profit to butchers. The second involves some value-adding where feedlot operators buy cattle from producers or cattle traders and fatten them for 3 to 4 months before selling them to the secondary or terminal market in Dar-es-salaam (Mkonyi *et al*., 2006). Although one expects a higher price of cattle as a result of rising feed costs, the relative increases in the price of cattle and meat are not justifiably proportional to the cost of feed. More importantly, why beef sourced from primary producers and from feedlot operators fetch the same price at consumer selling points remains inexplicable. There are a number of actors in the meat market chain in Mwanza, including primary cattle producers, small traders, middlemen, large-scale traders, feedlot operators, butchers, and supermarket outlets. The length of the market chain depends on proximity between primary producers and consumers: the longer the distance, the more actors.

Although it is generally thought that those in the industry are currently making more profit than they used to, it is not certain which of the actors in the chain are making more profit, by what proportion, at which level of transaction, and above all if the rise in beef prices has translated into increased income for feedlot operators and pastoralists.

2.9 Conclusion from Literature Review

From the literature review it can be concluded that beef production systems are variable with the most common ones in East and southern African countries being semi-intensive and extensive, it has been further noted that industrial byproducts that were formerly thrown or burnt have been widely researched and utilized in other countries resulting to weight gains in the range of 1 to 1.5 kg per day, and feed conversion rates of about 8 to 10 kg of feeds per kilogram of weight gain. Moreover different classes of animals respond well when put under feedlot like steers, barren females, cull cows, draught and drought stricken oxen's.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Overview

The study was conducted in three districts that are Magu, Nyamagana and Misungwi in Mwanza region. The criterion used to select these three districts out of eight districts was based on prevalence of 4 types of feeds used by feedlotters to feed their animals that were pre-determined to be monitored and this information was obtained from the secondary data.

The activity was carried out in two months, October and November, 2008. The study involved two phases where phase one involved baseline survey which was undertaken to collect information on the existing feedlot practices in Magu, Nyamagana and Misungwi districts. Phase two involved monitoring experiments, where performance of some animals that were selected to be under study out of the whole herd in different feedlots was done.

3.2 Preliminary Survey

In order to solicit background information and familiarize with the study area, preliminary survey was done. Secondary information on number of feedlots and type of feeds for each district were collected from previous research reports from government at Ministerial and at the local government offices, research centres and livestock markets. From the information that was obtained a structured questionnaire was prepared for baseline survey.

3.3 Study One: Baseline Survey

3.3.1 Description of the study area

Mwanza region is located in the Northern part of Tanzania between latitude 1°31' and 3° south of the equator, and between longitude 31°45' and 34°10' east of Greenwich. Regions bordering Mwanza region are Kagera to the west, Shinyanga to the south and south east, the north east boarders Mara region. The northern part of Mwanza is surrounded by the water of Lake Victoria which in turn separates the region from neighbouring countries of Uganda and Kenya. Mwanza region has eight administrative districts which are Nyamagana, Ilemela, Magu, Ukerewe, Geita, Sengerema, Kwimba and Misungwi. It is a relatively small region occupying 2.3 percent of the total land area of Tanzania mainland.

The districts are divided into 33 divisions; these in turn are further subdivided into 168 Wards. The village is the basic administrative unit. There are 682 villages in Mwanza region. The study was carried out in three districts which were Misungwi, Nyamagana and Magu.

3.3.2 Sampling procedure

The study on cattle feedlots or fattening was conducted in the periurban district of Mwanza City, namely Nyamagana and other two districts Misungwi and Magu that were identified during the preliminary survey. The three districts with feedlotters were purposely selected basing on the accessibility out of six districts that have feedlots. The feedlots in each district were blocked by the type of feeds they use and twenty four respondents representing each type of the feed used in the feedlot were picked at random. Out of the intended 24 respondents in each district only 16 in Misungwi, 22 in Nyamagana and 20 in

Magu agreed to fill the forms because some of the feedlot owners live in Bariadi district, Shinyanga region, and the animals were taken care by casual labourers who could not precisely fill the forms. A structured questionnaire (Appendix 1) was administered at one point in time. Focused group discussions (FGDs) was conducted in each district to explore the background of the invention in feedlotting, key informants such as researchers, persons involved in livestock marketing, herd owners, and other people involved in local cattle production so as to get an overview on how and to what extent has these practices been adopted, profitability of the enterprise, problems encountered in feedlotting and strategies formulated to alleviate the situation.

Figure 1: Map of Mwanza region with its three districts involved in the study.

Table 5: Sampling frame

District	Ward	Village	No. of Respondents
Misungwi	Misasi	Misasi	12
	Ukirigulu	Mwalomwabagole	04
Nyamagana	Nyakato	Buswelu	08
	Kisesa	Nyamhongoro	14
Magu	Lamadi	Lamadi	11
	Nyashimo	Masanzakona	06
	Magu	Ndagalu	03

3.3.3 Questionnaire design and pre-testing

The survey used both closed and open-ended questions that were included in structured questionnaire and administered to 58 respondents. The questionnaires were designed to get information from the feedlotters about:

- Background of the invention in feedlotting.
- Source and type of animals used and which type is more preferred.
- Best season for feedlot in terms of best sales.
- Type and sources of feeds.
- The purchasing price of cattle
- The selling price of cattle after feedlotting
- Profit margin obtained.
- Problems encountered in running the feedlots and way forward.

Prior to the actual interview the questionnaires were pre-tested to five feedlotters in Nyamagana district. The question's validity was determined to see how well it measured the concepts it was intended to measure or meet the anticipated objectives. Modified questionnaires were used for the actual survey (Appendix 1). A well designed checklist was used for semi-structured interview. Semi-structured questionnaires were used to collect information from face to face interviews.

3.3.3 Primary data collection

Primary data were collected using structured and semi-structured questionnaires. The primary data collected included both qualitative and quantitative data, and was gathered from feedlotters and key informants (Appendix 3) and focus group discussions (FGDs). In order to gather a wide range of responses, two focus group discussions for each district (4-10 individuals) were used. Conversation taking place during focus group discussions were noted. FGDs were used to identify major reasons for fattening livestock, major problems facing livestock enterprise, types of feeds used, their perception on the trend of livestock trade for the past few years, knowing whether it is increasing or decreasing and possible reasons. The interview guide is attached in Appendix 2.

3.3.4 Secondary data

Secondary information was collected from previous research reports from government at District Livestock offices, research centres like zonal Veterinary Investigation Centre (VIC- Mwanza), local government offices (Wards), livestock markets, Non government organisations (NGOs) such as Heifer Project International (HPI) and Community based organisation (CBOs) such as CARITAS where data on economic activities like buying and selling beef cattle were documented.

3.3.5 Data analysis

Data from questionnaires were coded and recorded in the spreadsheets for statistical analysis. Quantitative data were analyzed whereby frequencies, means and cross-tables were used to determine the conditions of purchase price of cattle and feeds, selling price of cattle after feedlotting. Estimates of total costs of production, revenues accruing from sales of feedlot animals and gross margins from the feedlots were obtained by calculating Gross margin (GM) for animals = Total revenue (TR) – Total Variable Cost (TVC). Later GM per animal was calculated by dividing by number of animals.

Qualitative information collected through questionnaire and key informants approach were analyzed through content analysis. Content Analysis indicated pertinent features such as comprehensiveness of background of the invention in feedlotting, constraints encountered on feedlotting, efforts being made by themselves to promote the business, their suggestions on what they think the government should do to assist improve the feedlot, meat industry in the country and way forward strategies through their own initiatives.

3.4 Study Two: Monitoring Experiment

3.4.1 Experimental design

During second phase monitoring of selected experimental animals from different feedlots to assess their performance was done. Four feedlotters from each district were selected from the previously interviewed feedlotters to participate in the monitoring study. The selection was based on the willingness to participate in the study, use of different types of feeds for fattening such that each feed was represented in the three districts. Feedlotters with newly introduced batch of cattle were picked for in-depth study giving a sample size of 12 feedlots which were arbitrarily allocated to four treatments as follows:

Treatment 1 (T1)	Were those grazing and using cotton seed hulls (60 animals).
Treatment 2 (T2)	Were those grazing and using a mixture of cotton seed cake and cotton seed hulls (60 animals).
Treatment 3 (T3)	Were those grazing and using Waste brewers mash (60 animals).
Treatment 4 (T4)	Were those grazing and using rice polishing (60 animals).

These four treatments each with twenty animals (i.e. each treatment had 20 animals x 3 districts = 60 x 4 treatment =240 animals) were monitored.

3.4.2 Experimental animals and their management

There were usually no regular animal health programmes as a management tool in feedlot activities. Ticks were controlled by hand spray pumps, usually at entry into the feedlot or when the parasites were seen on the animals. There were no dip-tanks in use. A variety of chemicals were used including chlorphenviphos (steladone), amitraz and synthetic pyrethroids, Worm control was done at the beginning, rarely whole herd, mostly on unthrifty animals, using piperazine, levamisole or albendazole. Sometimes trodax (very high doses) was used against liverflukes in unthrifty or animals not gaining well or those from liverfluke endemic areas, especially Ankole cattle from Kagera Region. Injectable antibiotic was mostly oxytetracyline in animals showing high body temperature reactions due to bacterial and tick-borne diseases. Twenty animals were monitored for one treatment for each feedlot and were identified by branding. Feedlots had feed troughs and water containers.

3.4.3 Sampling of feeds used

It was found that most feedlotters from Nyamagana and Misungwi districts were using molasses but it was not used in Magu district, moreover it was also found that some of the Magu feedlot operators were using rice bran/ rice husks mixed with Cotton seed hulls but was not used in other districts, therefore these were not taken into consideration as treatments in the study. Thus the four feeds that were involved in the study and sampled were cotton seed hulls; cotton seed cake (which was mixed with cotton seed hulls), brewers mash and rice polishing, and the samples were taken fortnightly, thoroughly mixed before chemical determination.

3.4.4 Measurement of feed intake and estimation of nutrient intake

Since the feed troughs were not partitioned supplementary diets were weighed and given to all animals in the kraal during the morning then repeated in the evening and the refusals were collected and weighed the next morning before offering another ration. Feed intake per individual animal was estimated from the total DM intake of all animals divided by the number of animals.

3.4.5 Estimation of body weights and calculation of body weight changes

One week before beginning the monitoring, the heart girth measurements were taken for two days consecutively that was used for estimation of initial body weights using a formula. Twenty animals from each of the four feedlots in the three districts which were selected were identified by using permanent marker pens. Body weights were estimated by use of heart girth circumference. Heart girth was measured in centimetres, as described by Phiri (2001) and Francis *et al.* (2002) using a tailor’s measuring tape. Measurements were carried out only after ensuring the animals were thoroughly restrained, standing on all four legs with the head maintained in an upright position. The measuring tape was placed around the brisket just behind the forelegs. To attain precise measurements the tape was pulled just tight enough but ensuring the flesh was not indented. The information obtained on change of weights was divided by number of days to get average daily gain. All animals in the feedlots were monitored to see the feeding regime, types of feed, amount and other management practices. Measurements were regularly done in the early morning between 6.30-7.30 am. At the end of the experiment measurements was again done for two days consecutively and the average measurements were later used for body weight estimation and were regarded as final weights.

3.4.5.1 Body length

Body length was obtained by measuring the distance between the prominence of the shoulders and the proximal edge of the ischium i.e. the length from the shoulder point to the pin bone. The unit of measurement was in centimetre by using measuring tape which was later changed into inches to be used in the formular of weight estimation.

3.4.5.2 Body weight estimation

Since there were no weighing scales, the body weight was estimated using a formula of Susan (1995) and Gibbs and Householder (1997) as described in literatures (Phiri, 2001; Lawrence and Fowler, 1997; Francis *et al*. 2002). Therefore the body weight was estimated in pounds and later the weights were changed into kilograms as:

$$\frac{(HG)^2 \times BL}{300}$$

Where HG is heart girth (in inches), BL is body length and the denominator is the constant number

3.4.6 Sample preparation for chemical analysis

Four feed samples from each of the 12 feedlots were collected for analysis; each sample was taken independently from each district that made triplets. Brewers mash was usually dried in the sun before feeding the animals to prevent the feed to ferment, therefore all 4 samples were dried for 5-7 days in the sun depending on the weather and then all samples were finally weighed and known as fed before being brought to the Department of Animal Science of Sokoine University of Agriculture (SUA), Morogoro for laboratory analysis. Although there is only one brewering plant in Mwanza region where all feedlotters from the three districts under study were collecting the brewers mash, samples were taken independently and analysed to see if there were any variation among the districts and find out what could be the causes as industrial by-products are commonly bulky and exhibit poor handling characteristics.

3.4.7 Daily gain and feed conversion ratio determination

Daily gain was obtained as the difference between the average initial weight and average final weight divided by the number of days the experiment took which were 56 days. Feed conversion ratio was obtained by dividing DM intake to the daily weight gain.

3.5 Laboratory chemical analyses of feeds

3.5.1 Dry matter determination

Four feed samples in triplicate that were brought to the DASP laboratory (CSH, CSC, BM, and RP) were weighed and labeled (W1), then were pre-dried in the oven at 60^0C, later reweighed (W2), the partial percentage of dry matter was then determined as

DM1 = W2/W1 * 100%

The representative feed samples in triplets were ground to pass through 1 mm sieve then those samples of 1g (W3) were dried in the oven at about 105^0C to constant weight for 24 hours, then were reweighed (W4). The percent dry matter (DM2) was determined as

DM2 = W4/W3 * 100%

Then percent dry matter (DM3) of the four feeds as fed was determined as:

DM3 = DM1* DM2

Where;

W1 = Weight of the feed samples as fed

W2 = Weight of the feed samples after drying at about 60^0C

W3 =Weight of pre-dried ground samples

W4 = Weight of the ground sample after drying at about 105^0C

DM1= Dry matter of feed samples after drying at about 60^0C

DM2 = Dry matter of feed samples at 105^0C

DM3 = Dry Matter of feed samples as fed (DM1 x DM2).

3.5.2 Chemical analysis of CP, EE, CF, Ash, NDF and ADF

The feed samples for CP, EE, CF and Ash content were determined according to the standard analytical procedures of Association of Official Analytical Chemists (A.O.A.C, 1990). Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) were determined according to the procedures of Van Soest *et al*. (1991).

3.5.3 Determination of *In Vitro* dry matter Digestibility

To determine ME for the diet the four feeds were subjected to an in vitro digestibility according to Tilley and Terry (1963) to determine dry matter digestibility (DMD%) which was then converted to digestible organic matter in the dry matter (DOMD%) by the following formula (MAFF 1976):

DOMD% = 0.98DMD% - 4.8

ME (MJ/kg DM) = 0.15DOMD%

3.6 Statistical Data Analysis

3.6.1 Socio- economic data

Data from questionnaires were analysed using the Statistical Package of social Science (SPSS, 2002) computer software to generate means frequencies and percentages. Other qualitative data from group discussion were synthesized and summarized.

3.6.2 Feed intake, Feed conversion efficiency and daily weight gain

Data on feed intake, feed conversion efficiency and average daily weight gain from Completely Randomised Design (CRD), with 20 animals for each treatment were subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) of SAS statistical package (SAS, 2001). The initial body weights were used as covariates so as to control its influence on live weight gains or response to treatments. The least square means tests were used to test differences between means for a significant "F" test. The model to fit was:

$$\mathbf{Y_{ijk} = \mu + D_i + T_j + (DT)_{ij} + b\,(X_{ij}k - \Sigma x/n) + e_{ijk}}$$

Where:

$\mathbf{Y_{ijk}}$ = Response of the **k**th animal from the **j**th treatment in **i**th district

$\boldsymbol{\mu}$ = Overall mean common to all animals in the study

$\mathbf{D_i}$ = Effect of the **i**th district

$\mathbf{T_j}$ = Effect of the **j**th treatment (type of feed)

$\mathbf{(DT)_{ij}}$ = Effect associated with the interaction between **i**th district and **j**th treatment

b = Regression coefficient of initial weight of animal on subsequent performance

$\mathbf{X_{ijk}}$ = Initial body weight of an individual animal

$\mathbf{\Sigma x/n}$ = Mean of individual initial body weight in the experiment

$\mathbf{e_{ijk}}$ = Random error specific to each individual.

CHAPTER FOUR

4.0 RESULTS

4.1 General Observation

Out of 72 expected respondents in the three districts only 58 feedlotters filled the questionnaires. These were 16 from Misungwi, 22 from Nyamagana and 20 from Magu making a total of 58 feedlotters. No problems were encountered in taking measurements from the selected feedlots. This chapter presents the results from 58 feedlotters detailed interview responses and performance of 240 feedlot cattle that were monitored. Generally, in most feedlots fattening lasted for 3-4 months with the exception that Ankole breeds that had bigger body frames took longer time up to 5 months. Animals were bought in and sold out in small groups of variable number depending on the financial ability of the feedlotter rather than an "all in" "all out" practice. Using an average of 3 rounds or crops per year the projected annual total number of animals in the feedlot could be estimated by multiplying the group size by 3.

Despite significant success cattle feedlots faced many constraints. Most important were inadequate market information, poor prices and markets. There was also need for designated feedlot areas to be provided with requisite infrastructures like roads, water, dips and electricity. In all feedlots, the feeds were provided in early morning and late evening, and the animals grazed during the day in the nearby rangelands, within 2 to 5 kilometers from the feedlot. The feed was provided in simple wooden containers. The average cost of feeds for feeding animals in the 3 districts varied according to type of feeds, source and quantity purchased with a range from Tsh. 1,470,000/= to 2,205,000/= (Appendix 10) The feed given to animals varied from 7 to 10 kg per animal per day. The size of animals also differed. Although monitoring was carried over 5 weeks the calculation on the economics of the feedlots cattle was done on the basis of the entire stay in the feedlot, as no animal was sold at 5 weeks of stay in the feedlot. Estimation of the feed intake, feed costs and other management costs were multiplied by 90 days which is the average number of days the animals stayed in the feedlot and selling price based on the information obtained from respondents when feeling the questionnaires as it was reported that most of the data observed during monitoring period remained constant up to the selling time.

