COMMUNAL CATTLE HUSBANDRY PRACTICES AND THEIR IMPACT ON MARKET PARTICIPATION: a case study of FSP farmers from Zambezi region in Namibia

By

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DECLARATION

I, Clifford Lubinda Akashambatwa, declare that “Communal Livestock Husbandry Practices And Their Impact On Market Participation: A Case Study From Zambezi Region In Namibia” is my own original work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references and this is my own independent work and that the thesis has not been previously submitted at any university or other higher education institution for the award of a degree.

Clifford Lubinda Akashambatwa **Date**

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ABSTRACT

Cattle play an important socio-economic role in the livelihood of communal farmers in Namibia. This study examines the socio-economic determinants of adoption of improved livestock management practices among communal livestock farmers in Zambezi region, Namibia. The main objective of the study was to explore the effect adoption of GIZ introduced livestock management practices on cattle production in the Zambezi region, the specific objectives were to conduct situational analysis of the livestock management practices in Zambezi region and examine factors influencing adoption of the newly introduced livestock management practices. Data for the study were obtained from a survey of a sample of 86 communal livestock farmers who are benefiting from the Farmer Support Project (FSP) in the Zambezi region. Descriptive statistics and a multi-logistic regression model were employed to analyse the data. Most respondents (48%) had secondary education, which is a significant factor in determining probability of adoption of improved agricultural management practices. 35% of the respondent's herd sizes ranged between 11 to 30 cattle, which was the highest and herd composition were mainly consisting of cows (34%), heifers (22%) and oxen (26%). The results revealed that about eight out of thirteen livestock management practices disseminated to farmers were adopted and in practice. Castration, tick control, branding and vaccination were the most adopted technologies. Multi-logistic regression model analysis indicated that probability of adoption of livestock management technologies increased with education, financial assistance, advice, total cattle owned, total cattle sales and experience. The study presented a very low off-take rate of 1.5%. Oxen older than 36 months were the most sold and the second most sold were cows 56% and 29% respectively. The findings imply that in order to increase adoption of improved technologies, access to education, financial assistance, and training in animal management practices should be enhanced. The empirical results showed that education, financial assistance, advice and total cattle owned were significant at 5%, 5%, 10%, and 10% respectively.

Key words: adoption, livestock management practices, multi-logistic regression model, socio-economic factors, weaners, communal areas, productivity.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

ADC	Agricultural Development Centre
ARDC	Agricultural Rural Development Centres
CLDP	Communal Land Development Project
DEES	Directorate of Engineering and Extension Services
DVS	Directorate of Veterinary Services
FED	Farmer Extension and Development
FMD	Foot and Mouth Disease
FSP	Farmers Support Project
GDP	Gross Domestic Product
GIZ	Dutsche Gesellschaft fur Internationale Zusammenasbeit
HHS	House Hold Size
LSU	Large Stock Unit
MAWF	Ministry Of Agriculture, Water and Forestry
MVA	Multivariate Analysis
NAP	Namibia Agriculture Policy
NCA	Northern Communal Areas
NNFU	Namibia National Farmers Union
NSA	Namibia Statistic Agency
SADC	Southern Africa Development Community
SPSS	Statistical Package of Social Sciences

SVCF	South of Veterinary Cordon Fence
VCF	Veterinary Cordon Fence

CHAPTER 1

1. INTRODUCTION

1.1 BACKGROUND

Namibia is a well-known livestock producing country as livestock forms an important asset for most households by being a store of wealth as well as food in terms of meat and milk and can be sold or bartered in times of need. The agriculture subsector's contribution to the national economy is well articulated in the country's Vision 2030 and the National Development Plan 4 (NDP4). According to Namibia National Farmers' Union [NNFU] (2006) and Sherbourne (2010) on average, 40% of households in Namibia own cattle. In terms of its contribution to the GDP, the agriculture subsector has been varying over time from 16.1% in1976, declined to 8.7% in 1981 (Harrison 1983) and 6.1% in 2000 down to 3.7% in 2014 (Namibia Economic Outlook, 2015). While the general contribution by the agriculture sector to GDP has been declining, the livestock farming sub sector has maintained an average contribution of 2.6% to GDP (Namibia Economic Outlook, 2015).

According to the National Household Survey of 2013/14 livestock farming's contribution to value addition in agriculture was 40% in 2001, but it increased to 60% in 2014, which accounting for 200,000 jobs, this statistics shows the possibility and potential of agriculture to integrate to value addition in the economy. The same survey showed that in 2012, agriculture and forestry's (excluding fishing and hunting) output contributed 5.5% of the GDP in 2012 but remained subdued in 2013 due to protracted drought conditions during the year. The sector's contribution swings from year to year are attributed to climatic conditions, drought and the general trends in the international markets during the period. This is also worsened by shrinking inventories in livestock, rapid increase in input costs, particularly feed and poor grazing conditions in the Northern Communal Areas. However, given that as for Namibia about one third of agriculture's contribution to GDP emanates from the

communal areas hence the potential role of the sector needs not to be over emphasized.

Beef industry in Namibia is the main agricultural production sector in the country, with the value of production estimated at an annual $90 million, of which approximately $45 million is contributed by cattle weaner exports. The average number of cattle was estimated at around 2.3 million in 2011 (Teweldemedhin and Mbai, 2012). The sector's contribution to the economy is estimated at about 75% to the total agricultural economy, 69% of which is estimated to be from commercial livestock production (Emongor, 2007 cited in Teweldemedhin and Mbai, 2012). Beef production is the most important part of the sector, followed by small stock (sheep and goat) production.

The sector is divided by fences known as the Northern Veterinary Cordon Fence (NVCF) and the Southern Veterinary Cordon Fence (SVCF) due to common occurrences of Foot and Mouth Disease in the northern part of the country. It is not allowed to transport animals or meat to the south, from the NVCF to the SVCF (Teweldemedhin and Mbai, 2012).

The sector can be categorised into commercial and communal sectors. The commercial farming sector constitutes approximately 4,200 farmers and occupies 44% of the arable land, whereas communal farmers account for 41% of the agricultural land and are estimated to make up 67% of the total population, 90 % of who are dependent on subsistence agriculture for their livelihood (Emongor, 2007 cited in Teweldemedhin and Mbai, 2012). It is estimated that 221 418 head of cattle were marketed during the first three quarters of 2011. Total marketing increased by 12.8 % in the first half of 2011 compared to the five-year average marketing and this can be attributed to the increase in the exports of weaners by 36.9 %. The total slaughtering in the SVCF has decreased by 13.7 % compared to the 5-year average (Schutz, 2011). Thus this can be attributed to factors such as diseases, bush encroachment, the establishment of wildlife conservancies and wildlife farming (Teweldemedhin and Mbai, 2012). The latest report of 2013 and 2014 shows that it only contributed about 11.4% and 7.3 % from the Northern Communal Areas (NCA) respectively (MAWF, 2015). The trend is indicative of low level of productivity by the livestock sector in the communal areas. Productivity of the livestock sector in the

communal areas is constrained mainly by high frequency of drought, overgrazing leading and poor grazing, low calving percentage, low off-take rate, traditional farming practices, as well as prevalence of foot and mouth disease in the NCA (MAWF, 2015). The sector however remains very critical in terms of its forward and backward linkages with other economic sub sectors, and particularly in terms of the number of people it provides with subsistence in one form of one kind or another. Zambezi region is one of the regions whose livestock are affected by the foot and mouth disease and the livestock and meat products face some restrictions.

According to Namibia Statistics Agency (NSA 2015) more than 50% of the households in the Zambezi region own livestock. Livestock contributes significantly to households in terms of food and cash as well as for ploughing, transport and as a form of store of wealth (Ashley, 2003). The livestock production system in Zambezi region just like in most communal areas is mainly based on pastoralism and agro-pastoralism as the majority of households are subsistence farmers. This production system influences the production objectives of livestock owners which ultimately are more diverse than in commercial livestock production. The livestock production function is satisfied by herd maximisation rather than maximising off-take and profit (Sweet, 1997). To shift the production function more towards maximization of off-take and profit among NCA farmers, government has introduced a raft of initiatives for improving the performance of the sector. Some of the interventions are research on livestock breeding, rangeland management, livestock infrastructure provision and provision of extension services. The Directorate of Extension is mandated to provide agriculture extension services in the form of advisory, information communication, and training services aimed at empowering farmers, encouraging the adoption of improved agricultural and related income generating technologies and practices which will improve livestock production (MWAF (National Agriculture Policy), 2015). The golden thread running through the initiatives is the need to increase and sustain the levels of livestock sector's productivity taking into consideration Namibia's fragile ecosystem.

There has been mixed results in terms of the success of the interventions and the adoption of the introduced farming practices. Generally, observed low rates of adoption of cattle management practices such as winter supplementary feeding, effective control of internal and external parasites, culling and selection have been

noted by stakeholders in the livestock sector among which is GIZ (Nowers *et al*,. 2013). One of the interventions being implemented is the Farmers Support Programme (FSP) technically and financially supported by the Federal Republic of Germany through the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and co-funded by the AgriBank of Namibia in partnership with the Namibia Agricultural Union (NAU), the Namibia Emerging Commercial Farmers' Union (NECFU) and the Namibia National Farmers' Union (NNFU). The initiative's goal is supporting farmers to improve rangeland and grazing, adoption of better livestock husbandry practices, infrastructure development and market participation. The initiative started in 2011 and so far 400 beneficiary in the NCA, which including Zambezi region.

It is against this background that a case study was conducted in Zambezi region in the Linyanti-Sibbinda polygon area to assess and examine the existing livestock husbandry practices. The idea was to determine the levels of adoption of the newly introduced livestock management practices and whether that has led to improved livestock production in terms of livestock management and off-take rates among the communal farmers.

1.2 STATEMENT OF THE PROBLEM

Despite national policies and strategies having been put in place to support the livestock subsector, market participation by smallholder cattle farmers from the NCA and from Zambezi region in particular remains subdued. This is evidenced by MeatCo closing down its abattoirs in Katima Mulilo and Oshakati due to viability challenges. Furthermore, there is low off-take in the NCA such that in 2013 of all the cattle sold through formal markets only 11.40% came from the Northern Communal Areas (NCA) with only 7.3 % coming from the Northern Communal Areas in 2014 (MAWF, 2015). This is despite the fact that 44 % of the national herd is found in the NCA (NNFU, 2006 and Sherbourne, 2010). As for the Zambezi region despite it being home to an estimated 151 765 cattle, annual off-take of cattle in the region between 2013 and 2014 was estimated at only 10%, which is below the national average off-take (NSA, 2015). The two abattoirs that were opened in the early 90s at Katima Mulilo and Oshakati have been incurring losses estimated to be about N$354

million and were operating at below 60 % capacity due to low volumes of slaughter livestock (The Namibian, 2016).

While several initiatives have been implemented to solve low off-take challenges there is dearth of evidence in terms of the new trajectories. Researchers are keen to understand how far have the initiative by GIZ and its partners gone to improve calving and off-take percentages and rangeland management. The interventions were premised on the understanding that the low off-take in the NCA regions, Zambezi region included, will be improved through the four main programming strategies. For that reason this study seeks to explore whether the adoption of the newly introduced livestock husbandry and management practices has led to improved livestock situation in Zambezi region.