4.2 Results for Study One

4.2.1 Socio-economic characteristics of feedlot owners

Results for the socio-economic characteristics of feedlot owners are shown in Table 6. It was observed that the majority of feedlot operators were married (98%), while 2% were widowed and were from Misungwi district. The age composition of feedlot operators was mostly found to be between 46 and 60 years old (43%) while those below 30 years old were 14%, between 31 and 45 years were 24% and those aged above 60 years were 19%. Survey results revealed that about 46% of feedlot operators had no formal education and 22% attained primary education. Further more; results show that 19% of the respondents attained secondary education while 13% attained college education where it was observed that they inherited the business from their parents. Magu had higher proportion of respondents that had no formal education (55%) followed by Misungwi (50%) and Nyamagana (33%). Nyamagana had higher proportion of respondents that attended college education 18% while Misungwi and Magu had 12% and 10% respectively. The average household size in Misungwi district was 5.4 persons per household while, in Nyamagana and Magu districts were 6.63 and 6.45 persons per household respectively (Table 6).

4.2.2 Major source of house hold income

Households' sources of income were varied; feedlotters depending on livestock keeping only were (26%), while those depending on both Livestock keeping and crop production were 69% and those involved in feedlotting in addition to formal employment were 05%. Nyamagana had higher proportion of its respondents that depended on livestock only (36%) while Magu had higher proportion of its respondents depending on both livestock and crop production (17%), Nyamagana had 10% of its respondents that depended on formal employment as their main source of employment.

Table 6: Socio-economic characteristics of feedlot owners in Mwanza region (% of respondents)

Variables	Percentage distribution of respondents by district			
	Misungwi (n=16)	Nyamagana (n= 22)	Magu (n=20)	Total (58)
Sex				
Male	100	100	100	100
Female	0	0	0	0
Total	**100**	**100**	**100**	**100**
Marital Status				
Single	0	0	0	0
Married	94	100	100	98
Divorced	0	0	0	0
Cohabiting	0	0	0	0
Widow	06	0	0	02
Total	**100**	**100**	**100**	**100**
Household size	5.4	6.6	6.5	6.2
Age distribution				
15-30 yrs old	12	14	15	14
31-45 yrs old	19	27	25	24
46-60 yrs old	44	41	45	43
60 and above	25	18	15	19
Total	**100**	**100**	**100**	**100**
Level of education				
Informal	50	33	55	46
Primary	19	27	20	22
Secondary	19	22	15	19
College	12	18	10	13
Total	**100**	**100**	**100**	**100**
Major Source of income				
Crop production only	0	0	0	0
Livestock keeping only	31	36	10	26
Both crop and Livestock	69	54	85	69
Formal employment	0	10	05	05
Total	**100**	**100**	**100**	**100**

4.2.3 Distribution of feedlots

Results on the distribution of feedlots are presented in Table 7. Misungwi had 32 feedlots able to contain 5237 cattle with a potential annual production of 16 750 cattle. Nyashimo and Lamadi in Magu district had 67 feedlots containing 3385 cattle and an annual production of 10 155 cattle where as Nyamagana had 28 feedlots with 3850 cattle and an estimated annual production of 10 506 cattle. From the results it shows that although Magu has more number of feedlots the size of each feedlot is smaller than Nyamagana and Misungwi districts.

Table 7: Distribution of feedlots in three districts in Mwanza region

District	Number of feedlots	Number of animals	Annual Production
Misungwi	32	5237	16750
Nyamagana	28	3850	10506
Magu	67	3385	10155

4.2.4 Source and types of animals used in feedlots

Results on sources and types of animals that were used in feedlots are presented in Table 8. Only 11% of the respondents reported purchasing feedlot animals from auction markets, 12% reported purchase from individual farms and 77% of the respondents purchased animals from both auction markets and individual farms. Almost all animals were Tanzanian short horn Zebu (TSHZ) (93%) sourced from within and neighbouring districts. Only few feedlots in Nyamagana had Ankole cattle (20%) sourced from Kagera and Kigoma region.

Table 8: Sources and types of cattle for feedlotting (% of respondents)

Variables	Misungwi (n=16)	Nyamagana (n= 22)	Magu n=20)	Total
Where cattle are bought				
Auction markets	19	9	5	11
Individual’s farms	6	19	10	12
Both	75	72	85	77
Total	**100**	**100**	**100**	**100**
Breeds of cattle for feedlots				
Tanzania Short Horn	100	80	100	93
Ankole	0	20	0	7
Total	**100**	**100**	**100**	**100**

4.2.5 Attitude towards feedlotting

Results on what motivated farmers to start feedlotting, breeds of cattle fattened, the season when feedlotters prefer to purchase cattle, methods used to buy cattle and where cattle are bought are summarized in Table 9. The majority of farmers practiced extensive beef production system before the idea of feedlotting arose, where cattle were herded continuously in rangelands. The majority of feedlotters (53%) reported that they started to supplement their cattle due to the presence of unused cotton seed hulls and rice byproducts in their area. While some feedlotters (38%) reported that the activity of feedlotting was the outcome of both presence of unused feed and lack of arable land. It was also reported that mature males were more preferred for fattening (65%) because they had higher finishing weight than other types of cattle. Majority of feedlotters (64%) from Nyamagana and 50% from Misungwi reported to start feedlotting due to presence of unused feeds in their area. Emaciated or sick animals were also preferred (25%) because they were bought at low price and usually picked up very fast leading to high return gain due to compensatory growth. Cattle for fattening were usually purchased during the dry season to make use of the crop and industrial byproducts. Visual observation was mostly used for buying cattle (83%) and cattle were mostly bought from both auction markets and individuals farms.

Most feedlotters from the three districts sold their animals during the dry season (49%), while 24% of feedlotters sold their animals during the rain season and there were 27% of feedlotters that were selling their animals on all year round basis. Majority of feedlotters from Misungwi (44%) sold their animals in Dar auction market while those from Nyamagana (64%) and Magu (70%) sold their animals to markets outside the country, as shown in Table 9.

Table 9: Attitude towards feedlotting (% of respondents)

Variables	Misungwi (n=16)	Nyamagana (n=22	Magu (n=20	Total
Why fattening started				
Lack of arable land	6	9	10	9
Due to unused feed	50	64	45	53
Both above	44	27	45	38
Total	**100**	**100**	**100**	**100**
Types of cattle				
Mature males	82	59	55	65
Barren females	6	14	10	10
Emaciated or sick	12	27	35	25
Total	**100**	**100**	**100**	**100**
When to buy cattle				
Rain season	6	14	10	10
Dry season	63	54	55	57
All year round	31	32	35	33
Total	**100**	**100**	**100**	**100**
Method used to buy				
Weighing	13	23	15	16
Visual observation	87	77	85	84
Total	**100**	**100**	**100**	**100**
Best season of selling				
Rain season	19	32	20	24
Dry season	56	36	55	49
All year round	25	32	10	27
Total	**100**	**100**	**100**	**100**
Place to sell cattle				
Nearby auction	19	18	15	17
Dar auction	44	9	10	21
Outside the country	12	64	70	49
To individuals	25	9	5	13
Total	**100**	**100**	**100**	**100**

4.2.6 Types, sources of feeds used and watering of animals

Results for types of feed used, buying places, frequency of watering and distance to watering points are summarized in Table 10. Cotton seed hulls were mostly used by feedlotters (27%) than other feeds due to its abundance. No feedlot used cotton seed cake alone. Majority of Magu feedlotters used rice polishing (35%). Generally about 16% of the respondents were using Brewers mash (BM), and only 4% used the mixture of BM and Molasses. It was also reported that 20% of the respondents were using rice polishing (RP) and those who were mixing RP with cotton seed hulls (CSH) were only 7%, while those who were mixing cotton seed cake (CSC) and CSH were about 17%.Those who mixed CSH and molasses were only 9%. About 57% of respondents reported that they were purchasing feeds from the ginneries, while those who were buying from feed shops and from individual operators of milling machines were 22% and 21% respectively.

With regard to frequency of watering, 61% of feedlotters reported that water was freely available to cattle, while 31% reported to get water within 1-5 km. The distance to the furthest watering point during feedlotting was reported not to exceed 10 km (8%). All farmers in Magu used the nearby Lake Victoria, while Misungwi feedlotters used rivers and dams, all at almost no cost. However, most of those in Nyamagana used the city tap water supply at costs of Tshs. 20 000 to 40 000 per month.

Table 10: Types, sources of feeds and watering of animals (% of respondents)

Variables	Misungwi (n=16)	Nyamagana (n=22)	Magu (n=20	Total (n=58)
Types of feeds used				
Cotton seed hulls (CSH) alone	25	23	35	27
Cotton seed cake (CSC) alone	0	0	0	0
Brewers mash(BM) alone	13	23	10	16
Mixtures of BM+Molasses	0	9	5	04
Rice polishing (RP) alone	25	14	20	20
Rice polishing+CSH	6	0	15	07
Mixture of CSH + CSC	19	17	15	17
Mixture of CSH + Molasses	12	14	0	9
Total	**100**	**100**	**100**	**100**
Where feeds are bought				
Market	19	27	20	22
Ginnery	62	55	55	57
Individuals (milling machine)	19	18	25	21
Total	**100**	**100**	**100**	**100**
Frequency of watering				
Freely available	38	50	65	51
Once a day	24	14	10	16
Twice a day	38	36	25	33
Total	**100**	**100**	**100**	**100**
Distance to watering point				
< 1 km	63	59	60	61
1-5 km	31	32	30	31
6-10 km	6	9	10	08
Total	**100**	**100**	**100**	**100**

4.2.7 Housing and transportation of animals to markets

Feedlot animals were kept in simple open kraals. Partitions were done to separate young cattle that had been bred within the farm and sick animals. Only one farmer in Mwanza kept his animals in unused rented godown during the night. Results for costs of transporting animals are shown in Appendix 5. Few farmers sold their animals to cattle traders at the feedlot. Rail transport to Pugu Market in Dar es Salaam cost Tsh. 20 000 to 25 000 per animal. However, rail transport was not preferred due to unavailability of wagons, delays on transit and high deaths of animals, sometimes up to 8%. Road transport by trucks costs between Tshs 30 000 to 35 000 per animal and it was preferred due to readily availability of trucks, fast and minimal deaths of animals.

4.2.8 Profitability of feedlot enterprises

The results in Table 11 have been expressed on per animal basis. The Gross Margin figure is output per head less variable costs. Respondents reported that on average the animals gains 90-100 kg for 3-4 months, meaning a daily average gain of 1kg. Nyamagana feedlotters reported the highest gross margin per animal of 210 000/= followed by Magu feedlotters that reported gross margin per animal of 190 000/= and the last were Misungwi feedlotters that reported gross margin per animal of 170 000. However further investigation was done to ascertain all costs incurred, it was revealed that operations that are carried out by owners manually like trekking of animals, feeding and watering were not considered as production costs, moreover it was reported by some feedlotters that animals gaining slowly stayed up to 6 months with an estimated gain of 90 kg thus the reported gross margin per animal remains questionable.

Table 11: Reported feedlot enterprise performance

District	Misungwi	Nyamagana	Magu
Av.Bwt. (Entry) in kg	170	235	210
Av.C. Price (Entry)	170 000	240 000	210 000
Av.Bwt (Exit)in kg	260	335	305
Duration of stay(days)	90 - 150	90- 120	100- 120
Total Variable Costs	270 000	330 000	300 000
Av. S. Price (Exit)	440 000	540 000	490 000
Gross Margin/animal	170 000	210 000	190 000

Key: Av.Bwt. (Entry) = Average body weight at entry; Av.C. Price =Average cost Price; Av. S. Price (Exit) = Average selling price at exit

4.2.9 Problems encountered in feedlot operations

Results on problems encountered in feedlot operations in the selected monitoring area are presented in Table 12. Major constraints cited by cattle feedlot operators were poor prices and markets for their fattened cattle, 12%, 9%, and 10% for Misungwi, Nyamagana and Magu districts respectively while some feedlotters reported that unreliable market was the major problem in the proportion of 6%, 14% and 5% for Misungwi, Nyamagana and Magu districts respectively. Absence of cooperative society to join the feedlot operators was also highly reported by Misungwi feedlotters (44%) followed by Nyamagana feedlotters (27%) and lastly Magu (20%). In the case of absence of modern abattoir as a limiting factor in feedlot operations, it was slightly noticed by Nyamagana respondents (5%) and followed by Magu feedlotters (10%). Generally the above four mentioned problems were cited by the majority of feedlot operators as major factors (46%) limiting their prosperity in feedlot operations. On animal health services absence of dip tanks was reported in the proportion of 6%, 9% and 5% by respondents from Misungwi, Nyamagana and Magu districts respectively, while diseases burden was reported by Misungwi, Nyamagana and Magu respondents in the proportion of 12%, 14% and 10%. High prices of drugs were also reported by Misungwi (6%), Nyamagana (14%) and Magu (10%). Generally the above mentioned problems were reported in the proportion of 64% for Misungwi, 45% for Nyamagana and 60% for Magu.

To address the problems of marketing, the feedlotters in the proportion of 13% from Misungwi, 14% from Nyamagana and 5% from Magu reported that there was a need for formation of their own co-operative societies that would help them to secure loans and have strong stand on market issues. Secondly, respondents in the proportion of 6% for Misungwi and 5% for Nyamagana suggested assistance from the Government in construction of modern slaughter houses.

Thirdly, respondents suggested that the government should also assist in linking up local feedlot operators with international buyers on market information by 13% for Misungwi and 4% for Nyamagana although it was not cited by Magu respondents. Majority of respondents reported that most of the problems could be solved by getting knowledge on modern or improved technologies in feedlot operations in the proportion of 25% in Misungwi, 23% in Nyamagana and 30% in Magu. The above suggested solutions with the exception of third solution were mostly pointed out by respondents in all three districts where higher proportion was observed in Magu (50%), followed by Nyamagana (40%) and lastly Misungwi (31%).

Table 12: Major constraints of feedlotters and their way forward (% of respondents)

Variables	Misungwi (n=16)	Nyamagana (n=22)	Magu (n=20)	Total
Market problems				
Poor prices of cattle	12	9	10	10
Unreliable market	6	14	5	8
No cooperative society	44	27	20	30
No modern abattoir	0	5	10	6
All above	38	45	55	46
Total	**100**	**100**	**100**	**100**
Animal Problems				
No dip tanks	6	9	5	7
High prices of drugs	6	14	10	10
Diseases burden	12	14	10	12
Parasites burden	12	18	15	15
All above	64	45	60	56
Total	**100**	**100**	**100**	**100**
Way forward				
Form cooperatives	13	14	5	11
Construct modern abattoirs	6	5	0	4
Linkage with foreign buyers	13	4	0	5
Acquire knowledge	25	23	30	26
Construct dip tanks	6	5	10	7
Routine disease control(Vaccinations)	6	9	5	7
All above	31	40	50	40
Total	**100**	**100**	**100**	**100**

4.3 Results from Study two (Monitoring)

This chapter presents monitoring results of the feedlot cattle on animal health and veterinary services, type of feeds and prices, cattle purchase prices, economics of the feedlots, chemical composition of feeds, *in vitro* digestibility of feeds, feed intake, its responses and finally average daily weight gain, feed conversion ratio expressed as kg of feeds per kg of gain from Tables 13, 14 and 15.

Plate 1: **Ankole cattle at the early days of feedlotting.**

Plate 2: Ankole cattle at last days of feedlotting.

Plate 3: Water trough at the feedlot.

Plate 4: Ankole cattle feeding Cotton seed hulls

4.3.1 The purchase price of cattle

The average purchase prices of cattle are shown in Table 13 and Appendix 5. The cattle prices were variable and as stated earlier animals were bought at an auction market or from individuals or both auction market and from individuals, the average purchase prices per animal for Misungwi were Tshs 332 500/= and Tshs 442 500/= for Nyamagana, while Magu reported that the average purchase prices of cattle were Tshs 532 500/=.

4.3.2 Type of feeds and prices

Types of feeds used in feedlots and their preferences are shown in Table 10, while feed intake per animal is shown in Appendix 9. Most feedlotters were using cotton seed hulls

(CSH) alone (Ration 1). Overall average price was Tshs. 10 000/= per 100 kg that is 100 000/= per ton. Reported bulk purchase prices were lower, Tshs. 90 000 to 95 000 per ton. Nutritive value or fattening efficiency for CSH was raised by addition of cotton seed cake (CSC) (Ration 2), in ratios of 7- 8 kg CSH and 2 kg CSC, The overall price of CSC was Tshs. 350 000/= per ton. Reported bulk purchase prices were almost in the same range, Tsh.300 000/= to 340 000/= per ton. Brewers mash (Ration 3) was used by some feedlotters and was bought from TBL plant in Mwanza city. The overall price in Tshs ranged from 50 000- 75 000/= per ton including transport.

Rice polishing and bran (RP) was cheaper at Tshs. 75 000 per ton; hence it was used to replace some of the more expensive CSC (Ration 4); the net result was production of the cheapest feed ration, at Tshs. 7500/= per 100 kg mixture.

4.3.3 Economics of feedlots

Estimates of total costs of production, revenues accruing from sales of feedlot animals and gross margins from 12 feedlots of each district are shown in Table 13 and Table 14 shows the Gross margin per dietary treatment while Appendix 11 shows the costs of gain in relation to the profit margin obtained per dietary treatment. Average gross margin per animal (which was obtained by taking total sales divided by total number of animals) was Tshs. 63 275/= with a range from 52375/= to 70025/=, where Nyamagana feedlotters had the highest return per animal (70025/=), Misungwi feedlotters had Tshs 67425/= while Magu feedlotters had the lowest return (52375/=). The Total Gross Margin per feedlot per 90 days ranged from 1 047 000/= to 1 400 500/=. These values were later multiplied by 3 to get a projected annual Gross margin.

Analysis of the effect or impact of the type of ration (Rations T1, T2, T3, and T4) was assessed as shown in Table 14 and Appendix 10. Animals that were given mixture of cotton seed hulls and cotton seed cake gave highest return rate 1 570 000/= for 20 animals or 78 500/= per animal followed by T1 (CSH) that was 1 416 600/= or 70 833/= per animal, then T3 (BM) had 1 088 660/= or 54 400/= and lastly T4 (RP) which had 1 056 600/= or 52 830/= per animal. However cost of concentrate consumed per animal was also higher in the mixture of cotton seed hulls and cotton seed cake than other diets. This was attributed by inclusion of cotton seed cake 2 kg per day (1.86 kg DM). Amount of concentrate consumed per animal was higher in Brewers mash diet (1080 kg/animal) for 3 months.

The cost of feed per kg of gain showed that BM had the lowest cost among the four rations which was 865/=, followed by CSH (1310/=), RP (1402.5/=) and the highest was the mixture of cotton seed hulls and cotton seed cake (2542.5/=). On average highest total costs per dietary treatment were observed in T2 (4 533 300/=) followed by T1 (4 220 000).