1.3 JUSTIFICATION

Cattle rearing and marketing plays a significant role to many rural communities by contributing to family food supplies and provides critical support to agriculture production. Cattle farming is important for rural area farmers, and Zambezi region farmers are no exception. Cattle farming provide milk, meat, hides and income to meet family financial need as well as a source of employment, collateral and insurance against natural calamities (Musemwa *et al*, 2008).

The study will be beneficial to various stakeholders in the livestock industry, such as the livestock farmers in the Zambezi region, by gaining new knowledge on improved cattle management practices which can positively improve production and viability of their cattle production. Ministry of Agriculture, Water and Forestry, sub-division of extension services stands to benefit from information on how best to service the cattle farming communities by being informed on how best to provide the services required in order for the farmers to improve productivity. Institutions of higher learning will also benefit as the study results are likely to open new community demanded research niches. Further still the results can be incorporated into teaching of agriculture courses. The study will enlighten the stakeholders about the economic importance and benefits associated with the adoption and implementation of semi-commercial practices. The study will enlighten stakeholders like GIZ, FSP and CLDP

about how best to improve their programming and how they are likely to improve level of adoption of improved livestock management practices by the farmers.

1.4 RESEARCH OBJECTIVES

The aim of the study is to explore the effect adoption of GIZ introduced livestock management practices on cattle production in the Zambezi region. The specific objectives of the study are to:

- Conduct situational analysis of the livestock management practices in Zambezi region'
- Examine factors influencing adoption of the newly introduced livestock management practices

1.5 RESEARCH HYPOTHESIS

- H_a: Farmers with high level of education have a high level of adoption of semi-commercial practices
- H_a: The number of cattle the farmer owns has a positive influence on adoption of semi-commercial practices

1.8 ORGANIZATION OF THE THESIS

The entire study is presented in seven chapters. Chapter two provides literature review on livestock dynamics and marketing discussions. Chapter three presents the industry back ground and chapter four presents methodology used in the study. This chapter also gives a detailed profile of the study area where the baseline study was conducted. Chapter five and six presents the results of the situational analysis and empirical results on the factors influencing adoption of technologies respectively. Chapter seven provides the conclusions and recommendations based on the outcome of the study.

CHAPTER 2: Overview of Cattle production systems in African context

2.1 Introduction

In this chapter literature about livestock husbandry in Africa is reviewed. The literature being reviewed pertains to work done in the context of livestock production, which includes aspects such as cattle production, land management, reproduction and health management. The purpose is to ground the discussions in this study in the context of cattle production in Africa and how Namibia situation relates to this situation.

2.2 Cattle Production Systems

Cattle production systems operate on three principal models: extensive grazing, mixed farming, and industrial (or intensive) livestock production. Extensive grazing accounts for 9.3% of global meat production, mixed farming for 53.9%, and industrial livestock production for 36.8% (Seinfeld *et al*., 1997).

In extensive grazing systems, cattle herds subsist on inputs readily available from pasture areas. These systems occupy about one-quarter of the world‘s land, yet yield less than 10% of global meat production. In this type of system, production growth primarily is achieved by opening new grazing areas. However, when expansion of grazing land is not possible, further production growth is achieved by increasing the number of animals on a fixed area of land, thereby increasing the pressure on rangelands (Steinfeld *et al*., 1997)

Mixed farming systems integrate livestock and crop production, whereby each provides inputs used in the other: livestock consume crop residues while manure contributes to crop fertilization. When input requirements for production growth overwhelm on-farm capacity to supply feed, expansion depends on increased supplies of external inputs, particularly feed grain (Thomas and Barton, 1995). The

introduction of modern strains of high yielding crops into traditional systems presents another challenge to mixed farming. These crops generate between one-third and one-quarter as much non-grain biomass as traditional varieties, reducing the amount of waste products available to feed livestock.

Of the three main production systems, output from industrial or intensive livestock production is growing at the fastest rate (4.3% per year versus 2.2% for mixed systems and 0.7% for extensive systems) (Seré & Steinfeld, 1996). The intensive production model relies on inputs imported from outside, particularly concentrate feed grains, and therefore can be sustained on small units of land.

2.3 Off-take

Negassa and Jabbar (2008) defines off-take rate is usually defined as a percentage of sale or slaughter at the end or during a production cycle to the initial stock. Negassa and Jabbar (2008) noted that in smallholder mixed farming and pastoral systems, animals are kept for multiple functions and sale or other forms of disposal are not a common phenomenon, rather sales are sporadic based on immediate cash needs.

In literature different methods are used in calculating off-take rates for smallholder mixed farming and pastoral systems (Negassa & Jabbar, 2008). Sutter (1987) calculated cattle off-take as the total number of animal's sold, slaughtered plus ceremonial exchange transaction over a given period divided by total herd size. Negassa & Jabbar (2008) calculated off-take rate as net commercial off-take rate which is given as the sales minus purchases made by the households as a percentage of the average stock. Within rural communities, cattle owners do not sell very often they sell cattle mainly during festive seasons and the beginning of the school year (Nkosi & Kirsten, 1993). According to Nkosi & Kirsten (1993) & Duvel (2002), there is a clear preference or tendency among cattle farmers to sell their cattle when they are old. Cattle farmers prefer selling older cattle because the younger ones (females) are used for breeding purposes.

Therefore, to understand the off-take of small-scale farmers it is important to clearly understand the reasons why farmers sell, and also why they prefer certain marketing channels.

Table 2.1: Annual off-take rates in communal areas of Africa

Reference	Location	Sale rate	Slaughter rate	Off-take
Scholtz & Bester, 2010	Commercial sector in South Africa			32.3%
Scholtz & Bester, 2010	Communal sector in South Africa	4.11%	1.84%	6.07%
Scoones, 1992	Mazvihwa, southern Zimbabwe	0% - 7.8%	1% - 4.2%	5.7%
Nthakheni, 1993	Venda, South Africa	1.1%	0.8%	6%
Ainslie *et al*., 2002	Eastern Cape, South Africa			2%
Rocha *et al*., 1991	southern Mozambique			8%
Bembridge, 1987	Transkei, South Africa			6.9%
Perry *et al*., 1984	Zambia			10%
Tschopp *et al*., 2014	Sellale, central Ethiopia			31.4%

2.4 Land tenure and governance

To participate in agricultural markets, secure a livelihood in subsistence farming and compete as an entrepreneur in the rural non-farm economy, it is a prerequisite that a farmer must have three core assets, i.e. land, water and human capital (World Bank, 2007). The resource and environmental components of livestock systems, and local and regional competition for them, complete the picture of a highly complex setting for development interventions (Rich *et al*., 2009). The high value attached to land also means that there are strong demands for land, due mostly to the growing population, with more and more people needing a place to live and to produce food for subsistence purposes. Thus, the many different levels of authority and users complicate the use and control of much of the land. At the tribal level, each area is ruled by a chief, who is served by a number of sub-chiefs and headmen (Araki, 2005;

Tapscott, 1990). Households acquire the right to use arable land in their own tribal areas through the head of the household who makes a payment to the local headman or chief. Yet the assets of the rural poor are often squeezed by population growth, environmental degradation, expropriation by dominant interests, and social biases in policies and in the allocation of land.

2.5 Livestock and Rangeland management

2.5.1 Grazing management

Grazing management means controlling grazing animals on pasture. The two most important tools for influencing the level of animal output under grazing are: concentration of animals (stocking rate) and system of grazing management (Kasale, 2013). The closeness to which a pasture is grazed is defined as grazing pressure. Grazing pressure is affected by both the stocking rate (animals per acre) and the available forage (pounds of forage per acre). Grazing pressure affects not only animal performance but also the plant species in a pasture. Low animal intake and low gain rates. The biggest challenge faced in the pasture system is reliably estimating the carrying capacity of the land. If land is to be utilized for pasture, its use during the year must be maximized to provide the best compromise between yield of animal growth and forage nutrient yield (Chester-Jones, 1996).

Grazing of livestock in many rural areas are on communally owned lands. The “tragedy of the commons” is well known, with a generalised application to ‘open access’ communal grazing resources, where ecologically determined carrying capacity rates are transgressed. This, it is argued, is because the marginal cost of such ‘over’ grazing to the individual livestock owner on the commons does not fully reflect the marginal cost to the community at large, resulting in sustained overgrazing incentives. Reality, however, is less clear. In situations of strong social cohesion, where access to communal grazing resources is managed, sound grazing and livestock husbandry practices could be implemented, with good sustainable results. Livestock improvement schemes introduced under such regimes succeeded in general and resulted in the evenly distributed improvement of participants’ livelihoods. In other cases however, uneven power relations could exploit

unclear/unspecified/open type communal grazing arrangements on the commons. This led to opportunistic behaviour and the skewed distribution of benefits to such ‘powerful elites’ in the community (Kasale, 2013).

2.5.2 Herd Composition

Studies have reported on herd composition, where age categories for different classes of animal are not closely specified, or where classification has been left to respondents, and variances in results have been noticed (Mapiye *et al*., 2009, Tschopp *et al*., 2014 & Rocha *et al*., 1991).

In communal cattle production weaning is largely controlled by nature so that a specific age for differentiation between calves and followers (heifers, steers, and bullocks) is hard to define. The categories ‘steer’, ‘bullock’ and ‘ox’ are often confused since some male followers are used as draught animals and castration is not carried out consistently at a particular age. Some farmers appear to delay castration in order to improve strength and body conformation for draught usage. The difficulty of using beef-production cattle classes for categorising communal cattle is shown by the lack of a directly equivalent local vernacular vocabulary in most communal rural areas of Southern Africa (Barrett, 1991).

The DVS collects information on individual animals at cattle crush pens during vaccination, recorded every time when cattle herds have to go to the crush pens in the individual farmer cattle registers. Unfortunately the data are not very reliable regarding herd composition, because of inconsistency by field staff in transferring animals from the ‘calf’ category in the records to adult categories. It is not uncommon to find dips with cow/calf ratios indicating impossible calving rates, even in excess of 100 %. A typical cattle herd in communal area appears to comprise between 45 to 50 per cent cows and heifers, about 35 % male adults and followers and between 15 to 20 % calves, including some animals which may be more than one year old. For estimating calf production, the key parameter is the number of breeding cows (Barret, 1991).

Commonly, herd composition is assessed according to gender and age, distinguishing calves less than a year old, heifers, breeding cows, and bulls/oxen. In the commercial sectors, the target percentage of breeding cows is 50 percentages (50%) (Scholtz & Bester, 2010).

Table 2.2: Herds composition in communal areas of Southern Africa

References	Location	Calves < 1y	Heifers (nulliparous)	Cows	Bulls > 1y	Oxen
Rocha *et al*., 1991	southern Mozambique	10.3%	17.2%	36.4%	15.4%	20.7%
Bembridge, 1986; Tapson, 1985	South Africa	10.7%	18.9%	35.6%	25.6%	9.2%
Perry *et al*., 1984	Zambia	19%	16%	35%	5%	25%
Chatikobo *et al*., 2001	Sanyati Communal Area, Zimbabwe	20%	32%		3%	45%
Nthakheni, 1993	Venda, South Africa	7.7%	19.5%	51%	17.9%	3.4%
Reed *et al*., 1974	Moshupa district, eastern Botswana	6.6%	18.9%	33%	10.8%	30.6%

2.5.3 Cow-to-bull ratio

In the commercial beef sector, it is recommended to have about one bull for 30 cows, but because communal cattle tend to roam freely, most breeding cows can be mated by almost any bull. Almost all (98%) of communal farmers allow natural mating throughout the year, with no restricted breeding period (Scholtz *et al* 2008).