Table 13: Costs and Gross Margin of feedlots per district in (1000)

Item	Misungwi	Nyamagana	Magu
Total cattle purchase price	6650	8500	10500
Feed Costs	1470	2205	1635
Animal health costs	99.5	112	112.5
Salaries	720	795	765
Security costs	720	795	765
Costs of trekking	60	240	170
Transport costs	630	535	480
Other costs	105	82.5	100
Total production costs	11401.5	13099.5	14577.5
Total sale price	12750	14500	15625
Gross Margins	1348.5	1400.5	1047.5
Gross Margin per animal/90 days	67.425	70.025	52.375
Gross Margin per feedlot/year	4045.5	4201.5	3142.5

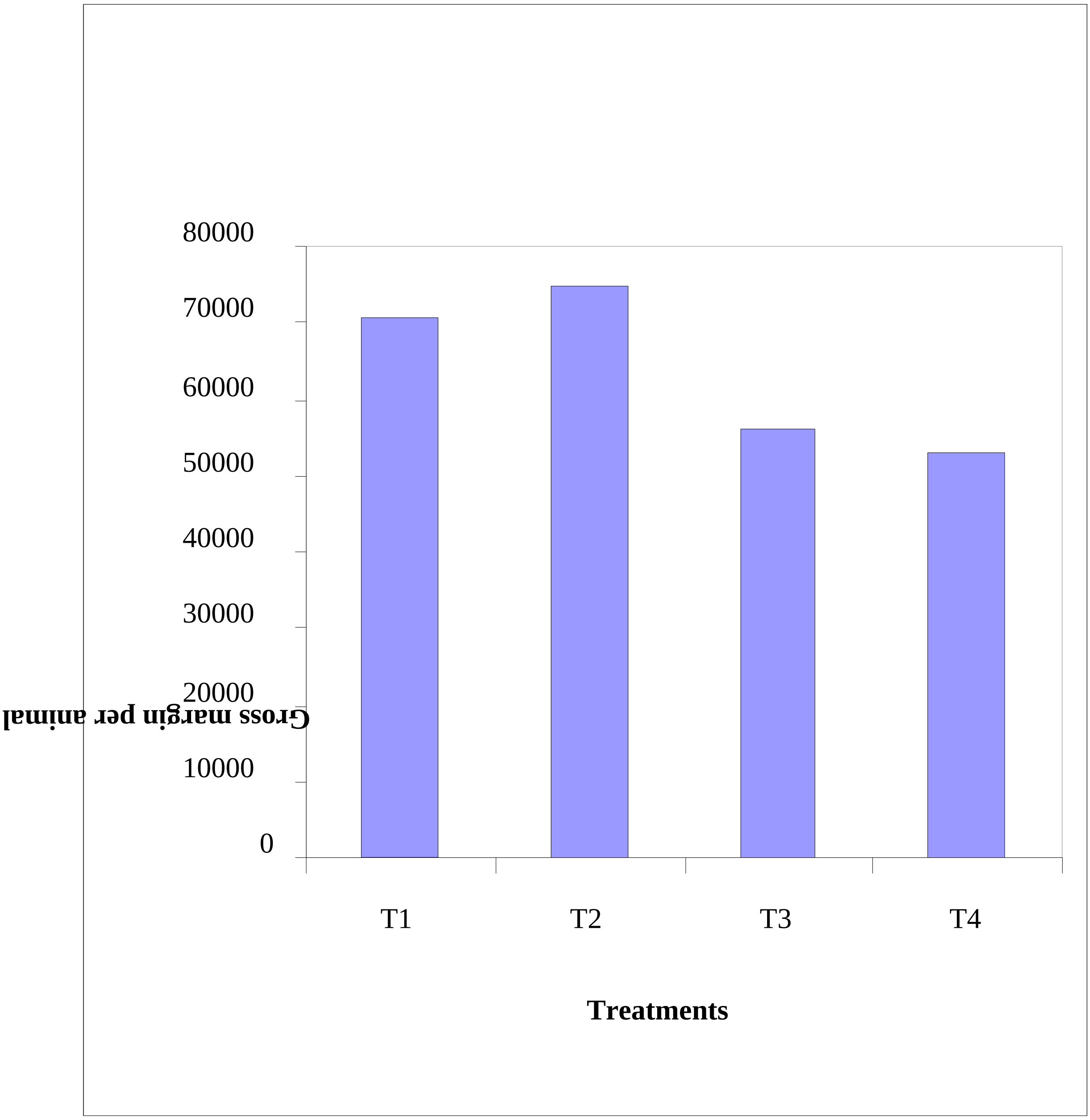

Figure 2: Gross margins of four treatment diets in 90 days

Table 14: Gross Margins per dietary treatment (in 1000's)

	Treatments	Total Cost	Total Revenue	Total Gross Margin	GM/animal
Misungwi	T1	3450	5000	1460	73
Misungwi	T2	4210	6100	1890	94
Misungwi	T3	3988	5000	1012	50
Misungwi	T4	3768	4800	1032	51.6
Nyamagana	T1	5210	7000	1790	89
Nyamagana	T2	5440	7000	1560	78
Nyamagana	T3	3926	5000	1074	53.7
Nyamagana	T4	3822	5000	1178	58
Magu	T1	4000	5000	1000	50
Magu	T2	3950	5000	1050	52
Magu	T3	4020	5200	1180	59
Magu	T4	4140	5100	960	48
Average	T1	4220	5666.6	1416.6	70.83
Average	T2	4533.3	6033.3	1570	78.5
Average	T3	3978	5066.6	1088.6	54.40
Average	T4	3910	4966.6	1056.6	52.83

4.3.4 Feed intake and Average daily gain

Total daily dry matter intake (% BW or kg/kg $W^{0.75}$) of feedlot cattle was significantly different (P<0.01) between the four treatments. Least square means for feed DM intake, proportion of intake relative to body weight and proportion of intake relative to metabolic body weight are shown in Table 15. Mean intake, which was obtained by taking total amount fed, divided by number of animals are shown in Appendix 9. Animals that consumed (CSH) had lower dry matter intake than those that consumed mixture of cotton seed hulls and cotton seed cake (CSC).

Intake levels on DM basis ranged from 4.68 - 8.84 kgd^{-1}.The lowest DM intake was observed in animals that consumed Brewers mash (4.68 $\pm$ 0.01). Whilst total energy intake (obtained by multiplying energy concentration and DM intake per day) ranged from 44.7 to 94.8 ME MJd^{-1} respectively, where animals under T2 had the highest energy intake (94.7 $MEMJd^{-1}$) and the lowest were those under T4 (44.7 ME MJd^{-1}). There was a significant ($P<0.01$) difference in total dry matter intake based on metabolic weight ($kg/W^{0.75}$). Animals that were supplemented with cotton seed hulls had the lowest DM intake per metabolic body weight per day (104g/kg).

Dry matter intake expressed as percentage of body weight (BW) was significantly higher for T3 ($P<0.01$) than other diets, whilst T1 had the lowest (2.54). During the entire feeding period ADG was different between the four treatments, ranging from 0.44- 0.78 kg/d where animals consuming mixture of cotton seed hulls and cotton seed cake had greater daily gain (0.78 kg/d) than animals consuming other diets. (CSH 0.60, BM 0.53 and RP 0.44).

Feed conversion ratio expressed as kg feed/kg gain was found to be better for animals that consumed the mixture of CSC and CSH (11.3) followed by animals that consumed CSH (13.1), where BM had (17.4) and the least were RP (18.8).

Table 15: Least square means and SEM on Feed intake Average daily gain and feed conversion efficiency as affected by type of feed

Parameter	Treatments				SEM	SL
	T1(CSH)	T2(CSH+CSC)	T3(BM)	T4(RP)		
No. of animals	60	60	60	60	-	-
Days of monitoring	56	56	56	56	-	-
Feed intake(Kg/d)DM	7.92^{d}	8.84^{b}	4.60^{a}	8.33^{c}	0.01	**
Energy intakeMEMJd^{-1}	58.1^{c}	94.8^{b}	46.8^{a}	44.7^{d}	0.6	*
As % BW	2.54^{c}	2.69^{b}	2.96^{a}	2.73^{c}	0.01	*
g/kg$W^{0.75}$	104^{c}	112^{b}	122^{a}	111^{b}	0.44	*
Initial live weight (kg)	222^{c}	297^{a}	287^{a}	267^{b}	0.06	*
Final live weight (kg)	257^{b}	341^{a}	317^{c}	292^{d}	0.33	*
Weight change	34.1^{b}	44.0^{a}	30.2^{c}	24.8^{d}	0.33	*
Average Daily Gain	0.60^{b}	0.78^{a}	0.53^{c}	0.44^{d}	0.01	**
Feed conversion ratio(Kg/kg gain)	13.1^{c}	11.3^{d}	17.4^{b}	18.8^{a}	0.12	**
Cost of feed/kg (Tsh)	100	225	50	75	-	-
Cost of feed/kg gain	1310	2542	865	1402	-	-

*Means within a row with different letters are significantly different (P<0.05).
** Means within a row with different letters are significantly different (P<0.01).
NS = Not significant; SL = significant level; SEM = Standard error of means
CSH= Cotton seed hulls, CSC=Cotton seed cake, BM=Brewers mash,
RP= Rice Polishing.

4.3.5 Animal health and veterinary services

The animal health costs were between 99 500 and 112 500/= for 20 animals during the monitoring period at the feedlot, as shown in Table 13 and Appendix 5. The differences on animal health costs was contributed by the physical condition of the animals on arrival, those animals that were emaciated had to be treated regularly against tick-borne diseases hence increasing costs. Growth promoters, minerals or vitamins for improvement of body weight gain were not used.

4.3.6 Chemical composition and in vitro digestibility of feedstuffs

The chemical composition of the supplementary rations is presented in Table 16. Dry matter contents were high for three feeds while Brewers mash had the lowest DM (233g/kg DM). However, Cotton seed cake (CSC) had the highest (926g/kg DM) followed by rice polishing and cotton seed hulls. Crude protein ranged from 60.6 to 243 g/kg DM for ration Cotton seed hulls (CSH) and Cotton seed cake. Cotton seed cake had the highest CP (243 g/kg DM) followed by Brewers mash (235 g/kg DM), Rice polishing (68.9 g/kg DM) and the lowest was cotton seed hulls with 60.6 g/kg DM. CF proportions were comparatively similar for three feedstuffs and high for Cotton seed hulls (472g/kg DM). EE values were relatively low in Cotton seed hulls (26.8g/kg DM) but CSC had the highest (130g/kg DM). NDF contents were comparatively high in CSH (809g/kg DM) and lowest in CSC while Brewers mash (BM) and rice polishing had almost similar values (578 and 589g/kg DM). ADF contents followed a similar trend like NDF values where CSH had the highest (590g/kg DM) followed by rice polishing (430g/kg DM) while CSC and BM had similar values (271 and 261g/kg DM). Ash contents were highest in rice polishing (194g/kg DM) while the remaining three rations had almost similar values. Energy concentration (MEMJ/Kg DM) as calculated from *in vitro* dry matter digestibility was higher in CSC (10.7), followed by BM (10.2), CSH (7.34) and the lowest RP (5.37).

Table 16: Chemical composition and in vitro digestibility of supplementary rations (as g/kg DM)

Component	Supplement diets		(Treatments)	
	Cotton seed hulls	Cotton seed cake	Brewers mash	Rice Polishing
Composition				
DM(g/kgfeed)	876	926	233	921
		g/kg DM		
CP	60.6	243	235	68.9
CF	472.3	226	178	249
EE	26.8	130	57.5	75.8
NDF	809	488	578	589
ADF	590	271	261	430
ASH	525	52.4	75.4	194
Digestibility				
IVDMD	464	614	659	317
IVOMD	489	714	679	358
MEMJ/KgDM	7.34	10.7	10.2	5.37

DM=Dry matter; CP= Crude protein; CF= Crude fibre; EE= Ether extract; NFE= Nitrogen free extract; NDF= Neutral Detergent fibre; ADF= Acid Detergent fibre; ME= Metabolizable Energy; IVDMD = In vitro dry matter digestibility; IVOMD = In vitro organic matter digestibility.

CHAPTER FIVE

5.0 DISCUSSION

5.1 Overview

This chapter presents a discussion of the observation made in the study. The findings of the baseline survey are discussed in section 5.2, 5.3 and 5.4.The section cover feedlotter characteristics and the types of animals used in the feedlot, types of feeds, costs of feeds, animals and other management costs. Sections 5.5 to 5.7 discuss the effect of feeds on performance of the feedlot under monitoring.

5.2 Baseline survey

5.2.1 Socio-economic characteristics of feedlot owners

In this study marriage was taken to include both formal and informal unions, and was categorized as single, married, widow, cohabiting or divorced. The marital status of the head of household could also influence the resource owned by a household and the capacity to work on farm. Generally, single people tend to have less own labour as compared to couples, other factors remaining constant e.g. number of dependants. This situation can be explained by the fact that feeding of feedlot cattle is a labour demanding activity, therefore feedlotters found it convenient to involve the whole family in management activities in order to get enough labour force. Alternatively, since married men or women have family obligations, they engage in farming to generate income and food to meet various family cash and food requirement. Another fact is that in the three study areas people regard herding of cattle and other feedlot operations as mans work. Therefore chances of finding a man engaging in feedlot activities were higher.

The age of head of household is related to the knowledge and experience of a person. A study in the central zone of Tanzania showed that older members of household had more local knowledge related to agricultural practices (FAO, 2004). In view of this study the age composition of higher percentage obtained for age group 40-60 years shows that this is the active group which is more involved in feedlotting and that this age group have more resources and knowledge that can be invested in feedlot.

These results indicate that most of the feedlotters are not educated, thus cannot adopt and implement new innovations easily. For example level of education has effect on the capacity of utilizing various technologies for crop production and inputs to ensure stable food security at household level (TFNC, 1988).

5.2.2 Household size

Results show that the three districts had greater household size than the overall average in the region, which are 6.2 persons per household which is higher than the population census of 2002 (URT, 2003) where the overall average household size of the region was 4.9 and was equal to the national average household size of 4.9. These results indicate that there were 1.26 increases in household size between 2002 and 2008.

5.2.3 Major source of house hold income

Feedlotters source of income were varied, they included livestock only and both crop production and livestock keeping sources. Both crop production and livestock keeping were major source of income in the study area as indicated by 69% of respondents, meaning feedlotters did not depend entirely on one source of income to sustain their life.

This is one way through which crop production and livestock keeping contribute to the livelihood of feedlotters in the study area in terms of income generation. Another way was through formal employment.

All feedlots visited in this study were headed by males. The dominance of males in feedlot enterprises and ownership of livestock concurs with the observation made by Maeda-Machang'u *et al.* (2000) in the study of gender analysis of agro-pastoral communities in Tanzania. This implies that the patriarchal system of male dominance on decision making favours males over women. In some feedlots where feedlot owners passed away the enterprise had been inherited by sons and not by the widows.

Cattle fattening activity in Mwanza region is usually done even at household level. Here animals that are found to be progressively emaciating, are supplemented with agro-industrial byproducts like cotton seedcake, cottonseed hulls, rice byproducts, molasses, brewers mash and home made left overs with the intensions not only to sell later but also for breeding purposes. From the results in Table 6 it indicates that feedlotting is mostly practiced by the economically active age of between 15 – 60 years of age. Therefore there is a possibility of introducing new innovations that will ultimately increase beef production in the region and later in Tanzania at large.

5.2.4 Source and type of animals used by feedlot practitioners

Most feedlotters in the study area relied upon Tanzania Short Horn Zebu (TSHZ) with various strains which were difficult to ascertain. There was no preference for breed for beef production. TSHZ were easily available and therefore used. Ankole cattle tended to be kept by smallholder farmers in Kagera region and northern part of Kigoma region (Kibondo district). Ankole cattle used in feedlots in Mwanza were bought from auctions in

Kibondo, Karagwe and (Nyakanazi) Chato districts. Nyamagana feedlotters with enough capital go to purchase those animals with the intention of fattening and later to sell them outside of the country markets where they are more preferred.

5.2.5 Chemical composition of experimental feeds

Cotton seed hulls (CSH) used in this study with a CP content of 60.6 g/kgDM is closer to the values reported by Ramachandran and Singhal (2008) who observed a CP content of 79.1 g/kg DM. Minimum and maximum values of CSH protein reported were 44 g/kg DM by Mertens, (1994) and 162 g/kg DM, by Chamatata (1995). The difference in nutritive value was however within the range (40- 162 g/kg DM) and that difference was probably due to different climatic and soil condition under which the plant is grown, year in which it was grown and ginning process where presence of kernel would increase CP content. The NDF content (809 g/kg DM) is about twice to those reported by Torrent *et al*. (1994) and Moore *et al.* (1990) that were 319 g/kg DM and 387 g/kg DM respectively. Higher NDF could be caused by high content of lint in the seed hulls an indication of poor delinting although the proportion of lint in the CSH was not evaluated in the current study.

CF content of CSH in this study (473 g/kg DM) was closer to that reported by Hall *et al.* (2000) and Church and Pond (1982) that were 470 and 480 g/kg DM however it was higher than the values reported by other researchers. The difference was probably due to the specie type of the plant, soil type and over maturing as discussed by McDonald *et al*. (1995) and Pham *et al.* (2008). Ash content in the feedstuff was 52.5 g/kg DM which was lower than the values reported by Rao *et al.* (1984) 94 g/kg DM but was higher than those reported by (Garleb, 1988; Chamatata, 1995). The ash content in CSH is mainly due to the deposition of minerals.

Cotton seed cake (CSC) that was used in this study had an average CP content of 242 g/kg DM which was relatively higher than the other three feedstuffs used. This was in agreement with values reported by Coppock and Wilkis, (1991); Calhoun, *et al.* (1995a); Forster *et al.* (1995) and Pham *et al.* (2008) but lower than that reported by NRC (1996). The difference might have been attributed by the way it was processed, storage or presence of impurities before processing moreover decorticated seed cake has higher CP than undecorticated. Cotton seed cake when mixed with cotton seed hulls has lower CP than when it is not mixed (NRC, 1996). Values of CP in CSC have been found to vary a great deal, for instance from 262 g/kg DM by Davis (1982), 268 g/kg DM by Machibula (2000) to between 408 and 457 g/kg DM for undicorticated and decorticated by McDonald *et al*. (1995).