Table 2.3: Cow to bull ratio in communal areas of southern Africa

References	Location	Cows per bull
Mapiye *et al*., 2009a	Eastern Cape, South Africa	28 - 32
Siegmund-Schultze *et al*.,	Okamboro, central Namibia	36
Perry *et al*., 1984	Zambia	35 - 39
Nthakheni, 1993	Venda, South Africa	3
Tschopp *et al*., 2014	Sellale, central Ethiopia	9.5

2.5.4 Calving Rates

Reproductive performance of cows are best reflected by the calving rate, which is the total number of calves born out of the total number of breeding cows (Mokantla *et al*, 2004). A breeding cow is defined as a cow susceptible to be pregnant, but studies differ on the age of puberty from which a cow can first bear a calf: 1.5 to 2 years (Nqeno *et al*, 2011), 2 to 2.5 years (Mokantla *et al*, 2004), Siegmund-Schuftze *et al*, 2012). Three years (Scones, 1992).

When calculating the number of calves in one year, one needs to take into account the seasonality of calving, and therefore averages over several years are more accurate (Lesnoff & Lancelot, 2009). Major perceived causes of low reproductive performances in communal cattle are delayed age at puberty and at first calving, long inter-calving interval and insufficient bull numbers (Nqeno, *et al*, 2011).

Depending on the studies, target calving rates in the commercial sector vary from 55% (Scholtz & Bester, 2010) to 95%-99% (Mokantla, *et al*, 2004), while in the communal sector, the accepted norm is 40% (Scholtz & Bester, 2010). Calving rates in communal areas are usually much lower than those in the commercial sector, and it appears that the main reason is malnutrition resulting in poor body condition of the dam and failure to conceive, as opposed to embryonic dearth or abortion (Mokantla *et al*, 2004; Nqeno *et al*, 2010).

Table 2.4: Calving rates in communal areas of Africa

References	Location	Type of study	Calving rate and range
Rocha *et al*., 1991	Southern Mozambique	Monthly questionnaire over 12 months (February 1987 - 1988)	49% (46% - 53%)
Scoones, 1992	Mazvihwa, southern Zimbabwe	Regular questionnaire with farmers over 12 years (1986 - 1998)	68% - 82%
Bembridge &Tapson, 1993	Ciskei and Transkei, South Africa	Unspecified	41% (39% - 43%)
Angassa & Oba, 2007	Southern Ethiopia	Retrospective analysis of data collected over 21 years (1938 - 2003)	55% (12% - 81%)
Perry *et al*., 1984	Zambia	Questionnaires based on farmers' recalls of preceding year	44% - 80%
Nthakheni, 1993	Venda, South Africa	Questionnaires based on farmers' recall	15%
Scholtz & Bester, 2010	Communal sector in South Africa	Questionnaires	27%
Scholtz & Bester, 2010	Commercial sector in South Africa	Questionnaires	61%
Tschopp *et al*., 2014	Sellale, central Ethiopia	Follow-up of identified animals on 20 farms every two weeks for 4.5 years	41%

2.5.5 Health management (Mortality rate)

Most communal cattle population studies report that calves have the highest mortality rate, due mainly to drought, malnutrition and tick-borne diseases; although many causes of dearth remain unknown because of limited access to animal health services (Chatikobo *et al*, 2001). Compared to the commercial sector where average annual mortality is around 3%, the communal sector suffers on average 13% annual mortality rate (Makgatho *et al*, 2005).

Table 2.5: shows mortality rates in various communal cattle population in Africa

References	Location	Mortality rate (total cattle)	Cows mortality rate	Calves mortality rate
Rocha *et al*., 1991	Southern Mozambique	8.4%	3.8%	23.8%
Makgatho *et al*., 2005	North West, South Africa	4.5%	4.8%	7.3%
Lesnoff *et al*., 2002	Ethiopian Highlands		3%	17%
Perry *et al*., 1984	Zambia		4% - 16%	4% - 32%
Nthakheni, 1993	Venda, South Africa	45.1%		75.6%
Bembridge, 1987	Transkei, South Africa	16.7%		26.8%
Scholtz & Bester, 2010	Communal sector in South Africa	4.7%		
Chatikobo *et al*., 2001	Sanyati Communal Area, Zimbabwe	26%		

In the developed countries production of quality beef is usually achieved through the feeding of high-energy rations to young animals (6 to 30 months old), the bulk of the beef produced in the developing countries still comes from rather extensive systems (Worku, 2015).

2.6 Summary

Literature has shown that globally extensive grazing systems occupy about one-quarter of the world‘s land, yet yield less than 10% of global meat production. In this type of system, production growth primarily is achieved by opening new grazing areas. Literature has shown that grazing of livestock in many rural areas are on communally owned lands and ecologically determined carrying capacity rates are transgressed resulting in sustained overgrazing. Studies have shown that a typical cattle herd in communal area appears to comprise between 45 to 50 per cent cows and heifers, about 35 % male adults and followers and between 15 to 20 % calves. Almost all (98%) of communal farmers allow natural mating throughout the year, with no restricted breeding period, which has an impact on reproduction and production. Literature has shown that most communal cattle population studies report that calves

have the highest mortality rate in Africa, due mainly to drought, malnutrition and tick-borne diseases; although many causes of dearth remain unknown because of limited access to animal health services. The following chapter gives an insight of Namibia’s cattle production systems.

CHAPTER 3: Overview of Namibia's cattle production systems

3.1 INTRODUCTION

This chapter presents an overview of the beef industry in Namibia. The chapter starts by presenting the marketing of cattle in Namibia, sheds light on the cattle marketing in NCA and Zambezi region in particular. The agriculture policy, trade and marketing of livestock in Namibia are also presented. The cattle off-takes, nationally, NCA and Zambezi region are also explored and support services. The chapter ends with a summary of the industry.

3.2 Cattle population dynamics

In Namibia, 61 % of the entire cattle population can be found in the communal area, of which 44 % is located in the NCA. Although only 10 % of all sheep in the country are found in the communal areas, just over 65 % of all goats are found in the communal areas (Kruger & Lammerts-Imbuwa, 2008).According to Namibia Statistical Agency (NSA 2015) report of Namibia Census of Agriculture 2013/2014, more than 50% of house hold heads in Zambezi region owned livestock. Zambezi rural household's livelihood is characterised by heavy reliance on either crop production, livestock production or sale of natural resources for food and income (Ashley, 2003).Cattle ownership account for about 65% of livestock, with the remaining percentage is shared among goats, poultry and donkeys (Ashley, 2003).Livestock are traditionally kept for multiple goals related to basic needs such as meat, milk, hides and draught power. Cattle are sold to local markets and MeatCo Company to earn cash (Ashley, 2003).

The commercial farming sector, which is almost exclusively based on livestock farming, is the largest employer in Namibia, providing employment to between 25

000 and 30 000 agricultural labourers and their dependants (Kruger & Lammerts-Imbuwa, 2008).

Namibia's agriculture has dualistic features that result in two distinct land tenure systems, the commercial farming sector (63 million ha) occupying 57 % of agriculturally usable land. Under this system the land is privately owned, and fenced off. This sector is capital intensive, well developed and export oriented (Sweet, 1998). The communal areas (27 million ha or 43 % of the available agricultural land), under this system the land is state owned with common grazing lands, which restrict the scope for improved management practices (Sweet, 1998).

3.3 Marketing of cattle in Namibia

MeatCo is the largest meat processor in Namibia, with abattoirs and beef-processing facilities forming the core of the Corporation's business activities. MeatCo's abattoirs utilise the latest technologies, meeting the highest international standards in terms of traceability, product yields, stock and financial controls. The corporation is HACCP and ISO9002 certified and the systems ensure that all necessary precautions are taken to guarantee that all products are safe for human consumption (MeatCo, 2009). Namibia's main export markets are South Africa and the European Union (EU), with 80 % and 20 % of total export volumes respectively (Business Namibia, 2006; Kirsten, 2002). Namibian beef is exported primarily to the EU as deboned beef and to South Africa on hoof (mainly weaners) (Mushendami *et al.*, 2006). MeatCo has four abattoirs, two of which are approved for export to the EU. The other two, namely the Oshakati and Katima Mulilo abattoirs, which are situated in the northern part of the country, are used for the slaughter of cattle destined for the South African markets. MeatCo also operates a tannery to maximise local value-adding to its hides. MeatCo is the key player in the industry and ensures that its viable and internationally accepted operations are major contributors to the country's economy whilst having a stabilising effect on the industry as a whole. The two abattoirs approved for export to the EU are centralised in Okahandja and Windhoek, since these are the two plants certified to export processed meat products to international markets. Namibia's cattle are generally slaughtered at the age of approximately 20 to

30 months at an average carcass weight of 350 kg (Von Bach, 1990). Beef producers are remunerated according to a carcass grading system. A well-established beef carcass grading system is used whereby beef is classed according to age, fat content and condition. The classifications A, B and C are indications of age, while the grades 1, 2, 3 and 4 indicate the fat content or conformation of the beef (Sartorius von Bach, 1990).

3.3 Marketing of cattle in the Northern Communal Areas (NCA)

Cattle purchased by MeatCo from the NCA regions of Kunene North, the NCR and the Kavango region were been slaughtered at the abattoir at Oshakati, while cattle from the Zambezi region are slaughtered at the Katima Mulilo abattoir. However, the marketing of cattle from the NCA is restricted by the VCF, as livestock producers north of the VCF are not allowed to freely market their animals to the SVCF due to FMD and Contagious Bovine Pleuropneumonia (CBPP) restrictions (Düvel, 2001).
Communal producers have been known to criticise the way in which MeatCo approaches the marketing of livestock, namely the low prices paid by MeatCo, the absence of competitors, and the lack of access to meat markets of the SVCF, which are deemed to be the major constraints to increasing their livestock sales (Arbirk & Vigne, 2002). Arbirk and Vigne (2002) acknowledged the generally poor condition of the animals delivered to the abattoir and the long distances over which producers must transport the animals to the abattoir.

3.4 Marketing of cattle in the Zambezi region

Cattle producers in the region market their cattle through formal and informal markets. MeatCo is classified as the only big formal buyer of cattle in the northern communal areas, Zambezi region included. Apart from MeatCo as the bigger of formal buyer, all other buyers of cattle are called smaller or informal buyers. The preferred marketing season for the Zambezi farmers is from February to June, when the animals are in good condition. However due to limited slaughter capacity of the MeatCo abattoir in Katima, all farmers are not able to market their cattle when in good condition (MBN, 2012).In a study by Thomas *et al*, (2013), titled Analysis of The Determinants of The Sustainability of Cattle marketing systems in Zambezi

region, the results from the study showed that the majority (62%) of small scale cattle farmers preferred to trade through informal marketing channel (comprising open market, private sales and butcheries). The abattoir was the single most preferred channel for 38% and the only available formal market.

3.5 Off-take

In year 2013 of all the cattle sold through formal markets only 11.40% came from the Northern Communal Areas (NCA) with only 7.3 % coming from the Northern Communal Areas in 2014 (MAWF, 2015). As for the Zambezi region despite it being home to an estimated 151 765 cattle, annual off-take of cattle in the region between 2013 and 2014 was estimated at only 10%, which is way below the national average off-take (NSA, 2015).

3.6 Sector policy formulation and support service

3.6.1 National Agriculture Policy

The National Agriculture Policy (NAP) was formulated within the overall national development objectives set out after Independence, focused on the alleviation of poverty and a reduction in income inequalities. The overall goal of the NAP is to increase and sustain levels of agricultural productivity, real farm incomes and national and household food security within the context of Namibia's fragile ecosystem (MAWF, 2011). The National Agricultural Policy aim to fix difficulties inherited from colonial administration. It provides an enabling environment for increased food production by smallholder producers, as a means of improving employment opportunities, incomes, household food security and the nutritional status of all Namibians. At the same time, it support and strengthen the large-scale farming sector which contributes significantly to agricultural exports, the food security of the nation and provides employment for a substantial number of the people. According to Werner (2011), in order to improve the current standard of living and quality of life of the people need to change; as a result the specific objectives of the National Agricultural Policy are summarized as follows to;

- Achieve growth rates and stability in farm incomes, agricultural productivity and production levels higher than the population growth rate.
- Ensure food security and improve nutritional status.
- Create and sustain viable livelihood and employment opportunities in rural areas.
- Improve the profitability of agriculture and increase investment in agriculture.
- Contribute towards the improvement of the balance of payments.
- Expand vertical integration and domestic value-added for agricultural products.
- Improve the living standards of farmers and their families as well as farm workers.
- Promote the sustainable utilisation of the nation's land and other natural resources.
- Contribute to balanced rural and regional development based on comparative advantage.

Policy initiatives intention is to redirect public resources towards sustainable economic growth and agricultural development (MAWF, 2011). To ensure implementation of the above policies the government support the agriculture sector as much as possible.

3.6.2 The Provision of Government Services (Support Service)

The Government is providing extension services to the agricultural sector in the form of information communication and advisory services aimed at changing farmers' perceptions and attitudes, and encourage adoption of improved technologies and practices among the farmers (MAWF, 2009).

Extension promotes participatory farming systems research and extension processes to help farmers with possible solutions to their farming problems. The role

of government is to ensure effective extension services provision the farmer support services includes input sales and distribution, infrastructure development, drought relief, ploughing services, direct marketing and credit delivery. This ensures food security objectives attainments that include issues of food consumption, as well as production, this are addressed within the framework of extension services (MAWF, 1995).

The importance of research is also highlighted in the policy document, that is to increases in agricultural output and productivity will depend to a large extent on a strong and practical programme of research (MAWF, 2009). The research improve and diversify agricultural production in market orientated farming systems and a more complex research programme, based on multi-disciplinary inputs aims at understanding local farming systems and farmers' priorities. A cost effective national agricultural research system, with an appropriate institutional and coordinating structure, focusing on decentralized adaptive research and on farm trials is established and fully supported by the government (MAWF, 2009). Research is capacitating production of practical technologies and advice for subsistence farmers to improve their productivity, food self-sufficiency and food security. The financial viability of agricultural technologies for smallholder producers are ascertained and demonstrated before farmers are encouraged to adopt them. In regard to policy in terms of subsidies, the government provide subsidy in form of credit, services (Feeds, vaccines, up-graded bulls) and prizes. Such subsidies are very useful to achieve certain agricultural or socio-economic objectives in the short-term and they have a positive impact on production, food security, employment, income distribution and fiscal sustainability. Subsidies that distort the prices of farm inputs and outputs, and discourage private sector investment and participation will be phased out, subsidies are only used to achieve social objectives and this are the ones budgeted and accounted for in a transparent manner. In such cases, subsidies are used cautiously in well-targeted programmes or poverty alleviation schemes. Subsidies are designed particularly to address the needs of subsistence farming families, especially food insecure and chronically poor groups. Bridging subsidies must encourage the target groups to adopt more productive approaches to farming and to produce surpluses for the market (MAWF, 1995).

3.6.3 Agricultural marketing and trade policy

This policy aims at serving as a policy input in the overall national marketing and trade policy and implementation taking due cognisance of the complementarities of other sectorial economic policies (MAWF, 2011). The policy is developed with the aim of contributing to the successful performance of the agriculture sector, as well as to complement other policies and strategies across the agricultural value chain. Agricultural marketing systems must ensure equitable market access for all participants. The Government will facilitate the creation of an environment that improves the efficiency of markets in order to reduce costs and increase demand. Such conditions are necessary for realizing the full potential of agriculture's contribution to meeting the needs of society and achieving balanced economic development. Government support to agricultural marketing will be largely aimed at addressing shortcomings in the service structure, the market environment and market mechanisms. Direct intervention will be limited to the correction of market imperfections and socially- unacceptable effects (MAWF, 2011). The major role of the Government in market development will be to develop an efficient market information collection and dissemination system. This will provide timely and accurate price information for the farming community, particularly the communal farmers, to enable them to respond more positively signals from the markets. The marketing needs of small-scale farmers will receive special attention. Their success in improving production for the market depends on, amongst other things, the provision of rural infrastructure s and marketing support services. The Government will assist local communities and private enterprises by creating a favourable policy and investment environment in which small-scale farmers have access to affordable marketing services and facilities (MAWF, 2011).

3.6.4 Agricultural Support services in Zambezi region

Zambezi region has a total of sixteen (16) Agricultural Development Centres (ADCs) responsible for facilitating; training, information dissemination, distribution of agricultural inputs and food production (Shikesho, 2003).

Zambezi region has a total of sixteen (16) ADCs/ARDCs three which are agricultural rural development centres (ARDC) namely; Bukalo, Sibbinda and Cincimani. The other thirteen are agricultural development centres (ADCs) located at Katima, Masokotwani, Dudukabe, Ngoma, Linyanti, Sangwali, Kabbe, Sachona, Kasheshe, Itomba, Kongola and Impalila. The region is administered from KatimaMulilo (Shikesho, 2003).

According to the government's National Agriculture Policy (1996) the Directorate of Extension (DEES) is mandated to provide agriculture extension services in the form of advisory, information communication, and training services. The aim is to empower farmers, and encouraging the adoption of improved agricultural and related income generating technologies and practices. This is in line with the National Agricultural Policy which seeks to increase and sustain the levels of agricultural productivity, real farm incomes and national and household food security, within the context of Namibia's fragile ecosystem (National Agriculture Policy, 1996).

The directorate of extension and engineering is made up of field group, which is composed of field staffs that are at the field level i.e. at Agricultural Development Centres (ADCs). The group is involved in assisting communities in developing their development programs. At this group communities are assisted in the development of their community action plans for their developmental issues. It is at this group where the interaction with farmers is on a day to day basis. This interaction involves the extension agents with individual farmers, Farmer Extension and Development (FED) groups, interest groups and farmer associations. It also consists of the technical support group; which consists of all researchers and subject matter specialists in the region (Shikesho, 2003).

3.7 Summary

Namibia's main export markets are South Africa and the European Union with 80 % and 20 % of total export volumes respectively. Namibian beef is exported primarily to the EU as deboned beef and to South Africa on hoof (mainly weaners). Meat-Co

Namibia is the key player in the industry with four abattoirs around the country of which two are approved for export to the EU. The marketing of cattle from the NCA is restricted by the VCF, as livestock producers north of the VCF are not allowed to freely market their animals to the SVCF due to FMD and CBPP restrictions, this set-up is viewed as disadvantaging NCA farmers by been excluded from the lucrative EU market. Despite more than 60% of the cattle population in the country been in the NCA, the region is only supplying a mere 11% of beef to the formal meat markets. The off-take percentage from the NCA and Zambezi region is low and measures are required to increase the off-take. Despite enabling policies such as the National Agriculture policy and Agricultural Development Support Services Centres in place, the development of the beef industry in the NCA leaves a lot to be desired.

CHAPTER 4: METHODOLOGY

4.1 Introduction

This chapter presents the research methodology followed and begins by highlighting the study area's location, demographic characteristics of the population, climate and livestock farming activities in the study area. The chapter then presents the 'research design, population and sampling procedures, techniques and methods used to collect all relevant data required for the study. Thereafter the model used for analysis is calibrated and then the ethical considerations followed.

4.2 Description of Zambezi region

The research was conducted in the Zambezi region of Namibia which is one of the fourteenth political regions of Namibia. The region is divided into three distinct areas which are western Zambezi, which has recently been incorporated into the region from the former Kavango region, the Zambezi strip, which is a national nature reserve, and eastern Zambezi. The Zambezi region is divided into the constituencies of Kongola, Linyanti, Sibinda, KatimaMulilo Rural, KatimaMulilo Urban, Judea Lyaboloma, Kabbe South and Kabbe. The region has a surface area of 19532 km^2 and is bordered by Angola and Zambia to the north, Zimbabwe to the east and Botswana to the south. The region is accessed from the main land of Namibia via the Kavango region to the west of the Zambezi region (Isaacson, 1995).

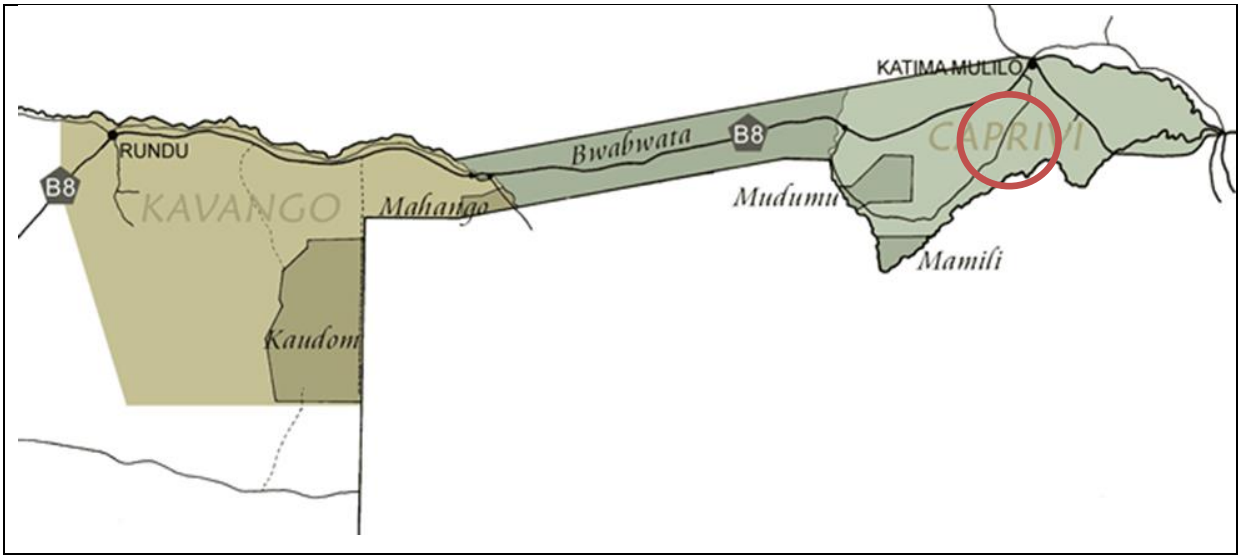

Figure 4.1: Study area (Google map, 2016)

4.3 Socioeconomic characteristics of the region

According to the Namibia Statistical Agency (NSA, 2011), Zambezi region's total population is estimated to be 90 596 and the gender composition between male and female is about 51% and 49% respectively. The economically active labour force was estimated to be 33004 of which 62.3% and 37.6% considered themselves employed and unemployed respectively.