In this study CSC had almost equal values (409 g/kg DM) of cell wall content (NDF) like those of 400 g/kg DM reported by Coppock and Wilkis, (1991) and 414 g/kg DM reported by Calhoun *et al.* (1995). The nutrient composition of cottonseed cake can vary depending on the region, soil type, condition and year in which it was grown (Tagari *et al.*, 1986). Other possible reasons for the variation in fibre content of CSC are the variety of the seed, agronomic practices applied and techniques involved in seed preparation before oil extraction (Rankin, 2004). NDF digestibility depends on lignin and silica content, rate of passage and rate of digestion, physical and chemical properties of the cell wall carbohydrates. In many crop residues, especially from cereals, NDF is the most important substrate for rumen fermentation. However NDF has a strong negative correlation with intake, the correlation can be improved by correcting for differences between individual intakes relative to common forage (Van Soest 1982; Lamba *et al.*, 2002).

Crude protein content of 234 g/kg DM in Brewers mash (BM) obtained in the present study is far below that of other workers. Minimum and maximum values of BM protein were 235 g/kg DM Mussato *et al*. (2006) and 525 g/kg DM (Sekin and Akbulut, 1987) respectively. It has been further seen that the CP value of BM can vary from one source to another due to several factors that are involved in the production process such as method of collecting, drying BM and source of yeast culture (Preston, 2002; Oster *et al*., 2007). Crude fibre of 173 g/kg DM in the present study is higher than the values reported by other workers. Preston (2002) and Mirzaei and Maheri (2008) reported the CF values of 140 and 159 g/kg DM respectively, while Mussato *et al*. (2006) reported the value of 167 g/kg DM which is almost similar to the values obtained in the current study. High content of CF obtained in this study may be attributed to high content of contaminants and other solids contained in wort raw materials such as brewers grain and hops which indicates low efficiency of wort filtration. The ash content of 76.8 g/kg DM is within the range reported by other workers, where minimum and maximum reported values of ash in BM were 40 g/kg DM Mussato *et al*. (2006) and 102 g/kg DM McDonald *et al*. (1995).

The CP content of Rice Polishing (RP) obtained in this study of 69.1 g/kg DM was lower than the values reported by several workers. Choo and Sadik (1982) reported the minimum fraction of 98 g/kg DM while Rao and Reddy (1984) reported the maximum of 174 g/kg DM. Present study showed high levels of CF i.e. 249 g/kg DM indicating mixing of rice polishing with rice husks, which means there were no proper separation of bran from husks. The type of milling machines also affects the inclusion level of the husks in the bran or polishing. The study also showed low level of EE in rice polishing of 74.8 g/kg DM as compared to several workers. The minimum and maximum values that have been reported were 110 g/kg DM by Choo and Sadiki (1982) and 149 g/kg DM by Nadeem (1998) however; proportion of Ash was 183 g/kg DM which was not in accordance to NRC (2000) which was 73 g/kg DM. The present results showed wide variation of chemical composition of rice polishing. It might be due to the differences of varieties of rice polishing used for feed or processing condition and the type of the milling machine used (Rao and Reddy, 1984). It is reported that polishing time and pressure affect the quality characteristics of rice grain. Moreover, major factors associated with rice polishing are varietals and environmental variability in average chemical composition, distribution of chemical constituents, thickness of anatomical outer layers, size and shape of grains, resistance of grains to breakage and abrasion (Ambreen *et al*., 2006).

5.3 Performance of feedlot cattle under monitoring experiment

5.3.1 Feed Intake

The results from the feed intake study showed that total dry matter intake was significantly (P<0.01) different between treatments. The DMI of feedlot cattle ranges from 98.9 to 148.5 g/kg $W^{0.75}$ (Taparia and Sharma, 1980; Lamba *et al.*, 2002). Therefore, in this study the feedlot cattle DM intakes of 104.17-122.05 g/kg$W^{0.75}$ were within the range which clearly indicates that all supplements were palatable and non-repugnant. Once the animal gets used to the new feed, intake increases.

In this study the mixture of cottonseed cake and cottonseed hulls seemed to have slightly improved the digestibility of the diet. Rice polishing has been reported to improve dry-matter intake, stimulate volatile fatty acid concentration, microbial numbers and efficiency of rumen synthesis (Preston *et al*., 1987; Elliot *et al.*, 1978; Cardenas *et al.*, 1992). The CP content of 69.1 g/kg DM of the rice polishing in treatment 4 obtained in this study could only satisfy the minimum 70 g/kg DM of CP required in feeds to support acceptable rumen microbial activity and the maintenance requirement of CP for the host ruminant (Van Soest 1982; McDonald *et al*., 1995). The low digestibility of fiber fractions (NDF and ADF) in the present study might have adversely affected the digestibility of rice polishing which led to low energy production. The intake (g/kgW $^{0.75}$) was also different in all 4 diets. However, the animals were able to maintain their body condition and substantial gain during the experiment, which gives an indication that indigenous feedlot cattle may require moderately lower levels of dietary protein than the recommended values in intensive feedlotting. On the other hand animals could have obtained extra protein from the feeds they obtained during grazing. The energy intakes varied from 44.7 to 94.7 MEMJ per day for all feedlot cattle under this study. Topps and Oliver (1993) reported the minimum total dietary energy requirement per day for steers under intensive system to be 104.9 MEMJ and total dietary energy requirement per day for steers under extensive system to be 113.8 MEMJ. Thus all animals did not meet even the minimum requirements from the supplement; therefore the lower weight gain per day observed could be attributed to the nutrients obtained from grazing, although it is difficult to quantify the amount of nutrients from grazing that contributed to gain, it explains the observed body weight gain.

Animals offered brewers mash consumed apparently less energy than other animals due to low DM intake caused by high moisture content of the feed. This resulted in lower weight gain compared to those offered mixture of CSH and CSC. Usually when the energy intake is increased in the body of the animal, they tend to retain either partly as protein if nitrogen intake is adequate, or entirely as fat, and the animals live weight increases. According to

McDonald *et al.* (1995), energy intake is the pace maker of production since animals tend to show a continuous response to changes in the quantities supplied. It should be borne in mind that as intake increases, rate of passage increases and digestibility decreases thus feed moves through the gastrointestinal tract faster hence digestibility is reduced because the feed will be exposed to digestive processes for a shorter time. Umunna *et al.* (1980) reported that feeding 7.59 kg of Brewers mash to confined cattle obtained an average daily gain of 0.86 kg which was higher than 0.53±0.01 obtained in this study. That could be contributed by the feeding system where part of the energy was used in grazing activity. The variations in performance response to supplementation are mainly due to the nature of the feeds used in supplementation, levels of supplementation, animal species differences and the quality of the basal rations involved.

Low feed conversion ratio (FCR) observed in the feeds might have been due to the unimproved or poor balance of amino acids in the rations as suggested by Preston and Leng (1987). The mixture of two feeds (CSH and CSC) protein sources, probably provided a better profile of amino acids and had a positive associative effect, thereby slightly improving the feed utilization or it could be due to by- pass protein from the diet.

5.3.2 In vitro dry matter and organic matter digestibility

In general, the IVDMD and IVOMD values obtained in this study for cotton seedcake were 614 g/kg DM and 714 g/kg DM which were within the range reported by other workers. For instance Ayo (2002) reported values for cotton seed cake IVDMD and IVOMD to be 654 g/kg DM and 753 g/kg DM. Hango, (2005) reported values for cotton seed cake IVDMD and IVOMD to be 482 and 500 g/kg DM which were lower than the obtained results in this study (614 and 714 g/kg DM). This difference could be due to the method of feed processing and the different chemical compositions of the feeds. It should also be noted that the IVDMD value of cottonseed cake in this study was much lower than the one reported in NRC (2000) Tables. Possible reasons for the variation in digestibility could be the fibre content of CSC being caused by the nature of the seed, which is related to the variety of the seed, agronomic factors and most importantly, the processing involved in preparing the seed before oil extraction. The fibre of CSC is influenced by the degree of removal of the adhering lint and seed coat. Removal of seed husk lowers the CF content and this has an important effect in improving the apparent digestibility of other constituents.

Moreover, the Brewers mash IVDMD and IVOMD values obtained in this study were 659 and 679 g/kg DM respectively which are lower than the values reported by Klopfenstein and Rounds (2005) which were 889 and 905 g/kg DM for IVDMD and IVOMD. The possible cause of the differences may be due to incorrect separation of brewers byproducts like brewers grains (wet or dried), brewers dried yeast, the brewering plant also can vary depending upon the type of substrate being used (barley, wheat, corn, etc.), proportions being fermented and fermentative process being used. It has been found that brewer's mash, due to its being a water cooked product, is deficient in certain minerals to provide the necessary nutrient balance in the overall feed composition, the mineral supplement contains the elements in weight percent based on the total weight of the feed composition.

The IVDMD and IVOMD for CSH were 464 and 489 g/kg DM, values that are higher and do not correspond with the average 330 to 450 g/kg DM digestibility determined by other researchers (Hsu *et al*. 1984; Garleb *et al*., 1988). The higher digestibility might have been caused by high energy and relatively low cell wall contents in the diet of the donor of the rumen liquor animal, since energy content of the feed is a factor, which enhances the activities of the microbes in the rumen (Garleb *et al*., 1988).

Rice polishing had the IVDMD and IVOMD of 317 and 358 g/kg DM which was lower than the values of 356 and 378 g/kg DM reported by Cardenas, *et al*. (1992). Who carried out a study on the effect of including Colombian rice polishing in the diet on rumen fermentation *in vitro* digestibility. The reason for this lower digestibility of supplemented feedlot cattle could be due to the low quality of the rice polishing used in the experiment that might have been caused by the low dehulling ability of the rice processing method. The higher the quantity of hulls in rice polishing the higher the mineral elements including silica that may reduce nutrient availability resulting in lower digestibility.

5.3.3 Average daily gain

The growth performance of 0.44 – 0.78 kg d^{-1} were not within the range of values reported by Mkonyi *et al.* (2006) of 1.0 - 1.5 kg d^{-1} who did monitoring in the same area but with different levels of feeds and different animals. The variation of reported values by Mkonyi *et al.* (2006) and the current study could be due to the difference in methods applied on estimating body weights, duration of animals from entry to exit, precision of taking measurements, quality/amount of the feed offered and season because the nutrient content and nutritive value of most feeds vary seasonally.

The animals that were offered the mixture of cotton seed hulls and cotton seed cake showed higher growth rate/weight gain. Higher daily gain was followed by animals fed the ration containing cotton seed hulls alone, and then was followed by animals that were using brewers mash and finally those offered the ration containing rice polishing. This could be due to the higher DM intake. The DM content in the brewers mash was lower than that of other feeds although weight gain was slightly higher than in RP diet, this could be due to better proportion of amino acids than RP and digestibility differences of the feeds.

The animals consuming the ration containing the mixture of cotton seed hulls and cotton seed cake required 11.3 kg DM of the ration to gain 1 kg of body weight and those fed with cotton seed hulls alone required 13.1 kg DM while those fed with brewers mash required 17.4 kg DM and finally animals that used rice polishing required 18.8 kg DM. The feed conversion ratio obtained in the animals fed with cotton seed hulls of 13.1 were slightly lower than the results reported by Chamatata, (1995) which was 10.3, and was the same as that reported by Morales (1989).

The good feed conversion ratio (FCR) observed in the animals fed with diets containing the mixture of cotton seed hulls and cotton seed cake was probably influenced by high digestible dry matter and energy content as compared to those fed with other diets. Providing feed is a major input cost in beef production, hence improvements in the efficiency of feed utilisation will reduce the cost of production. Thus the animals with FCR of 11.3 were better than those with 13.1. Energy intake is influenced among other things by palatability, a feed with high energy and protein concentration can be taken by an animal in little amount but still will be able to cater for adequate animal requirement. Additional protein increases the apparent digestibility of protein in the ration, but additional energy depresses it (Herd *et al*., 2004a).

5.4 Economic analysis

Total production costs per animal obtained as a sum of costs of buying animals, costs of supplementary feeds and other miscellaneous charges were observed to be higher in T2 than other feeds. This was attributed to the inclusion of cotton seed cake which was comparatively higher in price than other feeds (Tshs 350/kg). Based on this situation, production costs for treatment 1, 2, 3 and 4 were offset by high sale price obtained, however highest marginal profit per animal was observed in T2 due to higher ADG thus higher finishing weight.

The aforementioned range of marginal profit per animal is with agreement to that reported by Mkonyi *et al.* (2006) of 50 000/= to 70 000/= per animal in their study on The experience of farmers with cotton seed hulls as a primary feed material in cattle feedlots in Mwanza and Shinyanga regions of Tanzania. This suggests that inclusion level of cotton seed cake with 1.86 kg DM per animal per day resulted in higher daily gain than other treatments. Further investigation was done to ascertain all costs incurred, it was revealed that operations that are carried out by owners manually like trekking of animals, feeding and watering were not considered as production costs, moreover it was reported by some feedlotters that animals gaining slowly stayed up to 6 months with an estimated gain of 90 kg thus the reported gross margins per animal remains questionable.

Economic gains per feedlot comparatively varied between one and the other in spite of being under the same treatment and the reason could be caused by many variables that can affect feed intake, including animal factors, weather, ration ingredients and characteristics, water supply, feed trough design, and feeding management systems. The highest net profit gain per district per year was observed in Nyamagana (4 201 500/=) followed by Misungwi (4 045 500/=) while Magu had the lowest (3 142 500/=). This could be caused by higher cattle purchase prices than other districts. The cost of feed per kg gain showed that BM had the lowest value (865/=), while the mixture of CSC+ CSH had the highest (2542/=) and the ADG was also higher in this ration (0.78)

From these findings it can be concluded that despite of higher cost of feed per kg gain of feeding the mixture of CSC + CSH yet it resulted to highest gross margin during the 90 days of feedlot therefore it should be more encouraged than other feeds. On comparing the cost of gain and Gross margin obtained per animal as shown in appendix 11, T1 (1310 vs 70830) surpassed T2 (2542 vs 78500). On the hand for feedlotters with less capital feeding BM is recommended due to low cost of feed per kg gain. Finally it has been shown that feedlotters in the three districts have made substantial profits in the feedlot enterprise therefore it is worth operating this enterprise.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

From this study it can be shown that some of drought stricken cattle which were too emaciated and unfit for slaughter markets could at least find a market in feedlots where they are raised primarily on agriculture byproducts to excellent body condition within 3- 6 months, and that cotton seed hulls and rice polishing which were previously thrown away or burnt had suddenly become a valuable commodity from the cotton ginneries and rice milling factories.

The diets used for feedlot are of poor quality thus efforts should be geared towards advising feedlotters on best methods of mixing the available ingredients to optimize performance of feedlot cattle for carcasses to meet market specifications.

There were two sources of animals used in feedlotting for the three districts which were within the districts and from outside of the region (Kagera and Kigoma regions). Although indigenous zebu breeds serve varied functions across and within districts, it can also be used for producing quality beef.

Addition of 1.86 kg DM of cotton seed cake to cotton seed hull based diets resulted in higher ADG than other rations thus higher finishing weight, even if a feedlotter needed Tsh 2542/= to get 1kg of gain the production costs were offset by higher sales while using BM needed only Tsh 865/= to get the same 1kg of gain, but finishing weight was also low hence low gross margin. Feedlotters are encouraged to use the mixture of CSC+ CSH.

6.2 Recommendations

There is a need to assess, quantitatively and qualitatively, all crop residues and agro-industrial by-products that are actually available for feeding purpose on a year-round basis. Their feeding value needs to be established in order to be able to develop the year-round feeding strategies in the country. Trials should be held to characterize the response of feedlot cattle to different rations and feeding periods, and so determine what type of ration and for how long each class of animal should be fed.

Evaluation of carcass quality from cattle fattened using the different feeds to see whether they meet the criteria for quality meat. Perhaps one of the most interesting aspects to be investigated will be the performance of the various breeds and crosses under feedlot. The indigenous strains appears ideally suited to finishing but their turnover relative to costs of production are not documented.

There is a need for formation of feedlotters co-operative societies that will help them to acquire credits. There is a need for assistance from the Government in construction of modern slaughter houses in Mwanza region. Cattle will then be slaughtered and graded locally, ready for export, instead of distant transportation of live animals to Pugu, Kenya or Comoro. This will minimize loss of body condition, deaths, unreliable markets and low prices that occurs due to some unscrupulous middlemen.

The Government can also assist in providing market information and linking up local feedlot farmers with international buyers. Feedlotters prefer to produce on firm orders or contracts because it is a big loss for animals to overstay at the feedlot.

REFERENCE

A.O.A.C. (1990). Official methods of analysis 5th ed. Association of official analytical chemists, Washington DC.

Abate, A.N. (1990). Nutritive value of maize forage silage fed to dairy cows for an integrated system of grain and milk production in Kenya. Dissertation for Award of PhD Degree at University of Aberdeen, UK. Available at: [http://www.ext.nodak.edu/extpubs/ansci/beef/as1158w.htm]. Accessed on 15/07/08. 167pp.

Afshar, M. A. and Naser, M. S. (2008). Nutritive Value of Some Agro-Industrial By-products for Ruminants. *World Journal of Zoology 3 (2)*: 40-46, ISSN 1817-3098.

Aines, G., Klopfenstein, T. and Stock, R. (1987). *Distillers Grains*. MP51, Nebraska Agriculture Research Division, Lincoln. New York Macmillan Publishing Company. 465pp.

Allen, O. N. (1980). *Opportunities of Animal production in up land rice farming*. University of Wisconisin Press. 812pp.

Ambreen, N., Hanif, N. G. and Khatoon, S. (2006). Chemical composition of rice polishing from different sources. *Pakistan Veterinary Journal* 26(4): 190-192.

Arthington, J. D. and Kalmbacher, R. S. (2003). Effect of early weaning on the performance of three-year-old, first-calf beef heifers and calves reared in the subtropics. *Journal of Animal Science* 81: 1136–1141.

Arthur, P. F., Archer, J. A., Johnston, D. J., Herd, R. M., Richardson, E. C. and Parnell, P. F. (2001). Genetic and Phenotypic variance and covariance components of feed intake, feed efficiency, and other post-weaning traits in Angus cattle. *Journal of Animal Science* 79: 2805- 2811.

Ayo, E. M. (2002). The effect of substituting cotton seed cake with Waste brewers yeast on the performance of meat goats fed low quality hay. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania. 80pp.

Ballantine, H. T. 1998. Give your farm the eye, ear, nose, and knee test. In: Hoard's Dairyman report. April, 1998. 342pp.

Baiden, R. Y. and Duncan, L. (2008). *Performance of indigenous beef cattle under two management systems.* Animal Research Institute. Achimota. 532pp.

Berger, L. L. and Merchen N. R. (1995). Influence of protein level on intake of feedlot cattle - Role of ruminal ammonia supply In: *Proceedings of the Symposium on Intake by Feedlot Cattle.* (Edited by Willms, C. L), 3- 7 September 1995 Oklahoma State University. 270 - 291 pp.