The major source of income in Zambezi are farming estimated to be 20.6% of the total population; whereas business none farming activity, wages and salary and old age pension are 25.2%, 29.5% and 14% respectively (NSA, 2011).

In Zambezi total population and households involved related to agriculture is estimated to be 69 134 and 15 159 respectively. Out of this activities livestock ownership estimated to be 28.7%; crop (57.4%), poultry (9.7%) and other activities related to agriculture (4.2%) (NSA, 2011). The livestock ownership percentage is sufficient; therefore it is supposed to contribute significantly to the farmer's wellbeing.

According to Namibia Statistical Agency (NSA 2015) report of Namibia Census of Agriculture 2013/2014, more than 50% of house hold heads in Zambezi region owned livestock. Zambezi rural household's livelihood is characterised by heavy reliance on either crop production, livestock production or sale of natural resources for food and income (Ashley, 2003). Livestock production contributes significantly to

households needs. Cattle ownership account for about 65% of livestock, with the remaining percentage is shared among goats, poultry and donkeys (Ashley, 2003). Livestock are traditionally kept for multiple goals related to basic needs such as meat, milk, hides and draught power. Cattle are sold to local markets and MeatCo Company to earn cash (Ashley, 2003).

4.4 Climate

Zambezi region is distinctively more tropical than any of the other region, with an annual rainfall ranging between +550 and 600mm. The region experiences less evaporation and warmer winter than the rest of Namibia. However, even though the region receives the highest rainfalls in Namibia, the rainfalls are highly variable from year to year and from place to another and as well experiences serious droughts from time to time (Mendelsohn, 1997). The climate is optimum for a conducive rangeland which is required for a successful livestock production.

4.5 Research design

The study employed the quantitative research design. Creswell (2009) stated that the goal of the quantitative design is to determine the relationship between independent variables and dependent variables within a population. The overarching aim of quantitative research study is to classify features, count them, and construct statistical models in an attempt to explain what is observed. Data was collected from household heads, extension staff and from GIZ field staff.

4.6 Population and sampling procedure

According to Leedy and Ormrod, (2005), sampling is a process of selecting units from a population of interest. The results obtained from the sample may be used to generalize about the population. Therefore, the characteristics obtained from the sample should reflect approximately the same characteristics as the whole population. The population for the study were all the household heads in the study area who are involved in decision making on livestock farming and production. Due

to the homogeneity of the region's rural population the study ended up using household heads from selected villages within the study area.

In this study, a multi-stage sampling procedure was used starting with establishing the total population in the villages so as to establish the quota after which simple random sampling procedure was used to select respondents from each village. The quota system was based on the proportion of the total population of farmers participating in Farmers Support Programme (FSP) project within the study area which led to the selection of 86 household heads from a pool of 847 FSP project beneficiaries.

4.7 Data collection process

A structured questionnaire was designed and administered to the household heads who in this case were the respondents for primary data collection. The questionnaire consisted of both closed and open-ended questions and quantitative data. The questionnaire was administered to respondents through face-to-face interviews by trained enumerators with the main researcher supervising the data collection process.

In order to minimize errors in the questions the questionnaire was pre-tested. Before the communities were visited for the purpose of data collection, the communities were notified through the traditional authorities (Indunas) about the survey to be conducted and its purpose. The interviewers explained who they are and also explained to the respondents the purpose of the survey. The respondents were informed about confidentiality of the information been collected, and that it was solely going to be used for the purpose of the survey only.

4.8 Data analysis

After the data was collected it was then coded. Descriptive statistics were used to determine situational analysis of the livestock management practices in Zambezi region. The following data was used for obtaining this objective: Age, gender,

education level, household size, herd size, bull cow ratio. To examine factors influencing adoption of the newly introduced livestock management practices, Multi-logistic regression model was used. The following data was used to attain the objective: Education, gender, Farming experience, Training, Support received, Access to credit, Human capital, Costs of inputs, Number of cattle owned. To determine off-take rate in the region, descriptive statistics were used. The following data was used: number of weaners, bull to cow ratio, number of cattle marketed, age of marketed cattle, and category of marketed cattle.

4.9. CONCEPTUAL FRAMEWORK

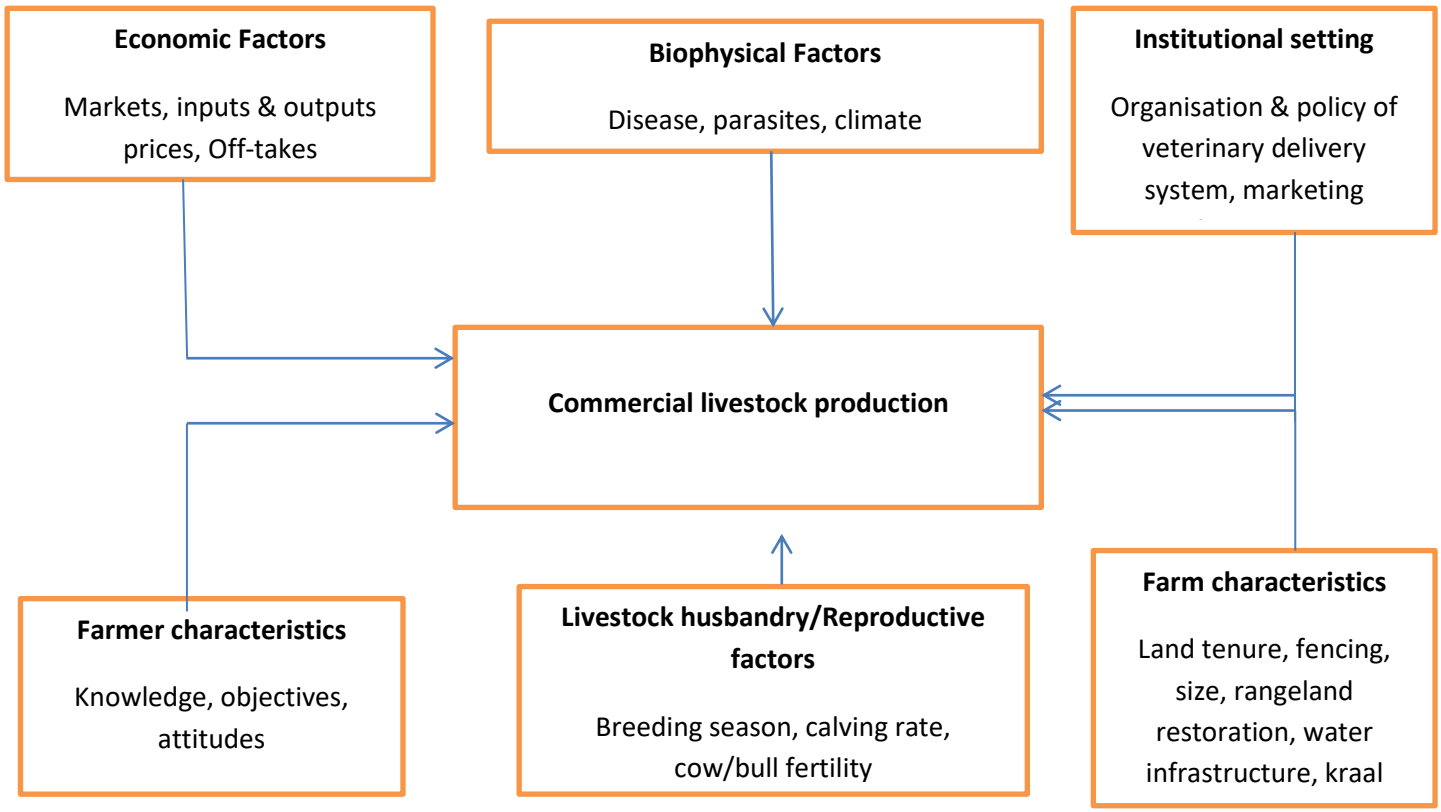

Figure 4.2: Conceptual framework of aspects affecting adoption of semi-commercial livestock production practices (Extracted from GIZ tool).

A conceptual framework of the aspects involved with the adoption of semi-commercial livestock production management practices is illustrated in Figure 4.2, indicating variables that are interacting in order for farming activities to be complete. These are grouped into variables that relate to characteristics specific to semi-commercial cattle production practices such as: Economic Factors, Biophysical Factors, Institutional setting, Farmer characteristics, Livestock husbandry/Reproductive factors and Farm characteristics.

This study was guided by the production theory; the theory involves some of the most fundamental principles of economics. These include the relationship between the prices of commodities and the prices (or wages or rents) of the productive factors used to produce (Debertin, 2012). The function gives for each set of inputs, the maximum amount of output of a product that can be produced. It is defined as the state of technical knowledge (that includes Technical efficiency and Allocative efficiency) (Dorfman, 2016). In production theory there are various decisions a business enterprise makes about its productive activities can be classified into three layers of increasing complexity. The first layer includes decisions about methods of producing a given quantity that is called short-run cost minimization. The second layer, including the determination of the most profitable quantities of products to produce in any given time and space is called short-run profit maximization. The third layer, concerning the determination of the most profitable size and equipment of plant, relates to what is called long-run profit maximization (Dorfman, 2016). In addition to this in terms of model to contemporary production theory involves choosing a functional form to represent the production process that is monotonically increasing, and can be readily inverted, such that parameters can be derived from either the cost or the physical input data (Debertin, 2012).

4.9. THEORETICAL FRAMEWORK

4.9.1 Multi-logistic regression analysis.

4.9.1.1 Multi-logistic regression model specification

$$\acute{Y}0= \beta1+\beta2X+\beta3X+\beta4X+ \beta5X+ \beta6X\ \beta7X\ \beta8X + \beta9X + \beta10X + \mu i$$

Adoption (y) = β1+β2 (education) + β3 (gender) + β4 (farming experience) + β5 (support received) +β6 (training) + β7 (access to credit) + β8 (cattle sales) + β9 (number of cattle) + β10 (gender of household head) + μi

The multi-logistic regression model econometric approach is characterised by a set of n binary dependent variables yi such that: (Green, 2000)

$Y\ i = 1$ if $x\ \beta i + \varepsilon i > 0$, or

= 0 if $x\beta i + \varepsilon i \leq 0, i = 1,2,K, n$,

where X is a vector of explanatory variables, β1,β2,… ,βn are the parameters of the vectors, and random error terms ε1,ε2,..,εn are distributed as multivariate normal distribution with zero means, unitary variance and an n×n contemporaneous correlation matrix R =[ρij] with density φ(ε1,ε2,..,εn;R), (Green, 2000).

The multi-logistic regression model was applied as simultaneous model with the set of explanatory variables on different adaptation measure, which allows the unobserved and unmeasured factors (error terms) to be freely correlated (Lin, Jensen & Yen, (2005); Green, (2000); Golob & Regan (2002).

Table 4.1: Explanatory variables used in the multi-logistic regression model

Variable	**Descriptive and measurement**	**Type of variable**	**Expected β sign**
Farming experience	Actual number of years in livestock farming	Continuous	+/-
Education	Education level of household head	Category	+/-
Training received	Livestock related training received	Continuous	+/-
Farm size	Total farm size owned by household head in hectares	Continuous	+/-
Gender of household head	Gender of household head, male or female. It was expected to give a positive influence on adoption, male farmers expected to have high calving rate and off-take rate	Category	+/-
Age of farmer	Actual years.	Continuous	+/-
Household size	Number of household members.	Continuous	+/-

Labor	Actual number of household members able to render labor.	Continuous	+/-
Livestock number	Actual number of livestock owned. It was expected that those with high number of livestock will adopt new and improved techniques.	Continuous	+/-
Support received& training	Types of extension services received.	Continuous	+/-
Access to credit	Availability of financial services ready to lender monetary services	Category	+/-
Total cattle sales	Actual cattle sales	Continuous	+/-

4.8.1 Multi-logistic regression model Specification

The model was chosen because it enables one to analyse data were explanatory variables are thought to influence dependent variables.

The following econometric model was also performed;

Ý0= β1+β2X+β3X+β4X+ β5X+ β6X β7X β8X + β9X + β10X + μi

Adoption (y) = β1+β2 (education) + β3 (gender) + β4 (farming experience) + β5 (support received) +β6 (training) + β7 (access to credit) + β8 (cattle sales) + β9 (number of cattle) + β10 (gender of household head) + μi

The error term (μi) is the surrogate of all those explanatory variables that were omitted from the model, but might have positive influence on the dependant variable, which is adoption of technology in this case (Y).

Table 4.2: Summary of Data analysis by objectives

Objective	Data	Data source	Analytical model used
1 Conduct situational analysis of the livestock management practices in Zambezi region'	Age, Rangeland management, animal husbandry practices, gender, education level, household size, herd size & composition, bull cow ratio, record keeping, , sales, category of sales	Face to face interviews (questionnaire)	Descriptive statistics
2 Examine factors influencing adoption of the newly introduced livestock management practices	Education, gender, Farming experience, Training, support received, access to credit, human capital, costs of inputs, number of cattle owned, total cattle sales	Face to face interviews (questionnaire)	Multi-logistic regression model, econometric: The model was used because it enables one to analyse data were explanatory variables are thought to influence dependent variables.

4.9.2 META analysis

The META analysis was applied for the situational analysis of the livestock farmers in the region. Meta-analysis allows researchers to compare or combine results across a set of similar studies. In the individual study, the units of analysis are the individual observations (Thorsteinson, 2003). In meta-analysis the units of analysis are the results of individual studies. The term meta-analysis means 'an analysis of analysis' in simple terms (Gough and Martin, 2012). A particular topic may have been replicated in various ways, using, for example, differently sized samples, and

conducted in different countries under different environmental, social and economic conditions. Sometimes results appear to be reasonably consistent; others less so. Meta-analysis enables a rigorous comparison to be made rather than a subjective eyeballing (Teweldemedhin and Mwewa, 2013). In conducting Meta-analysis, the following three stages are involved; identify the relevant variables, locate relevant research and then conduct the meta-analysis.

4.10 Ethical considerations

The respondents who participated in the survey were asked to participate voluntarily and were told that they had the right to withdraw whenever they felt so. They were assured of the protection of their confidentiality and privacy. No names or any form of identification was obtained from the respondents. The data that was collected was not in any way manipulated or fabricated. The survey forms were securely kept after data was captured and were not to be used for any other purpose other than this study and CLDP/FSP project

CHAPTER 5: SITUATIONAL ANALYSIS OF THE LIVESTOCK MANAGEMENT PRACTICES IN ZAMBEZI REGION

5.1 Introduction

This chapter present the situational analysis of the livestock management practices in Zambezi region. After presenting the socioeconomic characteristics of the respondents, such as household characteristics, herd size, herd composition, bull-cow ratio and animal husbandry practices and off-take; and then concluded with summary of the findings.

5.2 Socio-economic characteristics of the respondents

5.2.1 Household Characteristics

Out of 86 sampled response in this study 76% and 24% represent male and female respectively. This is in contrast to a study by (Musaba 2010) who found that female respondents were dominant in Omusati (63%), Oshikoto (62)%, Oshana (70)% and only in Ohangwena region where male respondents (61%) were dominant Many other studies have shown male dominance in cattle production and female more into crop production, although females in general are more involved in agricultural production compared to their male counterparts (Nnadozi and Ibe, 1996).Rahman (2008) established that in Kaduna state of Nigeria only 30% of female headed households' were more involved in livestock farming activities compared to 70% male headed households. The implication could be that cattle ownership in the study area is male dominated just like what was also established by Tavirimirwa (2013) in a study in rural areas of Zimbabwe. More on the social characteristics of the respondents is shown in Table 5.1

Table 5.1: Social characteristics of the respondents

Characteristic	Category	%
Gender	Male	76
	Female	24
Age of respondent	Less than -30 years	4
	31-45 years	29
	46-60 years	29
	> 60 years	38
Education level	No school	9
	Primary	28
	Secondary	48
	Tertiary	15
Household size	0-5	27
	6-10	65
	>11	8

As indicated in Table 5.1 the age distribution shows that above 60 years old dominated the sample, which represent about 38%, followed by age group of less than 30 years and between 31-45 years the same accounted for 29% and lastly group age less than 30 years represent smaller portion about 4%. This clearly shows the youth are not participating in the farming activity; this implying that older farmers are more likely to own more cattle and have more experience with cattle farming and are more likely to make informed decision about marketing channels compared to young and inexperienced farmers (Thomas, Togarepi and Simasiku, 2014). Similar study done by Chagwiza, Musemwa, Sikuka, Fraser, Chimonyo and Mzileni (2007), in Eastern Cape Province, South Africa found similar finding. They found out that young farmers (mean age = 48) were more likely to use auctions, while the older the farmer preferred to sale their cattle through private sales and speculators. Even though older farmers may have useful farming experience their main objective of cattle rearing may not be the best for the cattle industry. However age and gender alone may not give clear picture of market participation but should be understood in a holistic view with other factors discussed below.

In terms of educational attainment, 48%, 28%, 15% and 9% of educational attainment of Secondary, Primary, Tertiary and no formal education respectively. Education level of a farmer has implication on information collection and application of better farm management that implying that higher level of formal education are more likely to adopt better livestock husbandry practices such as provision of

supplement feeds, licks, and vaccinating, observing recommended stocking rates and take livestock farming as a business compared to the less educated as was also noted by (Musemwa *et al* (2008) and Kasale, 2013). Education increases the ability of the farmers to use resources efficiently that enhances the farmer‘s ability to improve farming system (Musaba, 2010).

Chagwiza *et al* (2007) also found that farmers who had a secondary and higher level of education had access to information about marketing and price, therefore were able to make better informed decisions about marketing channels. The study's finding concurs with results of Coetzee, Montshwe and Jooste, (2005) in South Africa who found that more educated farmers have more access to information on better markets for their cattle. In Uganda, Isabella and Steve (2007) reported a positive relationship between years of formal education and higher bargaining power when marketing cattle as educated farmers are more likely to get more current market information. This implies that education improves the farmer's productivity as it enables them to access important information concerning livestock production, research and market availability, therefore education is an important entity to the farmers.

The adoption of technology in farming is positively related to family size. Farmers with large families are likely to adopt cattle farming. They are expected to have sufficient labour, compared with those with smaller family sizes (Mavedzenge *et al*, 2006).

In this study household size in the study area ranged from 5 to 11 household members. Most households (65%) had 6-10 members, 27% of the respondent's having more than 10 members. This implies that other things being equal cattle farmers with a sizeable household membership have better chances of succeeding with livestock production as they have sufficient labour available for activities involved with livestock rearing.

5.2.2 Cattle ownership in Zambezi region

As shown in Figure 5.1 majority of the farmers about 52.30% own less than ten cattle, whereas one individual own about 300 cattle and another person about 360 cattle, this clearly shows on the communal land tenure system require some way of

improving the poor people ownership. In top of this few people causing huge land degradation from owning bigger number of cattle with poor management system in place.

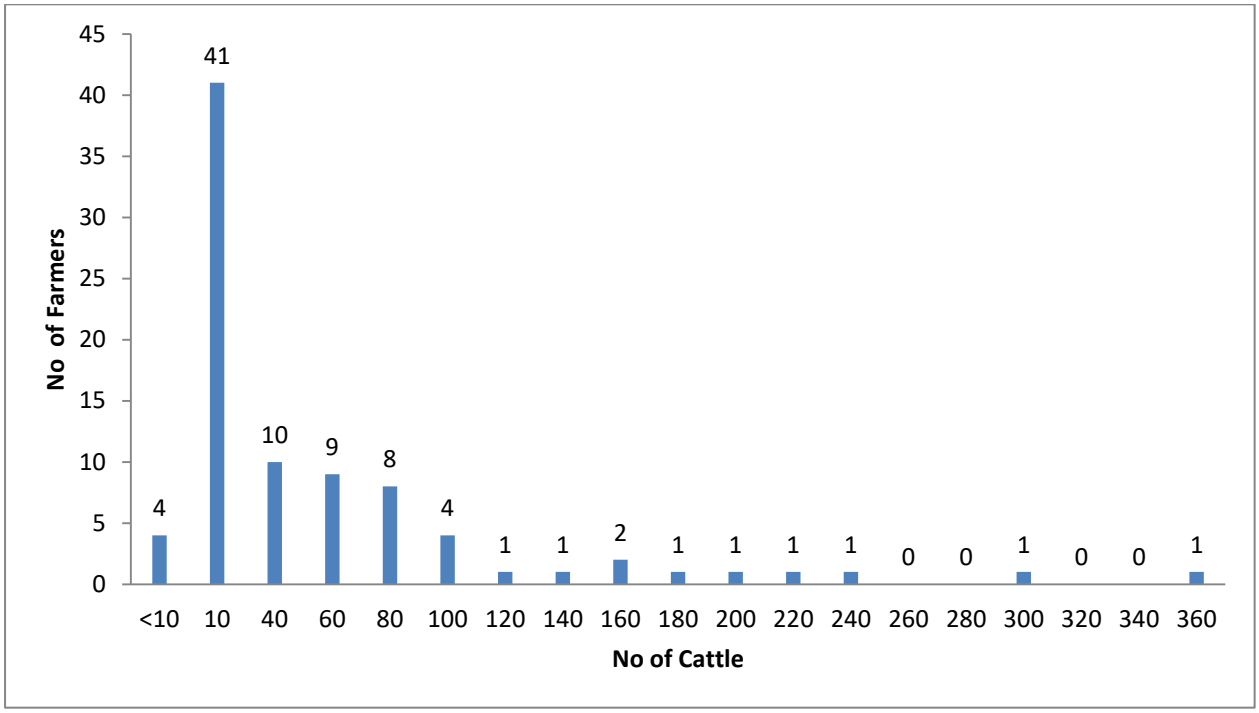

Figure 5.1: Distribution of cattle ownership

5.2.2.1 Cattle losses

As indicated in Figure 5.2 the major cause of loss was theft and drought, which represent at about 31% and 30% respectively; this indicate that the good environmental management plan would have improve the situation that align with the well structure herd management. Generally speaking the traditional way of farming will not benefit to environmental sustainability nor the economic benefit.