Blasi, D. A. and Drouillard, J. S. (2002). *Composition and feeding value of cotton seed by products for beef cattle.* Agriculture Experiment Station and Cooperative Extension Service. Kansas State University 537pp.

Bowman, J. G. P. and Sanson, D. W. (1996). Starch- or fiber based energy supplements of grazing ruminants In: *Proceedings of Western Section American Society of Animal Science* (Edited by Hahn, G. L), 4 – 7 April 1996, Oxford University Press, New York. 118- 135pp.

Brett, J. (1999). Water, the more the better. *Dairy Herd Management Science Journal* 7: 32 - 84

Calhoun, M. C., Kuhlmann, S. W. and Baldwin, B. C. (1995a). Assessing the Gossypol status of cattle fed cotton feed products In: *Proceedings of Pacific Northwest Nutrition Conference.* (Edited by Goodrich, R. D) 11 October 1995. Portland, USA. 87 – 125pp.

Cardenas Garcia, D., Newbold, C. J., Galbraith, H., and Topps, J. H. (1992). *The effect of including Colombian rice polishing in the diet on rumen fermentation in vitro. Animal Production.* 280pp.

Chamatata, B. A. (1995). Evaluation of cotton seed hulls as dry season roughage source of ruminants. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania. 97pp.

Choo, B. S. and Sadiq, M. M. (1982). *Indigenous Feed Stuffs and Poultry Feeds*. Poultry Production Research Centre. Sindh, Karachi. Pakistan. 312pp.

Church, D. C. and Pond, D. L. (1982). *Livestock feeds and feeding*. Council Spring Confederation. Texas Agriculture Research and Extension Publications. 242 pp.

Cochran, R. C., Adams, D. C., Currie, P. O. and Knapp, B. W. (1986). Cubed alfalfa hay or cottonseed meal-barley as supplements for beef cows grazing fall-winter range. *Journal of Range Management* 39: 361 - 364.

Coppock, C. E. and Wilkis, D. L. (1991). Feeding whole cottonseed and cottonseed meal to dairy and beef cattle. *2nd Natural Alternative Feeds Symposium*, *Journal of Dairy Science,* St. Louis, MO. Edition. M.L. Eastridge London 13: 217 - 343.

Creek, M. J. (2003). *Pilot Feedlot Project at Mtibwa Sugar Estate*. A DANIDA Agriculture Sector Support Programme Report. Unpublished June 9, 1999, 57pp.

Cundiff, L. V., Wheeler, T. L., Gregory, K. E., Shackelford, S. D., Koohmaraie, M., Thallman, R. M., Snowder, G. D. and Van Vleck. L. D. (2004). *Preliminary results from cycle VII of the cattle germplasm evaluation program report* United States Meat Animal Research Center. 672pp.

Davis, Jr. G. V. (Ed.) (1982). *Cottonseed meal, soybean meal, and dehydrated alfalfa for steers fed corn-silage growing rations*. Proceedings of the cattle feeders' day, Workshop, Kansas State University, 12 June 1982. 226pp.

Del Curto, T., Cochran, R. C., Harman, D. L., Beharka, A. A., Jacques, K. A., Towne, G. and Vanzant, E.S. (1990). Supplementation of dormant tall grass-prairie forage. *Journal of Livestock Sciences* 82: 86 – 112.

Devendra, C**.** (1995). Mixed farming and intensification of animal production systems in Asia. *Proceedings of the Joint FAO/ILRI Round Table on Livestock Development Strategies for Low Income Countries,* (Edited by Goldblatt, L.A.), 27 February to 2 March 1995. 133-145pp.

DiCostanzo, G. N. and Zehnder, C. M. (1996). Factors affecting profitability in the feedlot. *Journal of Livestock Sciences* 24: 3-23.

Elliot, R., Ferreiro, H. M. and Priego, A. (1978). An estimate of the quantity of feed protein escaping degradation in the rumen of steers fed chopped sugar cane, molasses/urea supplemented with varying quantities of rice polishing. *Tropical Animal Production Journal* 3: 36-39.

Food and Agricultural Organisation (FAO) (2004). The Role and Effect of Global Improvement in Food Security. [http://www.fao.org] site visited on 15/8/2008.

Forster, L. A., Jr. Cochran, R. C. and Calhoun, M. C. (1995). Nutrient values for cottonseed products deserve a new look. *Journal of Animal Science* 73: 657-664.

Francis, J., Sibanda, S., Hermansen, J. E. and Kriestensen, T. (2002). Estimation of body weights using linear body measurements, *Zimbabwe Veterinary Journal* 33 (1): 15-21.

Garleb, K. A., Bourquin, L. D., Hsu, J. T., Wagner G. W., Schmidt, S. J. and Tahey, G. C. (1988). Isolation and chemical analysis of non fermented fibre fractions of oat hulls and cotton seed hulls. *Journal of Animal Science* 69 (3): 1255-1271.

Ghazi, A. R. (1992). Measurement of true ME (TME) of indigenous feeding stuffs commonly used in poultry rations. Dissertation for Award of MSc Degree at University of Agriculture, Faisalabad, Pakistan, 117pp.

Gibbs, P.G. and Householder, D. D. (2007). Estimating cattle and horse body weight with a simple formula. Texas Agriculture University. [http://smith-tx.tamu.edu/publications/hrg012-bodyweight.pdf] site visited on 15/8/2009.

Gohl, B. (1981) *Tropical Feeds. 2nd edition*. FAO International. Foundation for Science,Stockholm, Sweden. pp 439.

Grimaud, P., Sauzier, J., Bheekhee, R. and Thomas, P. (2006). Nutritive value of tropical pasture in Mauritius. *Journal of Tropical Animal Health and Production* 38 (2): 159-167.

Hammack, S. P. (2003). Creating cattle breeds and composites. [online] Texas cooperative extension. [http://animalscience.tamu. edu/ansc Publications/beefpubs/E180 _composites.pdf>] site visited on 09/12/2008.

Hall, M. B., Hart, S. P., and Akinyode, A. M. (2000). Cottonseed hulls working with a novel fiber source. In: *Proceedings of 11th Annivesary Ruminant Nutrition Symposium*. (Edited by Wainman F. W.), 21- 24/3/2000, Gainesville, FLORIDA. 179–186pp.

Hango, A. A. (2005). Pilot study on a goat feedlot production system. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania. 111pp.

Harris, B. Jr., Van Horn, H. H., Manookian, K. E., Marshall, S. P., Taylor, M. J and Wilcox, C. J. (1983). Sugarcane silage, sodium hydroxide- and steam pressure-treated sugar cane bagasse, corn silage, cotton seed hulls, sodium bicarbonate, and *Aspergillus oryzae* product in complete rations for lactating dairy cows. *Journal of Dairy Science* 66: 474 - 485.

Herd, R. M., Oddy, V. H. and Richardson, E. C. (2004a). Biological basis for variation in residual feed intake in beef cattle. Review of potential mechanisms. *Journal of Experiments in Agriculture* 44: 423- 430.

Hersom, M. J., Horn, G. W. and Krehbiel, C. R. (2005). Feedlot performance of steers from different winter grazing programs. *Journal of Animal Science* 79 (13): 56 -71.

Hetzel, D. J. S. (1988). Comparative productivity of the Brahman and some indigenous Sanga and Bos indicus breeds of East and Southern Africa. *Animal Breeding Abstracts* 56 (4): 243–255.

Hicks, R. B., Owens, F. N., Gill, D. R., Martin, J. J. and Strasia, C. A. (1990). Effects of controlled feed intake on performance and carcass characteristics of feedlot steers and heifers. *Journal of Animal Science* 68:233.

Holloway, J. W., Warrington, B. G., Forrest, D. W. and Randel, R. D. (2002). Preweaning growth of F1 tropically adapted beef cattle breeds x Angus and reproductive performance of their Angus dams in arid rangeland. *Journal of Animal Science* 80: 911–918.

Hsu, J. T., Faulkner, D. B., Fahey, G. C. and Berger, L. L. (1984). Evaluation of corn fiber, cotton seed hulls and soy bean hulls as roughages sources for ruminants. *Journal of Animal Science* 65:244-255.

Jagadi, M. M., Rundgren, M. and Ogle, R. B. (1987). Chemical composition and protein quality of Tanzanian cottonseed expeller cakes; ILCA Bulletin No. 28, *International Livestock Centre for Africa*, Addis Ababa, Ethiopia. 561pp.

Khalique, A., Lone, K. P., Pasha, T. N. and Khan, A. D. (2004). Amino acid digestibility of chemically treated and extruder cooked defatted rice polishing. *Malasian Journal of Animal Nutrition* 10 (2): 195-206.

Kimambo, A. E., Mutayoba, S. K., and Lyimo, C. M. (1999). Effect of different bedding materials on the feeding value of poultry manure for ruminants. In: *Proceeding of the 26th Conference Tanzania Society of Animal Production* (Edited by Mbaga, S.H., Ndemanisho, E.E. and Kakengi, A.M.V.), 3 -5- August 1999. LITI –Tengeru, Arusha, Tanzania, 200-205pp.

Klopfenstein, T. and Owen, F. (1988). Byproduct feedstuffs for beef and dairy cattle In: *Proceedings of a symposium / sponsored by the center for alternative crops and products organizing committee*. (Edited by Stock, R), 16-18 February 1988, Institute of Agriculture, Nebraska 227-234pp.

Klopfenstein, T and Rounds, W. (2005). *Nebraska Beef Cattle Report* EC75-218 University of Nebraska, Institute of Agriculture and Natural Resources. 411pp.

Kuhl, G. L. (1992). Fine tuning your ration management. *Proceedings of Scott County Beef Cattle Conference.* Scott City USA.12-16 May 1992 19 pp.

Lamba, J. S., Wadhwa, M. and Bakshi, M.P.S. (2002). Effect of feeding naturally fermented urea wheat straw on the productive performance of feedlot cattle, *Journal of Animal Nutrition* 89 (2):72-79.

Lardy, G. (1999). Feeding management for backgrounders. North Dakota State University. Florida Cooperative Extension. [http://edis.ifas.ufl.edu/AN101].site visited on 17/05/2009.

Lawrence, J. L. J. and Fowler, V. R. (1997). *Growth of farm animals*. Centre for Agriculture and Biosciences International (CABI), Wallingford, U.K. 330pp.

Leeson, S. and Summers, J. D. (2001). *Nutrition of the Chicken*. University Books, Guelph, Ontario, Canada. 753pp.

Loy, D. (1999). *Feed bunk management*. Iowa State University. [*http://www.ibc.iastate.edu/pubs/feedbunk.stm*]. Accessed on 15 August 2008.

Machibula, B. P. (2000). The effect of substituting cotton seedcake with *Gliricidia sepium* on the performance of dairy cattle fed on Napier grass. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 118 pp.

Maeda-Machang'u, A. D., Mutayoba, S. K., Laswai, G. H., Mwaseba, D., Kimambo, E. S and Lazaro, E. (2000). Local knowledge and gender roles in different livestock production systems in Tanzania. In: *Proceedings of the 1st University-wide Scientific Conference*. (Edited by Matovelo, J.A.). 5-7 April 2000, Morogoro, Tanzania, 657-674pp.

Malik, M. Y. and Chughtai, M. I. D. (1979). Chemical composition and nutritive value of indigenous feedstuffs. *Pakistan Association of Advanced Sciences Journal* 4: 11-45.

MAFF, 1976. Ministry of Agriculture, Fisheries and Food. Department of Agriculture and Fisheries for Scotland, Department for Northern Ireland. *Energy Allowances and Feeding Systems for Ruminants Technical Bulletin* 33: 3.

Maule, J. P. (1990). *The Cattle of the Tropics*. Redwood Press Ltd, Melksam. 478pp.

Mertens, D. R. (1994). Non structural and structural carbohydrates In; *Large Dairy Herd Management Edition*, American Dairy Science Association, Champaign: 460pp.

McDonald, P., Edwards, R. A. and Greenhalgh, J. F. D. (1995) *Animal Nutrition. 5th edition.* Longman Science and Technology. Essex, England. 607pp.

Miller, Z. (1998). Bunk management needed for top beef and milk. In: *Hoard's Dairyman*. Department of Animal Sciences and Industry, Kansas State University Manhattan 645pp.

MLD. (2006) [http://www.mifugo.go.tz/dapro_page.htm] visited on 26th March 2009.

Mirzaei-Aghsaghali, A. and Maheri-Sis, N. (2008). Brewer's by-products generation, characteristics and improving their nutritional value. *Proceedings of 3rd National Congress of Recycling and Reuse of Renewable Organic Resources in Agriculture.* (Edited by Meiske, R. D.), 13-15 May 2008. Isfahan, Iran, 55: 442-512.

Mkonyi, P. A. (2006). The experience of farmers with cotton seed hulls as a primary feed in cattle feedlots in Shinyanga and Mwanza regions of Tanzania. In: *Proceedings of Tanzania Veterinary Association Meeting*, (Edited by Makungu L. S.), AICC-Arusha.18- 21 December 2007 28pp.

Moll, H. A. J. Turner, J. B. and Ibrahim, M. N. M. (2001). From Pasture to Meat: Smallholders' livelihoods and markets, *Proceedings of the 12th Symposium Tropical Animal Health and Production,* (Edited by Staal, S. J.), 19- 23 June 2001, University of Utrecht, Netherlands 1-15pp.

Moore, J. A., Poore, M. H. and Swingle, R. S. (1990). Influence of roughage source on kinetic of digestion and passage and on calculated extent of ruminal digestion in beef steers fed 65% concentrate diets. *Journal of Animal Science* 68 (10): 412 - 420.

Morales, J. L., Varn Horn, H. H. and Moore, J. E. (1989). Dietary interaction of cane molasses with source of roughage, intake and lactation effects. *Journal of Dairy Science* 72: 331- 338.

Mpofu, N., Mareko, M. H. D. and Makore, J. (1998). The growth performance of crossbred progeny of foreign sire breeds in semi-arid Africa. *Proceedings of the 6th World Congress on Genetics Applied to Livestock Production* (Edited by Setshwaelo, L.L.), 6- 12 March 1998, Bulawayo, Zimbabwe, 25:227-230.

Mpofu, N. (2002). *Comparison of indigenous and foreign cattle for beef production* at Matopos Research Station in Bulawayo, Zimbabwe. 312pp.

Murphy, T. A. and Loerch, S. C. (1993). Effects of restricted feeding growing steers on performance and carcass characteristics. *Ohio Beef Cattle Research and Industry Report* 93: 99-110 pp.

Mussatto, S. I., Dragone, G. and Roberto, I. C. (2006). Brewer's spent grain, generation, characteristics and. potential applications. *Journal of Cereal Science* 43: 1-14

Nadeem, M. A. (1998). Evaluation of poultry feedstuffs for TME and available amino acids under tropical conditions. Dissertation for Award of PhD Degree at University of Agriculture, Faisalabad, Pakistan. 356pp.

Norbaev, K. N. (1989). *Aetiology and semiology of hepatosis in fattening sheep*. *Veterinariya Moskva* 8: 57-59.

Norris, J., Macala, J., Makore, B. and Mosimanyana, B. (2002). *Feedlot performance of various breed groups of cattle fed low to high levels of roughage*. Department of Agriculture Research, Private bag 0033, Gaborone, Botswana.264pp.

NRC (1996). *Nutrient Requirements of Beef Cattle.* 7th edition. National Academy Press, Washington, DC. 213pp.

NRC (2000). *Nutrient Requirements of Beef Cattle***.** Seventh Revised Edition, Bill Weiss Department of Animal Sciences OARDC/OSU.381pp.

Okantah, S. A., Obese, F. Y., Oddoye, O. K., Karikari, P. K., Gyawu, P. and Bryant, M. J. (2005). The effect of farm (herd) and season of calving on the reproductive performance of Sanga cows in smallholder peri-urban dairy farms in the Accra Plains Ghana. *Journal of Agricultural Science* NARS edition 1: 37- 42.

Olayiwole, N. B. and Olrunju, S. A. (1987). Feedlot performance of yearling steers previously maintained on different crop residue/supplementation regimes. In: *Proceedings of the ARNAB Workshop on Utilization of agricultural by-products as livestock feeds in Africa.* (Edited by Little D. A. and Said A. N.) September 1986, Blantyre, Malawi. ILCA (International Livestock Centre for Africa) publication 72-82pp.

Oliveros, B. A., Klopfenstein, T. J., Goedeken, F. K., Nelson, M. L. and Hawkins, E. E. (1989). Corn fiber as an energy supplement in high-roughage diets fed to steers and lambs*. Journal of Animal Science* 67:1784-1792.

Oster, A., Thomke, S. and Gyllang, H. (2007). A note on the use of brewers dried grains as a protein feedstuff for cattle. *Journal of Animal Production* 24: 279-282.

Pham, T. N., Nguyen, V. T. and Preston, T. R. (2008). *Effects of different levels and sources of crude protein supplementation on feed intake, digestibility and nitrogen retention in local cattle compared to Charolais crosses.* College of Agriculture, Cantho University, Vietnam. 652pp.

Phiri, E. C. J. H. (2001). Performance of grazing crossbred cattle supplemented with minerals: Calcium, Phosphorus and zinc. Thesis for Award of PhD Degree at Sokoine University of Agriculture, Morogoro, Tanzania. 241pp.

Pires, A. V., Eastridge, M. L., Firkins, L.G. and Lin, Y. C. (1997). Effects of heat treatment and physical processing of cottonseed on nutrient digestibility and production performance by lactating cows. *Journal of Dairy Science*. 80: 1685-1694.

Plegge, S. D. (1987). Restricting intake of feedlot cattle. In: *Proceedings of the Symposium on Feed intake by beef cattle.* (Edited by Owens, F., Gill, D. and Lusby, K.) 20 - 22 November 1986, Oklahoma State University, Stillwater. 97- 112pp.

Pond, W. G. and Maner, J. H. (1974). *Swine Production in Temperate and Tropical Environments*. W.H. Freemany and Company, San Francisco, 616pp.

Preston, T. R. and Leng, R. A. (1987). *Matching Ruminant Production System with available resources in the Tropics and Sub-tropics*. Penabul Books, Armidale, Australia.196pp.

Preston, R. L. (2002). *Feed composition guide*, 191 Columbia Court, Pagosa spring CO81147-7650. 412pp.

Price, M. A. and Berg, R. T. (1981). On the consequences and economics of feeding grain *ad libitum* to culled beef cows. *Journal of Animal Science* 61:105-111.

Pritchard, R. (1992). *Consistency Improves Performance in Feeder Performance*. Department of animal sciences and industry. Kansas State University. 397pp.

Pritchard, R. H. (1998). Bunk management – Observations from research plains nutrition council spring conference. *Texas Agriculture Research and Extension. Publication* (AREC) 98: 24 68.

Ramachandran, M. and Singhal, K. (2008). *Cotton Seed Hulls Based Complete Diets for Crossbred Cattle*. Department of Animal Nutrition, Madras Veterinary College, TANUVAS, vepery, Chennai-600007, India.

Rankin, D. L. (2004). *By-product Feeds for Alabama Beef Cattle*. Alabama Cooperative. Extension. Animal Research Centre.1237pp.

Rao, P. V. and Reddy, M. J. (1984). Evaluation of chemical and nutrient composition in raw, de-oiled and parboiled rice polishing and maize. *Indian Journal of Poultry Science* 21 (1): 72-74.

Rege, J. E. O. and Tawah, C. L. (1999). The state of African cattle genetic resources II. Geographic distribution, characteristics and uses of present-day breeds and strains. In: *Animal genetic resource information* AGRI No. 26. (Edited by Galal, S. and Boyazoglu, J.), FAO, Rome, 1-25pp.

Ruíz-Flores, A., Núñez-Domínguez, R., Ramírez-Valverde, R., Domínguez-Viveros, J., Mendoza-Domínguez, M. and Martínez-Cuevas, E. (2006). Levels and effects of inbreeding on growth and reproductive traits in Tropicarne and Brown Swiss cattle. Agrociencia 40: 289–301.

Sainz, R. D. and Paulino, P. V. (2004). Residual feed intake. [online] Sierra Foothill Research and Extension Centre, University of California. [<http://0-repositories.cdlib.org. innopac .up.ac.2a:80/anrec/sfrec/2004] site visited on 12/9/2009.

SAS, 2001. SAS/STAT Guide to personal computers, Version 7. Statistical Analysis System, (Statistical Analysis System Institute Inc., NY, USA).

Saunders, R. M. (1990). The properties of rice bran as a foodstuff. *Cereal Foods World Journal* 35: 32-636.

Schoonmaker, K. (1999a). Pre-fresh heifers need a separate transition diet. *Dairy Herd Management* January, 1999. 21- 34pp.

Schoonmaker, K. (1999b). Huddle your team. *Dairy Herd Management* May, 1999. 28-54pp.

Sekin, Y. and Akbulut, N. (1987). Possibility of utilization of waste beer yeast. *Journal-Fakiilesi* 24: 229-235.

Singh, K. S. and Panda, B. (1988). *Poultry Nutrition*. 1st Edition, Kalyani Publishers, New Delhi, India. 293pp.

Stanton, D. W., Clanton, D. C. and Rush, I. G. (1988). Intake and digestion of low quality meadow hay by steers and performance of cows on native range when fed protein supplements containing various levels of corn. *Journal of Animal Science* 68: 595- 603.

Sunvold, G. D., Cochran, R. C. and Vanzant, E. S. (1991). Evaluation of wheat middlings as a supplement for beef cattle consuming dormant bluestem-range forage. *Journal of Animal Science* 69: 304 - 315.

Susan, P. (1995). *Estimate Body Weight from Animal Measurement*. Extension Agent, 4-H Youth Development, University of Arizona Cooperative Extension, Cochise County, USA. 278pp.

Tagari, H., Pena, F. and Satter, L. D. (1986). Protein degradation by rumen microbes of heat-treated whole cottonseed. *Journal of Animal Science* 62: 17 - 32.

Taparia, A. L. and Sharma, V. V. (1980). Some factors affecting voluntary food intake in beef cattle. *Cambridge Journal of Agriculture Sciences* 95: 147-159.

Tawonezvi, H. P. R. (1993). Adaptability of beef cattle. *Journal of the Zimbabwe Society for Animal Production* 5:15-22.

TFNC (1988) “ Uimarishaji wa lishe ya kina mama na watoto” *In: Utunzaji wa Matatizo ya Chakula na lishe*. 2nd Edition. Wizara ya Elimu na Mafunzo, Dar – es – Salaam Tanzania. 165pp.

Thomson, S. and Patricia, P. (2008). The economics of beef production in the South West. *Guidelines for Establishment and Operation of Cattle Feedlots in South Australia, 2nd Edition,* University of Plymouth, UK. 560pp.

Tilley, J. M. A. and Terry, R. A. (1963). A two stage technique for the in vitro digestion of forage crops. *Journal of British Grassland Society* 18: 56 - 104.

Topps, J. H. and Oliver, J. (1993). Animal foods of central Africa. *Zimbabwe Agricultural Journal Technical Handbook No 2* Modern Farming Publications, Harare, Zimbabwe. 76- 105pp.

Torrent, J., Johnson, D. E. and Kujawa, M. A. (1994). Co-product fiber digestibility: Kinetic and in vivo assessment. *Journal of Animal Science* 72:790-795.

Umunna, N. N., Yusuf, A. A. and Aganga, A. A. (1980). *Evaluation of Brewers' mash and Palm kernel Meal as Major Sources of Nitrogen for Growing Cattle*. Department of Animal Science, Ahmadu Bello University, P M B 1044 Zaria, Nigeria. 463pp.

United Republic of Tanzania (2003). *National Food Security Policy* (Draft). 34pp.

Van Renen, (1997). *Supply Response, Stocks for Southern African Beef*. University of Pretoria, Department of Agricultural Economics, Extension and Rural Development, South Africa. 359pp.

Van Soest, P. J. (1982). Effect of environment and quality of fiber on nutritive value of crop residues. In: *Proceedings of a Workshop Plant Breeding and Nutritive Value of Crop Residues.* (Edited by Wine R. H.), 7-10 December 1987, ILCA, Addis Ababa, Ethiopia. 71- 96pp.

Van Soest, P. J., Robertson J. B. and Lewis, B. A. (1991). Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science* 74: 358-359.

Whitlock, L. A. (1999). Effect of level of top spoilage in the diet on feed intake, nutrient digestibilities, and ruminal metabolism in growing steers fed whole-plant corn silage based diet. Dissertation for Award of Msc Degree at Kansas State University, Manhattan. 128pp.

World Bank, (1994) Policy Research Working Paper on Tanzania Agriculture, Washington D.C. USA. 158 - 162pp.

APPENDICES

Appendix 1: Questionnaire on cattle feedlots or fattening in Mwanza region

Study Title: Emerging feedlots of indigenous cattle in Mwanza region is providing significant quality beef: How could it be assisted to perform better?

PART A:
GENERAL HERD LEVEL INFORMATION.
Inventory and statistics of cattle in feedlots (sketch the table below on the other side of this page and list as indicated)

Serial Number	Name of Feedlot/owner	Location/Area/Street	Number of cattle at peak business
1			
2			
3 etc.			

For each of three selected feedlots/owners group animals into three categories, namely,
Group I: Bigger animals such as steers, castrates, bulls.
Group II: Medium size animals such as females/cows and
Group III: Small animals. Then give the following:

Name of feedlot/kraal	Group		
Group	I	II	III
Cattle Nos.			
Av.B.Wt. (Entry)			
Av.C. Price (Entry)			
Av.B.Wt. (Exit)			
Av. S. Price (Exit)			

3. Feeds ration consumed in a feeding group of animals

Name of feedlot	
No. of cattle in group	
Feed Type I Name	
Amount (Kg. In ration mixture*	
Amount consumed per day (kg.)	
Price	
Feed Type 2 Name	
Amount (kg) in ration mixture*	
Amount consumed per day (kg)	
Price	
Feed type 3: Name	

Amount (kg) in ration mixture)*	
Amount consumed per day (kg.)	
Price	
Feed Type 4 Name	
Amount (Kg.) in ration mixture*	
Amount consumed per day (kg.)	
Price	

*Note: Ration mixture to be added up down the column in each feedlot.

Average duration of stay (months) at the feedlot (period from entry to exit)………...

Sourcing of animals for the feedlot:

Name of Place/District…………………………………………………………………

Name of Livestock Market …………………………………………………..

Type of animals/breed…………………………………………………………………

Sex………………………………………………………………………………………

Are you getting enough? Yes…………………. No……………………………………

PART B: FEEDLOT HUSBANDRY PRACTICES:

From the few selected feedlots/owners give detailed feedlot husbandry practices as follows:

Animal health practices on entry into the feedlot:
Tagging/identification: Yes……………… No………………….
Clinical examination: Yes………………No………………..….
Check for body weight (Entry wt.): Yes…………. No……….
Check for Body temperature: Yes………………… No……….
Check for Blood parasites (B/S, Haematocrit): Yes……..No…..
Check for External parasites: Yes……………..No……….
Check for Internal parasites (faeces, urine): Yes……. No……..
(Usually representative sample, e.g. animals in poor condition?)

Groupings or segregation of herd (say into obviously healthy animals, heavily parasitized, poor condition, sick etc): Yes………….. No……………
Treatments on different groups: Yes……………No………………………….
Control of external parasites (whole herd dipping/spraying):
Yes………… No……………Cost………………………………………
Control of internal parasites (whole herd worm control):
Yes………… No………Cost……………………………………………

Control of specific parasites or diseases identified (e.g. liverflukes, trypanosomiasis etc): Yes………No…………Cost…………………

List most common diseases or parasites encountered among entry animals………………………………………..

…………………………………………………………………

Periodic animal health practices continued during stay at the feedlot:

Yes……………………No……………………………………………

Check for body weight gains: Yes…………. No…………..

Check for diseases or parasites: Yes……….No………….

Dipping/spraying: Yes……………. No……………………

Worms control: Yes……………… No……………………

List most common diseases or parasites encountered during stay at the feedlot…………………………………………………………

Cost of dipping/spraying and treatment during stay at feedlot………

…………………………………………………………………………

Housing, feeding and watering structures provided: Yes………..No……………..

Open feedlots/kraals: Yes………………. No……………………..

Roofed animal houses: Yes……………….. No………………….

(To keep out rain and sun)

Feeding structures available: Yes……………….No………………

(To reduce feed wastage)

Watering points (of construction to ensure clean water supply): Yes…………………… No……………..

Costs of water supply………………………………………………..

Is feed and water freely available to animals (ad libitum)?

Yes………… No…………………

PART C: MARKETING OF FEEDLOT CATTLE

Tracking of profit margins.

Is there a mechanism of assessing costs of production over time against expected sale prices? Yes…No………………………………

Is there a practice of culling prematurely non-performing animals? Yes………….. No…………………………………………………

What factors determine the sale or exit of animals from feedlot? Tick as applicable:

-Attainment of body condition as per order…………………………………………….

-Attainment of body weight as per order……………………………………………….

-Forced to sell when profit margins get too little or loss making…………………….

Economics of feedlots:

For each of the several feedlots studied in detail estimate and compare the total costs of production against expected total sale prices to determine profit margins for the group (or per animal). (Carry over from Qns/Tables 2,3,6,7)

Name of feedlot	Group		
Group	I	II	III

1. Cattle numbers			
2. Total sale Price (expected)			
3. Total cost/purchase price			
4. Costs of feed and water			
5. Costs of Animal Health			
6. Labour/Salaries			
7. Other costs (specify)			
8. Total production costs (3+4+5+6+7)			
9. Total Gross margins (group) (2minus 8)			
10. Gross margin per animal (9/1)			

Indicate efforts if any at the feedlot to promote growth rates hence reduce duration of stay on station (but maintaining profitability) such as:-
-Higher energy feeds rations (molasses, concentrates): Yes……….. No…………
-Mineral supplements (licks, powder)): Yes………………. No……………………..
-Vitamins/mineral supplements (injectable) Yes……………… No…………………
-Others (specify)……………………………………………………………………..

Indicate efforts to promote or advertise the feedlot/animals/meat business:
-Informal contacts with customers (through friends etc): Yes……. No………….
-Formal contracts with customers (telephones, mail etc) Yes……. No…………
-Advertisements in radio: Yes………….. No………………………………………
-Advertisements in television, newspapers: Yes…………… No…………………

Indicate efforts to add value to feedlot cattle (by owner or in partnership) such as slaughter, processing and packaging of meat products: Yes………….. No………
Briefly describe how it is being done……………………………………………………

PART D: WAY FORWARD AND FUTURE:

What plans do you have (and means or resources to implement them) in order to improve your feedlot/fattening enterprise?
……………………………………………………………………………………..
……………………………………………………………………………………..
……………………………………………………………………………………..

What do you think the Government (DC, Municipality, MLD) could assist you in order to improve your feedlot business?
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………

Give general recommendations on what is required to improve feedlots and the meat industry in this country.
……………………………………………………………………………………..
……………………………………………………………………………………..

………………………………………………………………………………………..

Appendix 2: Focus-Group Interview Guide

1. Livestock trade: What are major reasons for fattening livestock? What are the major problems facing livestock enterprise? Ask about their perception on the trend of livestock trade for the past few years? Ask whether it is increasing or decreasing and why? Ask how price has influence selling of livestock and what situations determine higher sales? Identify and discuss together significant conditions which make them to fatten or not fatten livestock. What is the use of extra cash? (Probe on investing on IGAs, bank deposit (account) or re-stocking); ask which livestock types are fattened mostly, Why; If young and immature animals do not appear in the list, ask them why.

2. Decision making: what is the ownership pattern of livestock in the fattening units? How the decision to sell livestock is made? Examine who determine when to sell animal and why?

3. Livestock breeds: ask for the favourite/preferred breed, and discuss why. Probe their awareness on importance of having larger breeds (e.g. boran) and crosses

4. Income Generating Activities (such as hotels, shops and guest houses) offer opportunity to make life. Get their views on IGAs.

5. Different national policies and programmes have been directed towards livestock industry in trying to modernize. Ask how they find the impact of such interventions on their part.

Appendix 3: Key Informants Interview Guide

1. Livestock trade: What are major reasons for fattening animals before selling them? Ask where do they buy animals for fattening? What are the major problems facing livestock enterprise? Ask about their perception on the trend of livestock trade for the past few years? Ask whether it is increasing or decreasing and why? Ask how price has influence selling of livestock and what situations determine higher sales? Identify and discuss together significant conditions which make them to sell or not sell livestock. What is the use of extra cash? (Probe on investing on IGAs, bank deposit (account) or re-stocking); ask which livestock species/types are sold mostly, Why; If young and immature animals do not appear in the list, ask them why.

2. Decision making: what is the ownership pattern of livestock in the fattening units? How the decision to sell livestock is made? Examine who determine when, to sell animals and why?

3. Livestock breeds: ask for the favourite/preferred breed, and discuss why. Probe their awareness on importance of having larger breeds (e.g. boran) and crosses

4. Income Generating Activities (such as hotels, shops and guest houses) offer opportunity to make life. Get their views on IGAs.

5. Different national policies and programmes have been directed towards livestock industry in trying to modernize. Ask how they find the impact of such interventions on their part.

Appendix 4: ANOVA Results on Cattle Performance

ANOVA for Dependent Variable weight 2 (W2)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	897536.3009	74794.6917	5829.84	<.0001
Error	227	2912.3262	12.8296		
Corrected Total	239	900448.6271			

ANOVA Dependent Variable Weight 3 (W3)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	902753.9809	75229.4984	19360.9	<.0001
Error	227	882.0414	3.8856		
Corrected Total	239	903636.0223			

ANOVA for Dependent Variable W4

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	908057.2051	75671.4338	12150.7	<.0001
Error	227	1413.6934	6.2277		
Corrected Total	239	909470.8984			

ANOVA for Dependent Variable Weight 5 (W5

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	921760.9852	76813.4154	15630.7	<.0001
Error	227	1115.5360	4.9143		
Corrected Total	239	922876.5212			

ANOVA for Dependent Variable Weight change (wtchange)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	11828.38659	985.69888	200.63	<.0001
Error	227	1115.25661	4.91302		
Corrected Total	239	12943.64319			

ANOVA for Dependent Variable Average daily gain (ADG)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	3.78531073	0.31544256	202.45	<.0001
Error	227	0.35368885	0.00155810		
Corrected Total	239	4.13899958			

ANOVA for Dependent Variable Feed conversion ratio (FCR)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	2447.127741	203.927312	228.17	<.0001
Error	227	202.878209	0.893737		
Corrected Total	239	2650.005950			

ANOVA for Dependent Variable Dry matter intake (DMI)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	107.5039371	8.9586614	621.87	<.0001
Error	227	3.2701813	0.0144061		
Corrected Total	239	110.7741183			

ANOVA for Dependent Variable Metabolic body weight (MetBW)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	29559.98940	2463.33245	9584.62	<.0001
Error	227	58.34104	0.25701		
Corrected Total	239	29618.33044			

ANOVA for Dependent Variable intake g/kg W 0.75 (gkgmeBw)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	59939.90705	4994.99225	449.42	<.0001
Error	227	2522.93155	11.11424		
Corrected Total	239	62462.83859			

Appendix 5: Miscellaneous costs and net return of the feedlot

Variable	District	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Average wt at entry	Misungwi	4	220	35.59	17.79	170	250
	Nyamagana	4	302.5	121.48	60.74	180	450
	Magu	4	317.5	26.29	13.14	280	340
Average cattle Price	Misungwi	4	332500	27537	13768	300000	360000
	Nyamagana	4	442500	149080	74540	320000	650000.0
	Magu	4	532500	78898	39449	420000	600000.0
Average wt at exit	Misungwi	4	370	47	23	300	400.00
	Nyamagana	4	470	140	70	320	650
	Magu	4	507	54	27	430	550
AveragePrice at exit	Misungwi	4	637500	85391	42695	550000	750000
	Nyamagana	4	737500	171925	85962	570000	950000
	Magu	4	781250	68358	34179	680000	825000
Ave. duration stay	Misungwi	4	122.5	20	10.30	100	150
	Nyamagana	4	125	10	5	120.00	140.00
	Magu	4	127.5	15	7.5	120.00	150.00
Total sale price exp.	Misungwi	4	12750000	5229623	2614811	1250000	12000000
	Nyamagana	4	14750000	3696845	1848422	11000000	19000000
	Magu	4	15625000	1466003	733001	13400000	16500000
Total cost of buying	Misungwi	4	6650000	550757	275378	6000000	7200000
	Nyamagana	4	8500000	2645751	1322875	6000000	12000000
	Magu	4	10500000	1428285	714142	8400000	11400000
Total Prod. costs	Misungwi	4	11401500	287899	143949	3540000	4210000
	Nyamagana	4	13099500	844049	422024	3822000	5440000
	Magu	4	1457700	80570	40285	3950000	4140000
Total Gross Margin	Misungwi	4	1348500	415956	207978	1012000	1890000
	Nyamagana	4	1400500	333296	166648	1074000	1790000
	Magu	4	1047500	95699	47849	960000.0	1180000
GM per Animal	Misungwi	4	67425	20797	10398	50600.00	94500.00
	Nyamagana	4	70025	16664	8332	53700.00	89500.00
	Magu	4	52375	4784	2392	48000.00	59000.00