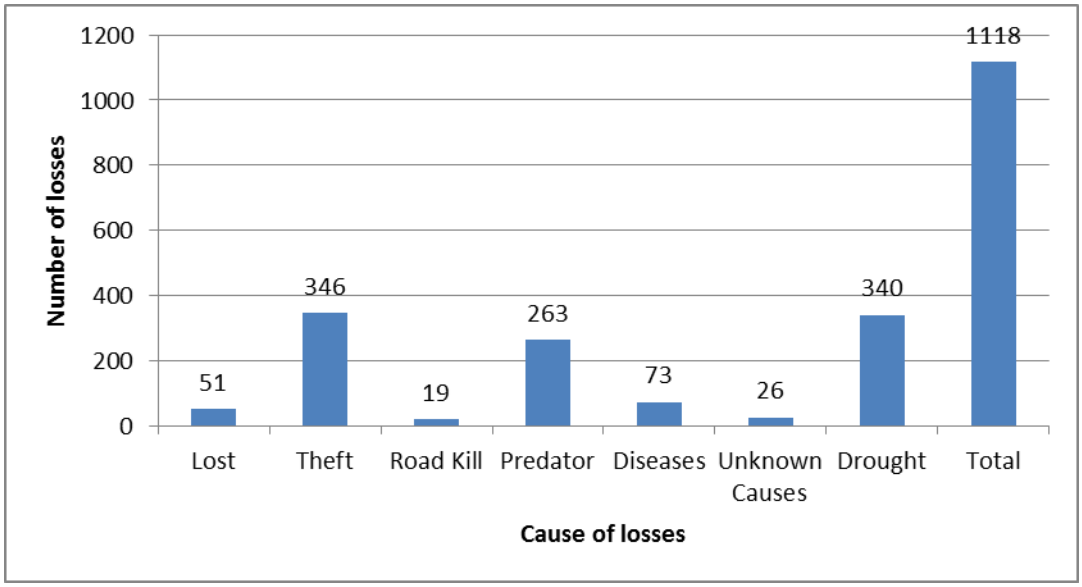

Figure 5.2: Distribution of cattle losses

When compared with other communal areas within Southern Africa, the average herd size in the study area was higher. The average herd size in Mpumalanga, and Bushbuckridge in South Africa was 19 and 20 respectively (Scholtz et al 2008, Dovie *et al* 2006). Chatikobo *et al* (2001) found that the average herd size in Sanyati communal area in Zimbabwe was only 4 cattle.

According to Casey and Maree (1993), it is estimated that owning 10 cattle is the minimum number required to address primary needs for subsistence cattle farmer in Southern Africa. What can be observed from the study is that the average herd size is higher than that stated by Casey and Maree (1993) implying that respondents have better means to address their subsistent needs compared to communal areas of South Africa and Zimbabwe. This is based on the observation that the majority of the farmers (35%) owned between 11 and 30 herd of cattle.

5.2.3 Cattle herd composition and cow to bull ratio

It was observed that of all the total number of cattle owned by the respondents cows make up 34% of the total herd followed by oxen (26%) and heifers (22%). Calves were just about 16% of the herd with active bulls making up 2% of the total herd. In the commercial sectors, the target percentage of breeding cows should be 50% (Scholtz & Bester, 2010). A typical cattle herd in communal areas comprise of

between 45 to 50 % cows and heifers with about 35 %, bulls and adults and followers and between 15 to 20 % calves (Barret, 1991). However, the surveyed farmers' herd composition is not consistency with Barret (1991). In this study shows that the breeding cows were found to be 34% and heifers being 22% which is below the average for communal areas of Southern Africa (Barret, 1991).

The explanation could be because subsistence farmers in NCA are crop-livestock integrated farmers who would require oxen for the provision of draught power thereby the ownership of more oxen (26%). Worth noting is the low percentage of active bulls which could be used to explain the low calving rate among the respondents. The ratio of active bulls and breeding cows is 1:18 ratio, which is within the expected range of 9 to 39 cows per bull (Gaudex, 2015).

The study results showed a ratio of 18 cows per bull, while the national average is 36 cows per bull (NSA, 2014). According to Gaudex (2015), the standard practice should have been ratio range is 9 –36 cows per bull in Southern Africa. The general recommendation for bull: cow ratio is typically 1 bull to 20-30 females, with mature bulls closer to 1:30 ratio and yearling bulls at 1 bull: 20 cows. However this is influenced by the type of ranging, either controlled or free roaming management (Day, 2015). In the communal livestock sector the free range system results in breeding cows to be mated by any bull as was also noted by (Scholtz *et al*., 2008), thus making these ratio not applicable to most communal grazing systems.

The results implies that the cattle herds in the study area are not maximized and there is room for increasing production by increasing the cow to bull ratio which will eventually increase output, therefore increase the rate of off-take thus making the industry a viable economic option instead of it been subsistence.

5.3. Castration, dehorning, tick control, and deworming.

5.3.1 Dehorning

Of all the 86 respondents, only 16% were dehorning their cattle. Cattle without horns attract some preference over horned cattle in the market (Mavedzenge *et al*, 2006). In beef cattle production, every feed intake is expected to be converted into muscle gained; therefore horns are viewed as a waste of feeds (Mavedzenge *et al*, 2006). In addition to this dehorned cattle get higher price than horned ones as they are safer to handle and require less feed bunk and barn space as well as being easy to transport to the market.; furthermore, dehorned cattle easier to handle during training and during ploughing, as the horns are used as handling tools compared to dehorned cattle. As indicated in Figure 5.1 about 84% of the respondents indicated that they do not dehorn their cattle possibly implying that farmers in the study area are disadvantaging themselves due to lack of knowledge of better management practise such as dehorning.

According to Mavedzenge *et al* (2006), horns are of no practical use to commercial beef cattle. However, the objective of rearing cattle determines if the farmer dehorns the cattle or not (Ndlovu *et al*, 2004). Horned cattle (oxen) are much easier to handle during training and during ploughing, as the horns are used as handling tools compared to dehorned cattle. The later reasoning found by Masikati (2010) and Khombe (2002) can be used to justify the low percentage of farmers dehorning their cattle among the surveyed cattle farmers in Zambezi region.

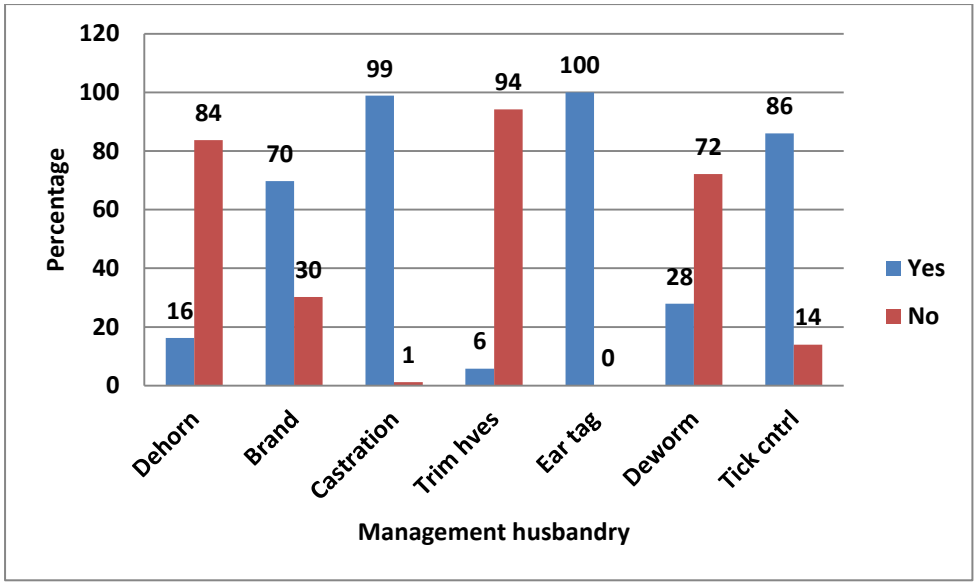

Figure 5.3: Animal management husbandry by surveyed cattle farmers

5.3.2 Castration

As shown in Figure 5.3, out of 86 respondents 99% castrated their bulls. This could be mainly because most of the farmers use oxen for draught animal power. This finding is in agreement with the finding by Chimonyo, Kusina, Hamudikuwanda and Nyoni (1999) who established that cattle farmers in rural districts of Zimbabwe also castrated their bulls for draught power purposes. Castration also plays a role in selecting best bull for breeding purpose, in a sense ensuring superior quality genes are passed on to calves which is positive for the cattle industry (Mashoko *et al*, 2007). This presents a positive aspect of cattle production in the study area, as best bull materials are selected, by castrating bulls exhibiting inferior genes.

5.3.3 Deworming

The study established that 73% of the respondents provide medicine for deworming their cattle to control internal parasites (see Figure 5.3). There is a need to control internal parasites due to the fact that communal areas are heavily stocked leading to a higher parasite burden than lightly stocked ones (Gadberry, 2010). This is common in communal areas where stocking rates are not been controlled and the cattle are not given supplement feed during the dry seasons which exposes them to internal

parasites. That is why it is important to overcome the worms to improve production of the animals (Gadberry, 2010).

Communal cattle farmers rarely vaccine their cattle against internal parasites as compared to external parasites. The possible reason is that internal parasites are not easily and early detected as was found in rural areas of Zimbabwe were only about 40% of farmers indicated that they deworm their cattle (Francis and Sibanda, 2001). The results from this study give a positive indication that farmers are treating their cattle against internal parasites and could enhance their participation in the cattle industry and marketing thereof.

5.3.4 Tick control

Of all the respondents, 86% indicated to control external parasites which are responsible for heavy economic losses to livestock industry, due to lowered productivity of the affected animals (see Figure 5.3). As indicated in Gadberry (2010) direct effects of ticks on cattle are tick worry, blood loss, damage to hides and skins of animals and introduction of toxins. Tick control is essential part of cattle management husbandry practices which has an effect on cattle production. This implies that farmers in the study area are concerned and controlling external parasites, which is a positive practice to enhance livestock production.

5.3.5 Record keeping

Record keeping results show that extremely few cattle farmers of the surveyed population do keep records about their cattle farming activities. All farmers kept the records of their cattle numbers; this is so because the Directorate of Veterinary Services (DVC) by law requires farmers to have a record book of all livestock kept. More than 90% of the farmers surveyed indicated not to be keeping records for: livestock birth, livestock purchased, livestock lost, livestock marketed and number of livestock weaned, as it can be observed in Figure 5.4.