Appendix 6: Socio-economic characteristics of feedlot owners in Mwanza region

Variables	Percentage distribution of respondents by district			
	Misungwi(n=16)	Nyamagana(n= 22)	Magu n=20)	Total(58)
Sex				
Male	16(100)	22(100)	20(100)	58(100)
Female	0	0	0	0
Total	**16(100)**	**22(100)**	**20(100)**	**58(100)**
Marital Status				
Single	0	0	0	0
Married	15(94)	22(100)	20(100)	57(98)
Divorced	0	0	0	0
Cohabiting	0	0	0	0
Widow	01(06)	0	0	1(02)
Total	**100**	**100**	**100**	**58(100)**
Household members	5.4	6.6	6.5	6.2
Age distribution				
15-30 yrs old	02(12)	3(14)	3(15)	8(14)
31-45 yrs old	3(19)	6(27)	5(25)	14(24)
46-60 yrs old	7(44)	09(41)	09(45)	25(43)
60 and above	04(25)	4(18)	3(15)	11(19)
Total	**16(100)**	**22(100)**	**20(100)**	**58(100)**
Level of education				
Informal	8(50)	7(33)	11(55)	26(46)
Primary	3(19)	6(27)	4(20)	13(22)
Secondary	3(19)	5(22)	3(15)	11(19)
College	2(12)	4(18)	2(10)	8(13)
Total	**100**	**100**	**100**	**58(100)**
Main Source of income				
Crop production only	0	0	0	0
Livestock keeping only	05(31)	8(36)	02(10)	15(26)
Both crop and Liv	11(69)	12(54)	17(85)	40 (69)
Formal employment	0	02(10)	01(05)	3(05)
Total	**100**	**100**	**100**	**58(100)**

Key: Numbers outside of the bracket is frequency while the number inside the bracket is percentage of respondents

Appendix 7: Feeds and watering

Variables	Misungwi (n=16)	Nyamagan (n=22)	Magu (n=20	Total (n=58)
Types of feeds used				
Cotton seed hulls (CSH) alone	25	23	35	27
Cotton seed cake (CSC) alone	0	0	0	0
Brewers mash(BM) alone	13	23	10	16
Mixtures of BM+Molasses	0	09	05	04
Rice polishing (RP) alone	25	14	20	20
Rice polishing+CSH	06	0	15	07
Mixture of CSH + CSC	19	17	15	17
Mixture of CSH + Molasses	12	14	0	9
Total	**100**	**100**	**100**	**100**
Where feeds are bought				
Market	19	27	20	22
Ginnery	62	55	55	57
Individuals (milling machine)	19	18	25	21
Total	**100**	**100**	**100**	**100**
Frequency of watering				
Freely available	38	50	65	51
Once a day	24	14	10	16
Twice a day	38	36	25	33
Total	**100**	**100**	**100**	**100**
Distance to watering point				
< 1 km	63	59	60	61
1-5 km	31	32	30	31
6-10 km	6	9	10	08
Total	**100**	**100**	**100**	**100**

Appendix 8: Economic analysis on Gross Margin per feedlot in each treatment

Variable	Treatment			Std. Error
Total Production costs	Cotton Seed Hulls	Mean	4250000	498029
		Std. Deviation	862612	
		Minimum	3540000	
		Maximum	5210000	
	CSH + CSC	Mean	4533333	459504
		Std. Deviation	795885	

		Minimum	3950000	
		Maximum	5440000	
	Brewers Mash	Mean	3978000	27592
		Std. Deviation	47791	
		Minimum	3926000	
		Maximum	4020000	
	Rice polishing	Mean	3910000	116051.7
		Std. Deviation	201007	
		Minimum	3768000	
		Maximum	4140000	
Total Gross Margin	Cotton Seed Hulls	Mean	1416666	229080
		Std. Deviation	396778	
		Minimum	1000000	
		Maximum	1790000	
	CSH + CSC	Mean	1500000	244335
		Std. Deviation	423202	
		Minimum	1050000	
		Maximum	1890000	
	Brewers Mash	Mean	1088666	49048
		Std. Deviation	84954	
		Minimum	1012000	
		Maximum	1180000	
	Rice polishing	Mean	1056666	64128
		Std. Deviation	111073	
		Minimum	960000	
		Maximum	1178000	

Appendix 9: Raw data for feed intake, ADG, DMI, MeBW and FCR

District	Fintake	Trt	W1	W2	W3	W4	W5	Wtchange	ADG	FCR	DMI	MeBW	g/kgW $^{0.75}$
Misungwi	8	1	209.97	218.79	227.75	236.15	246.79	36.82	0.66	12.17	7.41	62.27	119.01
Misungwi	8	1	238.14	246.54	255.68	264.62	273.62	35.48	0.63	12.63	7.41	67.28	110.15
Misungwi	8	1	208.33	216.03	225.65	233.81	241.32	32.99	0.59	13.58	7.41	61.23	121.03
Misungwi	8	1	240.16	249.65	257.71	265.75	274.79	34.63	0.62	12.94	7.41	67.49	109.80
Misungwi	8	1	166.31	174.72	182.68	190.72	199.24	32.93	0.59	13.60	7.41	53.03	139.73
Misungwi	8	1	187.03	195.26	204.50	213.69	221.06	34.03	0.61	13.17	7.41	57.33	129.26
Misungwi	8	1	228.79	236.09	244.91	253.07	262.67	33.89	0.61	13.22	7.41	65.25	113.57
Misungwi	8	1	151.85	160.58	168.45	176.98	185.58	33.73	0.60	13.28	7.41	50.28	147.38
Misungwi	8	1	156.06	164.62	172.56	181.09	190.70	34.64	0.62	12.93	7.41	51.32	144.40
Misungwi	8	1	180.30	188.23	196.06	204.02	212.63	32.34	0.58	13.85	7.41	55.68	133.08
Misungwi	8	1	213.33	222.58	230.56	238.47	246.06	32.72	0.58	13.69	7.41	62.13	119.28
Misungwi	8	1	184.77	192.60	200.42	208.13	217.06	32.28	0.58	13.88	7.41	56.55	131.04
Misungwi	8	1	218.70	227.08	235.04	243.42	251.06	32.36	0.58	13.85	7.41	63.07	117.49
Misungwi	8	1	250.05	258.25	266.05	274.72	282.56	32.52	0.58	13.78	7.41	68.92	107.52
Misungwi	8	1	160.34	168.34	176.07	184.52	192.58	32.24	0.58	13.90	7.41	51.70	143.35
Misungwi	8	1	171.23	179.37	187.06	195.32	203.58	32.34	0.58	13.85	7.41	53.89	137.50

Misungwi	8	1	257.13	265.07	273.51	281.35	299.07	41.94	0.75	10.68	7.41	71.92	103.04
Misungwi	8	1	253.07	260.42	269.38	277.61	285.05	31.99	0.57	14.01	7.41	69.37	106.82
Misungwi	8	1	203.65	211.35	219.48	227.06	236.03	32.37	0.58	13.84	7.41	60.22	123.06
Misungwi	8	1	254.02	262.83	270.56	278.24	286.07	32.05	0.57	13.98	7.41	69.56	106.53
Misungwi	8	2	221.64	232.56	243.80	254.62	265.79	44.14	0.79	10.15	7.44	65.83	113.10
Misungwi	8	2	220.81	232.93	244.69	256.31	268.07	47.26	0.84	9.48	7.44	66.25	112.37
Misungwi	8	2	207.31	218.51	230.83	243.01	255.05	47.74	0.85	9.38	7.44	63.82	116.65
Misungwi	8	2	228.42	240.18	252.22	264.70	276.32	47.90	0.86	9.35	7.44	67.77	109.85
Misungwi	8	2	263.40	275.05	287.09	299.41	311.17	47.77	0.85	9.38	7.44	74.09	100.49
Misungwi	8	2	291.55	299.25	306.53	314.09	325.99	34.44	0.62	13.01	7.44	76.72	97.04
Misungwi	8	2	276.67	287.85	298.66	309.37	320.79	44.12	0.79	10.15	7.44	75.80	98.22
Misungwi	8	2	261.81	272.35	283.56	295.86	306.31	44.50	0.79	10.07	7.44	73.22	101.68
Misungwi	8	2	247.49	258.39	269.37	280.52	291.59	44.09	0.79	10.16	7.44	70.56	105.51
Misungwi	8	2	316.19	327.80	338.67	349.68	360.68	44.48	0.79	10.07	7.44	82.76	89.95
Misungwi	8	2	300.58	311.47	322.79	333.65	345.83	45.26	0.81	9.90	7.44	80.20	92.83
Misungwi	8	2	253.07	264.56	275.09	286.58	298.03	44.97	0.80	9.96	7.44	71.73	103.79
Misungwi	8	2	229.11	240.51	252.51	263.56	274.08	44.97	0.80	9.96	7.44	67.36	110.52
Misungwi	8	2	241.09	260.09	271.58	283.25	294.56	53.47	0.95	8.38	7.44	71.10	104.71
Misungwi	8	2	205.99	216.58	227.69	238.66	249.05	43.05	0.77	10.41	7.44	62.69	118.75
Misungwi	8	2	281.58	292.78	303.83	314.68	326.65	45.07	0.80	9.94	7.44	76.83	96.89
Misungwi	8	2	226.33	237.35	248.62	259.52	270.06	43.74	0.78	10.24	7.44	66.62	111.75
Misungwi	8	2	244.52	255.47	267.03	278.43	289.52	45.00	0.80	9.96	7.44	70.19	106.07
Misungwi	8	2	243.30	254.64	265.65	276.06	287.02	43.73	0.78	10.25	7.44	69.73	106.76
Misungwi	8	2	293.75	304.56	315.58	326.41	337.83	44.08	0.79	10.16	7.44	78.80	94.48
Misungwi	9	3	228.01	235.85	243.83	252.09	260.21	32.20	0.58	15.65	8.36	64.79	128.98
Misungwi	9	3	208.03	215.73	223.57	231.83	238.39	30.36	0.54	16.60	8.36	60.67	137.74
Misungwi	9	3	204.12	211.96	220.08	228.20	235.34	31.22	0.56	16.14	8.36	60.09	139.08
Misungwi	9	3	254.26	261.54	269.94	278.20	285.78	31.52	0.56	15.99	8.36	69.51	120.23
Misungwi	9	3	244.06	252.04	259.60	268.00	275.28	31.22	0.56	16.14	8.36	67.58	123.65
Misungwi	9	3	250.93	259.05	266.19	274.31	281.31	30.38	0.54	16.59	8.36	68.69	121.66
Misungwi	9	3	240.43	250.23	258.07	266.33	274.33	33.90	0.61	14.87	8.36	67.41	123.97
Misungwi	9	3	226.53	234.09	242.35	249.91	256.91	30.38	0.54	16.59	8.36	64.17	130.23
Misungwi	9	3	223.56	231.68	239.94	247.78	254.78	31.22	0.56	16.14	8.36	63.77	131.04
Misungwi	9	3	363.83	371.95	379.65	387.79	395.79	31.96	0.57	15.77	8.36	88.73	94.17
Misungwi	9	3	265.98	273.96	282.08	289.36	297.36	31.38	0.56	16.06	8.36	71.61	116.70
Misungwi	9	3	235.20	243.32	251.30	259.56	267.56	32.36	0.58	15.57	8.36	66.16	126.32
Misungwi	9	3	298.29	306.13	314.39	323.49	330.49	32.20	0.57	15.65	8.36	77.51	107.81
Misungwi	9	3	209.97	217.25	225.09	232.79	240.07	30.10	0.54	16.74	8.36	60.99	137.01
Misungwi	9	3	219.15	227.55	234.95	242.65	250.07	30.92	0.55	16.30	8.36	62.89	132.88
Misungwi	9	3	322.04	329.46	337.58	345.56	352.56	30.52	0.55	16.51	8.36	81.36	102.71
Misungwi	9	3	237.57	245.51	253.63	261.47	268.61	31.04	0.55	16.24	8.36	66.35	125.94
Misungwi	9	3	267.59	275.43	283.69	291.39	298.39	30.80	0.55	16.36	8.36	71.79	116.39
Misungwi	9	3	222.81	229.95	237.87	245.99	253.09	30.27	0.54	16.65	8.36	63.45	131.70
Misungwi	9	3	194.23	201.93	209.91	217.47	224.47	30.24	0.54	16.67	8.36	57.99	144.10
Misungwi	8.5	4	283.95	292.07	300.05	306.91	309.91	25.96	0.46	18.34	7.84	73.86	106.09
Misungwi	8.5	4	203.41	209.57	215.45	221.47	227.47	24.06	0.43	19.78	7.84	58.57	133.79
Misungwi	8.5	4	238.19	244.91	251.49	257.79	263.79	25.60	0.46	18.59	7.84	65.46	119.72
Misungwi	8.5	4	261.49	267.09	272.97	279.69	285.69	24.20	0.43	19.67	7.84	69.49	112.77
Misungwi	8.5	4	262.24	268.84	274.72	281.44	287.44	25.20	0.45	18.89	7.84	69.81	112.25
Misungwi	8.5	4	303.34	309.64	316.50	323.08	329.09	25.75	0.46	18.49	7.84	77.27	101.42
Misungwi	8.5	4	283.65	289.53	295.55	302.27	308.27	24.62	0.44	19.33	7.84	73.57	106.51
Misungwi	8.5	4	232.30	238.18	244.34	250.36	256.36	24.06	0.43	19.78	7.84	64.07	122.31
Misungwi	8.5	4	200.55	207.12	213.19	219.35	226.35	25.80	0.46	18.45	7.84	58.36	134.28
Misungwi	8.5	4	244.06	249.94	255.96	262.82	268.82	24.76	0.44	19.22	7.84	66.39	118.04
Misungwi	8.5	4	235.20	241.92	248.56	255.36	261.67	26.47	0.47	17.98	7.84	65.06	120.45
Misungwi	8.5	4	214.17	220.29	227.01	233.83	239.83	25.66	0.46	18.55	7.84	60.94	128.58
Misungwi	8.5	4	284.88	290.72	296.74	302.90	308.90	24.02	0.43	19.82	7.84	73.68	106.35
Misungwi	8.5	4	283.56	289.16	296.00	302.86	308.86	25.30	0.45	18.81	7.84	73.68	106.36
Misungwi	8.5	4	297.15	302.87	309.73	316.54	322.54	25.39	0.45	18.75	7.84	76.11	102.96
Misungwi	8.5	4	254.02	259.90	265.50	271.66	277.66	23.64	0.42	20.14	7.84	68.02	115.20
Misungwi	8.5	4	321.23	327.11	333.35	340.07	346.07	24.84	0.44	19.16	7.84	80.24	97.66
Misungwi	8.5	4	269.74	276.32	282.48	288.20	294.20	24.46	0.44	19.46	7.84	71.04	110.31
Misungwi	8.5	4	325.19	330.97	336.85	342.87	348.87	23.68	0.42	20.10	7.84	80.72	97.08
Misungwi	8.5	4	274.40	280.02	286.04	292.90	298.98	24.58	0.44	19.36	7.84	71.90	108.99
nyagana	8	1	237.57	243.35	250.07	256.85	269.76	32.19	0.57	13.92	7.41	66.56	111.33
nyagana	8	1	195.08	203.48	211.60	219.86	227.86	32.78	0.59	13.67	7.41	58.65	126.36
nyagana	8	1	196.28	204.40	212.66	221.76	230.76	34.48	0.62	12.99	7.41	59.21	125.16
nyagana	8	1	168.54	176.52	184.78	194.58	202.58	34.04	0.61	13.16	7.41	53.70	138.00
nyagana	8	1	211.73	219.65	227.91	236.47	244.47	32.74	0.58	13.68	7.41	61.83	119.86
nyagana	8	1	204.22	211.08	219.20	227.72	235.72	31.50	0.56	14.22	7.41	60.16	123.18
nyagana	8	1	197.63	205.61	213.87	222.41	230.41	32.78	0.59	13.67	7.41	59.14	125.30
nyagana	8	1	188.08	196.62	205.30	214.12	222.12	34.04	0.61	13.16	7.41	57.54	128.80
nyagana	8	1	183.55	191.39	199.51	208.05	216.05	32.50	0.58	13.78	7.41	56.35	131.50

nyagana	8	1	217.70	225.82	234.36	243.04	252.04	34.34	0.61	13.05	7.41	63.26	117.15
nyagana	8	1	206.87	214.99	222.83	231.79	239.86	32.99	0.59	13.58	7.41	60.95	121.58
nyagana	8	1	206.90	215.52	224.34	233.30	241.98	35.09	0.63	12.77	7.41	61.35	120.78
nyagana	8	1	177.34	185.18	193.72	202.54	210.54	33.20	0.59	13.49	7.41	55.27	134.07
nyagana	8	1	220.23	210.21	218.47	227.01	255.56	35.33	0.63	12.68	7.41	63.92	115.94
nyagana	8	1	208.33	216.45	224.85	233.39	241.39	33.06	0.59	13.55	7.41	61.24	121.00
nyagana	8	1	132.25	141.35	151.99	163.05	172.55	40.30	0.72	11.12	7.41	47.61	155.65
nyagana	8	1	229.13	237.25	244.81	253.37	261.37	32.24	0.58	13.90	7.41	65.00	114.00
nyagana	8	1	215.20	223.18	231.44	240.40	248.40	33.20	0.59	13.49	7.41	62.57	118.43
nyagana	8	1	192.00	200.12	208.38	217.06	225.07	33.07	0.59	13.55	7.41	58.11	127.53
nyagana	8	1	188.16	196.14	204.82	213.64	219.64	31.48	0.56	14.23	7.41	57.05	129.88
nyagana	10	2	317.75	325.87	334.15	343.25	354.25	36.50	0.65	15.34	9.31	81.66	113.97
nyagana	10	2	297.92	307.72	318.36	329.42	340.42	42.50	0.76	13.18	9.31	79.25	117.42
nyagana	10	2	311.36	322.14	333.23	344.12	355.12	43.76	0.78	12.80	9.31	81.81	113.76
nyagana	10	2	262.44	273.50	284.14	295.34	306.44	44.00	0.79	12.73	9.31	73.24	127.06
nyagana	10	2	268.56	276.96	287.60	297.40	309.77	41.21	0.74	13.59	9.31	73.84	126.03
nyagana	10	2	294.35	305.13	316.17	327.09	338.46	44.11	0.79	12.70	9.31	78.91	117.93
nyagana	10	2	317.75	328.57	339.43	349.49	360.65	42.89	0.77	13.06	9.31	82.76	112.45
nyagana	10	2	311.17	319.63	329.69	339.51	351.62	40.45	0.72	13.84	9.31	81.20	114.61
nyagana	10	2	299.70	310.62	321.68	330.64	341.62	41.92	0.75	13.36	9.31	79.46	117.11
nyagana	10	2	282.24	292.88	303.80	314.54	325.67	43.43	0.78	12.89	9.31	76.66	121.39
nyagana	10	2	265.35	275.17	285.03	295.45	306.62	41.27	0.74	13.57	9.31	73.27	127.00
nyagana	10	2	288.25	297.21	307.01	317.43	328.86	40.61	0.73	13.79	9.31	77.23	120.50
nyagana	10	2	296.19	305.15	315.61	325.85	336.83	40.64	0.73	13.78	9.31	78.62	118.36
nyagana	10	2	312.28	322.84	331.24	342.44	353.62	41.35	0.74	13.54	9.31	81.55	114.12
nyagana	10	2	321.46	332.52	344.14	353.24	364.56	43.10	0.77	12.99	9.31	83.43	111.54
nyagana	10	2	284.05	294.97	306.17	317.51	328.33	44.27	0.79	12.65	9.31	77.13	120.65
nyagana	10	2	285.61	296.33	307.67	319.39	330.68	45.07	0.80	12.43	9.31	77.55	120.01
nyagana	10	2	295.12	306.08	315.04	323.72	335.05	39.93	0.71	14.03	9.31	78.31	118.83
nyagana	10	2	332.71	341.67	352.31	362.93	373.24	40.54	0.72	13.81	9.31	84.92	109.59
nyagana	10	2	312.28	321.24	330.34	339.02	351.02	38.74	0.69	14.46	9.31	81.10	114.75
nyagana	9	3	285.43	294.25	302.83	311.51	318.56	33.13	0.59	15.21	8.36	75.40	110.82
nyagana	9	3	259.00	265.86	273.00	280.28	287.78	28.79	0.51	17.51	8.36	69.87	119.60
nyagana	9	3	217.40	224.56	231.98	239.40	247.44	30.04	0.54	16.78	8.36	62.39	133.94
nyagana	9	3	238.14	245.65	252.47	259.71	266.54	28.40	0.51	17.75	8.36	65.97	126.68
nyagana	9	3	285.61	292.53	299.67	306.81	313.19	27.58	0.49	18.28	8.36	74.45	112.25
nyagana	9	3	332.71	339.83	347.07	353.99	360.46	27.76	0.50	18.16	8.36	82.73	101.01
nyagana	9	3	221.90	228.76	235.88	243.12	250.34	28.44	0.51	17.72	8.36	62.94	132.78
nyagana	9	3	168.56	175.98	183.10	189.96	196.34	27.78	0.50	18.14	8.36	52.45	159.32
nyagana	9	3	203.13	210.05	217.13	224.41	232.65	29.52	0.53	17.07	8.36	59.57	140.28
nyagana	9	3	259.21	266.14	273.26	280.68	287.55	28.34	0.51	17.79	8.36	69.83	119.67
nyagana	9	3	306.80	313.62	320.74	328.02	335.29	28.49	0.51	17.69	8.36	78.35	106.65
nyagana	9	3	253.07	260.29	267.37	274.25	281.46	28.40	0.51	17.75	8.36	68.72	121.61G
nyagana	9	3	269.74	276.98	284.40	291.62	298.64	28.90	0.52	17.44	8.36	71.84	116.32
nyagana	9	3	290.36	297.22	304.08	311.34	318.62	28.26	0.50	17.83	8.36	75.42	110.81
nyagana	9	3	305.56	312.34	319.76	326.90	334.02	28.46	0.51	17.71	8.36	78.13	106.95
nyagana	9	3	229.40	236.32	243.44	250.86	257.28	27.88	0.50	18.08	8.36	64.24	130.08
nyagana	9	3	260.25	267.49	274.63	281.89	288.34	28.09	0.50	17.94	8.36	69.97	119.42
nyagana	9	3	280.32	287.58	294.44	301.58	308.42	28.10	0.50	17.93	8.36	73.60	113.54
nyagana	9	3	303.24	310.08	317.50	324.76	331.35	28.11	0.50	17.93	8.36	77.66	107.60
nyagana	9	3	325.19	332.11	339.67	346.53	353.57	28.38	0.51	17.76	8.36	81.54	102.49
nyagana	8.5	4	212.42	219.26	226.54	233.96	239.34	26.93	0.48	17.68	7.84	60.85	128.78
nyagana	8.5	4	211.79	218.09	224.67	231.53	237.86	26.07	0.47	18.26	7.84	60.57	129.38
nyagana	8.5	4	173.26	178.86	185.16	191.74	197.68	24.42	0.44	19.49	7.84	52.72	148.64
nyagana	8.5	4	200.79	207.37	213.53	220.25	226.24	25.45	0.45	18.70	7.84	58.33	134.33
nyagana	8.5	4	192.08	198.38	205.06	211.92	217.65	25.57	0.46	18.62	7.84	56.66	138.29
nyagana	8.5	4	271.79	227.67	283.97	290.83	296.87	25.08	0.45	18.98	7.84	71.52	109.57
nyagana	8.5	4	174.88	180.90	187.06	193.92	199.42	24.54	0.44	19.40	7.84	53.07	147.67
nyagana	8.5	4	193.75	200.17	207.05	214.19	220.56	26.81	0.48	17.75	7.84	57.23	136.92
nyagana	8.5	4	197.63	203.79	210.65	216.81	222.45	24.82	0.44	19.18	7.84	57.60	136.04
nyagana	8.5	4	205.41	211.29	217.31	224.03	230.58	25.17	0.45	18.91	7.84	59.17	132.43
nyagana	8.5	4	234.74	240.60	247.32	254.04	260.32	25.59	0.46	18.60	7.84	64.81	120.91
nyagana	8.5	4	205.72	211.78	218.50	225.38	231.72	26.00	0.46	18.31	7.84	59.39	131.94
nyagana	8.5	4	266.56	272.44	279.26	285.98	291.76	25.20	0.45	18.89	7.84	70.59	111.00
nyagana	8.5	4	247.86	253.74	259.80	265.96	271.47	23.61	0.42	20.17	7.84	66.88	117.17
nyagana	8.5	4	219.10	224.98	231.04	237.82	243.45	24.35	0.43	19.55	7.84	61.63	127.14
nyagana	8.5	4	203.65	209.81	216.39	223.11	229.72	26.07	0.47	18.26	7.84	59.01	132.80
nyagana	8.5	4	247.04	253.10	259.26	265.98	271.83	24.79	0.44	19.20	7.84	66.95	117.05
nyagana	8.5	4	189.12	195.42	201.58	208.30	214.32	25.20	0.45	18.89	7.84	56.01	139.89
nyagana	8.5	4	229.40	235.98	242.70	249.56	255.34	25.94	0.46	18.35	7.84	63.88	122.68
nyagana	8.5	4	243.55	249.73	256.29	263.15	269.15	25.60	0.46	18.59	7.84	66.45	117.93
magu	7.8	1	292.69	298.57	305.15	311.87	328.65	35.95	0.64	12.15	7.24	77.19	93.83
magu	7.8	1	315.92	322.78	329.85	336.99	344.89	28.97	0.52	15.08	7.24	80.03	90.49

magu	7.8	1	212.66	219.58	226.86	234.28	242.33	29.67	0.53	14.72	7.24	61.42	117.92
magu	7.8	1	278.89	285.67	292.79	300.35	308.06	29.17	0.52	14.98	7.24	73.53	98.49
magu	7.8	1	340.31	347.45	354.73	361.59	369.82	29.51	0.53	14.80	7.24	84.33	85.88
magu	7.8	1	214.58	215.14	222.98	231.52	249.34	34.76	0.62	12.57	7.24	62.75	115.42
magu	7.8	1	243.82	254.60	265.24	276.30	284.47	40.64	0.73	10.75	7.24	69.27	104.56
magu	7.8	1	229.40	239.20	249.84	260.62	269.44	40.03	0.71	10.91	7.24	66.50	108.90
magu	7.8	1	283.65	292.77	303.41	314.33	322.44	38.79	0.69	11.26	7.24	76.09	95.18
magu	7.8	1	280.32	290.96	300.76	311.68	319.51	39.19	0.70	11.15	7.24	75.57	95.83
magu	7.8	1	275.53	286.17	295.97	307.03	315.76	40.23	0.72	10.86	7.24	74.91	96.69
magu	7.8	1	313.97	323.09	333.51	344.43	352.79	38.81	0.69	11.25	7.24	81.40	88.97
magu	7.8	1	297.83	306.65	316.45	327.23	335.39	37.56	0.67	11.63	7.24	78.37	92.41
magu	7.8	1	261.61	270.29	280.93	291.85	300.33	38.72	0.69	11.28	7.24	72.14	100.39
magu	7.8	1	205.72	214.68	223.36	233.18	242.44	36.72	0.66	11.90	7.24	61.44	117.88
magu	7.8	1	180.90	189.86	198.96	209.60	218.82	37.93	0.68	11.52	7.24	56.89	127.29
magu	7.8	1	304.06	312.88	321.98	332.22	340.14	36.08	0.64	12.11	7.24	79.20	91.44
magu	7.8	1	265.69	274.65	285.29	296.21	304.42	38.73	0.69	11.28	7.24	72.88	99.37
magu	7.8	1	218.57	227.25	236.37	247.01	255.66	37.08	0.66	11.78	7.24	63.94	113.27
magu	7.8	1	226.53	235.49	245.29	255.93	264.93	38.40	0.69	11.37	7.24	65.67	110.29
magu	8.5	2	321.23	329.77	338.89	349.53	360.29	39.05	0.70	12.19	7.91	82.70	95.65
magu	8.5	2	364.98	376.18	387.52	399.14	410.50	45.52	0.81	10.46	7.91	91.20	86.74
magu	8.5	2	296.65	307.71	319.57	331.05	342.58	45.92	0.82	10.37	7.91	79.63	99.34
magu	8.5	2	317.75	329.09	340.91	352.95	363.46	45.70	0.82	10.42	7.91	83.24	95.03
magu	8.5	2	282.24	293.66	304.72	316.20	327.96	45.72	0.82	10.41	7.91	77.07	102.64
magu	8.5	2	358.84	369.90	380.54	392.14	403.43	44.58	0.80	10.68	7.91	90.02	87.87
magu	8.5	2	308.37	319.71	331.47	343.09	354.02	45.66	0.82	10.43	7.91	81.62	96.92
magu	8.5	2	250.05	261.25	272.73	283.79	295.78	45.74	0.82	10.41	7.91	71.32	110.90
magu	8.5	2	341.09	352.01	362.79	373.43	384.33	43.24	0.77	11.01	7.91	86.80	91.13
magu	8.5	2	323.38	334.84	345.76	356.82	367.09	43.71	0.78	10.89	7.91	83.86	94.32
magu	8.5	2	379.62	391.04	402.10	413.82	424.73	45.11	0.81	10.55	7.91	93.56	84.55
magu	8.5	2	324.89	336.23	347.19	358.67	369.76	44.87	0.80	10.61	7.91	84.32	93.81
magu	8.5	2	303.24	314.30	326.06	337.40	348.06	44.82	0.80	10.62	7.91	80.58	98.16
magu	8.5	2	341.18	352.66	363.86	375.20	386.56	45.39	0.81	10.49	7.91	87.18	90.73
magu	8.5	2	358.84	369.48	380.26	391.32	402.31	43.47	0.78	10.95	7.91	89.83	88.06
magu	8.5	2	384.40	395.32	406.10	417.16	428.63	44.23	0.79	10.76	7.91	94.20	83.97
magu	8.5	2	395.98	407.32	418.24	428.88	439.47	43.48	0.78	10.95	7.91	95.98	82.41
magu	8.5	2	430.08	441.14	451.92	462.56	473.65	43.57	0.78	10.93	7.91	101.53	77.91
magu	8.5	2	411.14	421.78	432.84	444.32	455.86	44.73	0.80	10.64	7.91	98.66	80.18
magu	8.5	2	369.00	379.68	390.60	402.02	413.09	44.09	0.79	10.80	7.91	91.63	86.33
magu	10	3	317.75	328.67	339.73	351.15	352.97	35.21	0.63	15.90	9.29	81.43	114.02
magu	10	3	288.25	295.11	302.25	309.53	323.47	35.21	0.63	15.90	9.29	76.27	121.73
magu	10	3	319.58	326.46	333.18	340.32	357.37	37.79	0.67	14.82	9.29	82.19	112.97
magu	10	3	386.45	393.17	400.29	407.71	422.09	35.64	0.64	15.71	9.29	93.12	99.71
magu	10	3	420.05	426.63	433.91	441.47	454.58	34.52	0.62	16.22	9.29	98.45	94.31
magu	10	3	434.54	441.26	448.38	455.66	466.42	31.89	0.57	17.56	9.29	100.37	92.51
magu	10	3	281.47	288.23	295.37	302.93	313.56	32.09	0.57	17.45	9.29	74.51	124.61
magu	10	3	288.25	295.37	302.19	309.33	316.32	28.07	0.50	19.95	9.29	75.01	123.79
magu	10	3	332.28	339.00	345.76	352.90	359.32	27.04	0.48	20.71	9.29	82.53	112.50
magu	10	3	312.28	319.14	326.28	333.60	340.76	28.48	0.51	19.66	9.29	79.31	117.07
magu	10	3	402.53	409.11	415.67	422.81	429.52	26.99	0.48	20.75	9.29	94.35	98.41
magu	10	3	380.31	387.13	394.25	401.67	408.56	28.25	0.50	19.82	9.29	90.88	102.17
magu	10	3	346.18	353.74	360.66	367.81	374.76	28.59	0.51	19.59	9.29	85.18	109.01
magu	10	3	325.19	332.31	339.13	345.87	352.52	27.34	0.49	20.48	9.29	81.36	114.13
magu	10	3	282.24	289.12	296.24	303.80	310.56	28.32	0.51	19.77	9.29	73.98	125.51
magu	10	3	406.82	413.12	419.84	427.26	434.42	27.60	0.49	20.29	9.29	95.15	97.58
magu	10	3	368.04	374.90	381.62	389.18	396.45	28.41	0.51	19.71	9.29	88.85	104.51
magu	10	3	339.40	346.52	353.38	360.52	367.81	28.41	0.51	19.71	9.29	83.99	110.55
magu	10	3	390.81	397.67	404.79	411.32	418.42	27.61	0.49	20.28	9.29	92.51	100.36
magu	8	3	389.78	396.36	403.18	410.46	417.46	27.68	0.49	16.18	7.43	92.36	80.43
magu	8	4	288.98	296.10	303.66	311.50	316.62	27.64	0.49	16.21	7.43	75.06	98.96
magu	8	4	272.54	278.84	284.72	290.88	296.59	24.04	0.43	18.63	7.43	71.47	103.93
magu	8	4	288.75	294.77	301.49	308.35	314.75	25.99	0.46	17.24	7.43	74.73	99.40
magu	8	4	296.32	302.90	308.78	314.94	320.25	23.92	0.43	18.73	7.43	75.70	98.12
magu	8	4	274.28	280.36	286.52	293.04	299.73	25.46	0.45	17.60	7.43	72.04	103.11
magu	8	4	304.21	310.79	317.51	323.53	329.42	25.21	0.45	17.77	7.43	77.32	96.06
magu	8	4	320.76	326.64	332.80	339.38	345.81	25.05	0.45	17.88	7.43	80.19	92.63
magu	8	4	400.52	406.54	412.56	418.16	424.44	23.91	0.43	18.73	7.43	93.51	79.44
magu	8	4	336.78	342.80	348.88	354.76	360.34	23.56	0.42	19.01	7.43	82.71	89.81
magu	8	4	352.39	358.69	364.71	370.87	376.39	24.00	0.43	18.67	7.43	85.45	86.93
magu	8	4	335.24	341.28	347.17	353.19	359.24	24.00	0.43	18.67	7.43	82.52	90.02
magu	8	4	368.91	375.13	381.15	387.19	393.79	24.87	0.44	18.01	7.43	88.40	84.03
magu	8	4	340.82	346.54	352.56	358.68	364.66	23.84	0.43	18.80	7.43	83.45	89.01
magu	8	4	306.47	312.39	318.43	324.71	330.87	24.40	0.44	18.36	7.43	77.58	95.75
magu	8	4	398.05	404.35	410.37	415.97	420.66	22.61	0.40	19.82	7.43	92.88	79.97

magu	8	4	402.82	408.60	414.68	420.56	425.88	23.05	0.41	19.43	7.43	93.75	79.23
magu	8	4	276.42	282.44	288.48	294.20	300.56	24.14	0.43	18.56	7.43	72.19	102.90
magu	8	4	312.72	318.86	324.88	330.76	336.25	23.52	0.42	19.05	7.43	78.52	94.60
magu	8	4	286.19	292.07	298.09	304.25	310.65	24.45	0.44	18.32	7.43	73.99	100.39
magu	8	4	292.93	299.27	305.35	311.65	317.82	24.89	0.44	18.00	7.43	75.27	98.68

Appendix 10: Gross Margins per dietary treatment (12 feedlots)

	Treatments	Total Cost	Total Revenue	Total Gross Margin	GM/animal
Misungwi	T1	3450	5000	1460	73
Misungwi	T2	4210	6100	1890	94
Misungwi	T3	3988	5000	1012	50
Misungwi	T4	3768	4800	1032	51.6
Nyamagana	T1	5210	7000	1790	89
Nyamagana	T2	5440	7000	1560	78
Nyamagana	T3	3926	5000	1074	53.7
Nyamagana	T4	3822	5000	1178	58
Magu	T1	4000	5000	1000	50
Magu	T2	3950	5000	1050	52
Magu	T3	4020	5200	1180	59
Magu	T4	4140	5100	960	48
Average	T1	4220	5666.6	1416.6	70.83
Average	T2	4533.3	6033.3	1570	78.5
Average	T3	3978	5066.6	1088.6	54.40
Average	T4	3910	4966.6	1056.6	52.83

Appendix 11: Cost of gain relative to Gross margin per dietary treatment

Item	T1	T2	T3	T4
Cost of gain (Tshs)	1310	2542	865	1402
Profit margin (Tshs)	70830	78500	54400	52830
Gain/day	0.60	0.78	0.53	0.44