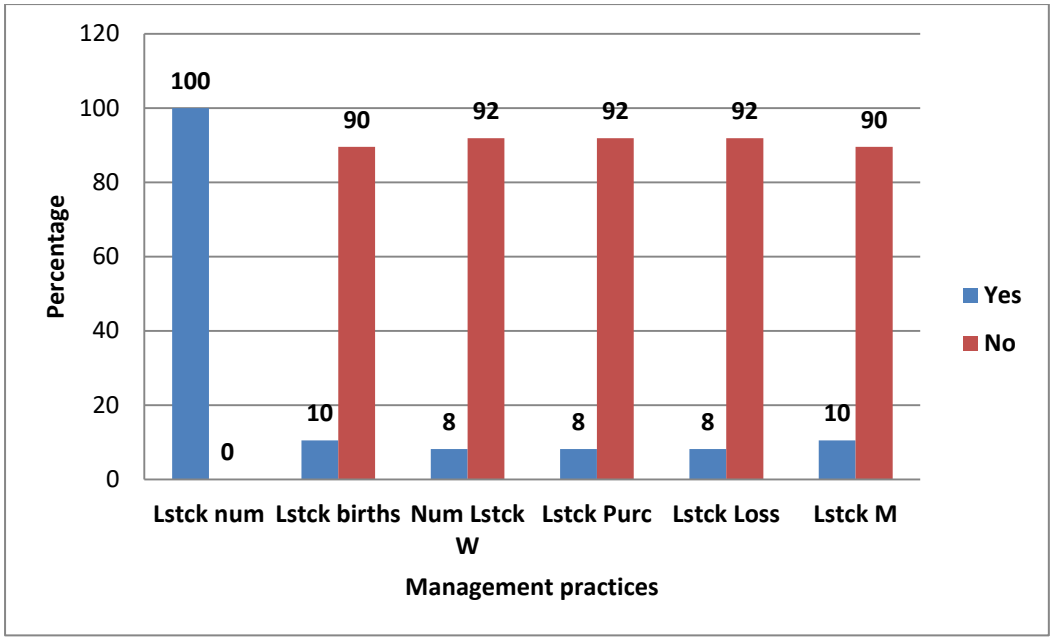

Figure 5.4: Livestock number record keeping

This scenario is common among communal farmers. Similar results were found by Tavirimirwa (2012) in Manicaland, who found that most communal farmers did not keep records of many cattle farming activities and only kept records of herd sizes which they are required by the directorate of veterinary services.

Record keeping is a critical aspect of managing a beef cattle operation. Without secure records, farmers may be at a loss if their system is working or not. Record keeping is an important tool for information like health records, livestock numbers, livestock birth, sales and purchases or pedigree unavailable in the herd.

The results shows that communal farmers are lucking behind in terms of livestock management aspects, and record keeping is one of the essential aspect of cattle management. This implies that farmers have little information about their cattle enterprises, thus decision making is not based on records, but rather uninformed data.

5.3.6 Rangeland management

The results show that very little effort is put towards rangeland management. As can be observed from Figure 5.5, 83% and 71% of the respondents do not practice rangeland restoration neither do they adjust their herd sizes in respond to pasture

availability and rangeland conditions respectively. Worth to notice from the study result was that 70% of farmers practiced rotational grazing. The farmers indicated that they move their cattle depending on the grazing availability in different areas. However, 30 % were unable to move their cattle to other areas due to non-availability of land, while well-off farmers who have land in more than one village are the majority of those practicing rotational grazing. Of all the respondents 85% have unfenced rangeland and crop fields as fencing of rangeland is prohibited in communal areas.

Grazing of livestock in many rural areas are on communally owned lands. The “tragedy of the commons” is well known, with a generalised application to ‘open access’ communal grazing resources, where ecologically determined carrying capacity rates are transgressed (Kasale, 2013).

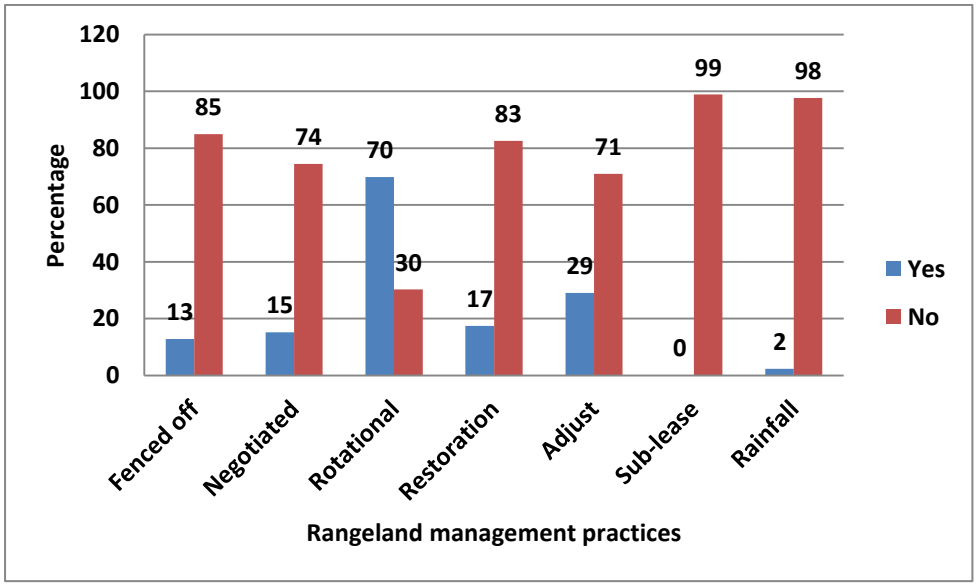

Figure 5.5: Rangeland Management

Similar results were found in Amathole, Chris Hani and Ukhahlamba districts of the Eastern Cape Province, South Africa, were farmers applied no form of rangeland management at all, absence of rules and lack of seasonal restrictions on rangeland resource use were the orders of the area (Moyo, Dube, Lesoli and Masika 2009).

A well-managed rangeland will increase animal production and profit, whilst improving rangeland productivity. Poorly managed rangeland will result in range degradation and poor cattle production. The results from the study implies that farmers are not well looking after the rangeland, and this will negatively affect the quality of cattle, thus affecting the industry and cattle marketing negatively.

5.3.7 Livestock husbandry practices

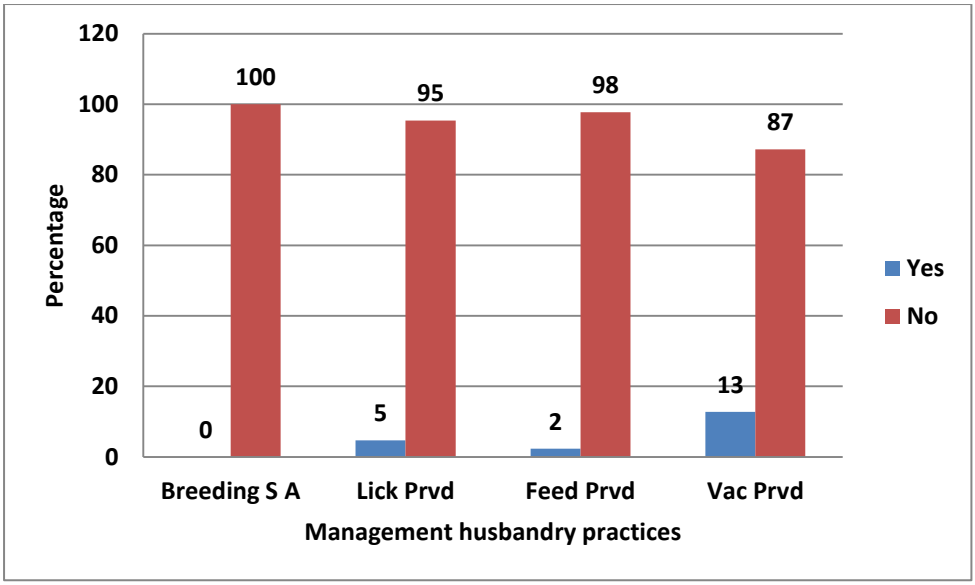

Figure 5.6: Livestock management husbandry practices

All farmers surveyed (100%) indicated not to practice breeding season. They attributed this to the constraints of communal farming systems and open grazing system in NCA. The open grazing system makes breeding seasoning almost impossible as cattle roam and mate freely with other herds during grazing (Chata, pers com, 2015). This is in agreement with Tavirimirwa (2012) who also indicated that communal cattle farmers in rural Zimbabwe experienced interbreeding between different herds as farmers made no attempt to control mating, which makes breeding seasoning none existing. According to Tavirimirwa (2012) this is attributed to the open grazing system in the rural communal areas.

More than 95% indicated that they do not to provide lick with 98% not providing supplementary feeding to their cattle. Apart from state financed FMD vaccine program, 87% do not vaccinate their cattle against various common diseases

compared to only 13% who systematically vaccinate their herd against common diseases annually.

Communal cattle are rarely supplemented with commercial feeds or improved legume fodder resulting which explains poor livestock productivity (Tavirimirwa *et al* 2012; Ngongoni *et al*., 2007). Since livestock feed is a challenge communal cattle have less feed hence the poor body condition and low weight gains and a higher predisposition of the animals to endoparasites (Mashoko *et al* 2007) especially during the dry season. Due to scarcity of feed and water communal animals in the research area have to move much further away from the homesteads which further contribute to poor body condition as was also established by Kasale (2013). Masikati (2010) and Maburutse *et al* (2012) concluded that cattle due to longer distances of 14km and 10km cattle have to travel to water points in Nkayi and Simbi respectively in Zimbabwe the cattle loose body condition, thus collecting low market value at abattoirs. Provision of licks, feeds and vaccination plays an important role in beef cattle industry. The results imply that farmers are not implementing cattle improving management practices, therefore their cattle are not meeting the standards required by the formal markets. This negatively affects the marketing prospects of cattle for beef in the region.

5.3.8 Sales trends

The study established very low off-take in the study area. From the total number of cattle sold collectively (84) out of 5552 translates into a 1.5% off-take. Oxen older than 36 months were the most sold category,(6%) of the total oxen older than 36 months were sold, and the second most sold category by numbers were cows, which was 1.25%. Heifers were the least sold, as a mere 1.2% combine heifer's categories were sold.

The results of the cattle sold have interesting implication on the quality of the meat and consequently the price farmers got. As cattle become older their meat becomes progressively tougher (Bloem, 2014). There are four maturity groupings, designated as A through D. Approximate ages corresponding to each maturity classification are: A = 9 to 30 months, B = 30 to 42 months, C = 42 to 72 months and D = 72 to 96 months old (MeatCo, 2013). The market prefers young and tender carcass grade A

and B, and the communal farmers supply to the market is in contrast to the consumer's preference. The study showed that older oxen and cows are the most sold, and these are in grade D, therefore collecting lowest N$/kg at Meat Co abattoirs.

According to Nkosi and Kirsten (1993) and Duvel (2002), there is a clear preference or tendency among communal cattle farmers in South Africa to sell their cattle when they are old. Communal cattle farmers prefer selling older cattle because the younger ones (females) are used for breeding purposes. The finding by Nkosi and Kirsten (1993) and Duvel (2002) are in agreement with the finding from this study, as the results showed that majority of the cattle sold were older oxen and older cows (6%) and (1.25%) respectively. The low sale figures could as well be attributed to the closure of MeatCo abattoir in Katima Mulilo and the presence of FMD which restricted movement of cattle and slaughtering activities during the year 2015, therefore farmers were restricted to informal markets and live sales of their cattle.

The marketing results implies that the two parties involved, MeatCo and cattle producers in the study area are not speaking the same language when it comes to the type of cattle to be sold for the formal market. The cattle producers prefer selling old oxen and cows, while MeatCo prefers weaners. The end result is low supply of the right cattle for slaughter by Meat Co, negatively affecting the cattle industry in the region at large.

As indicated in Figure 5.5 11.61% (10 out of 86) made profit in 2015; that is only one individual make about N$50 000; whereas their profitability stands below N$10 000 per annum. This clearly shows due to poor management system farmers making huge loss.

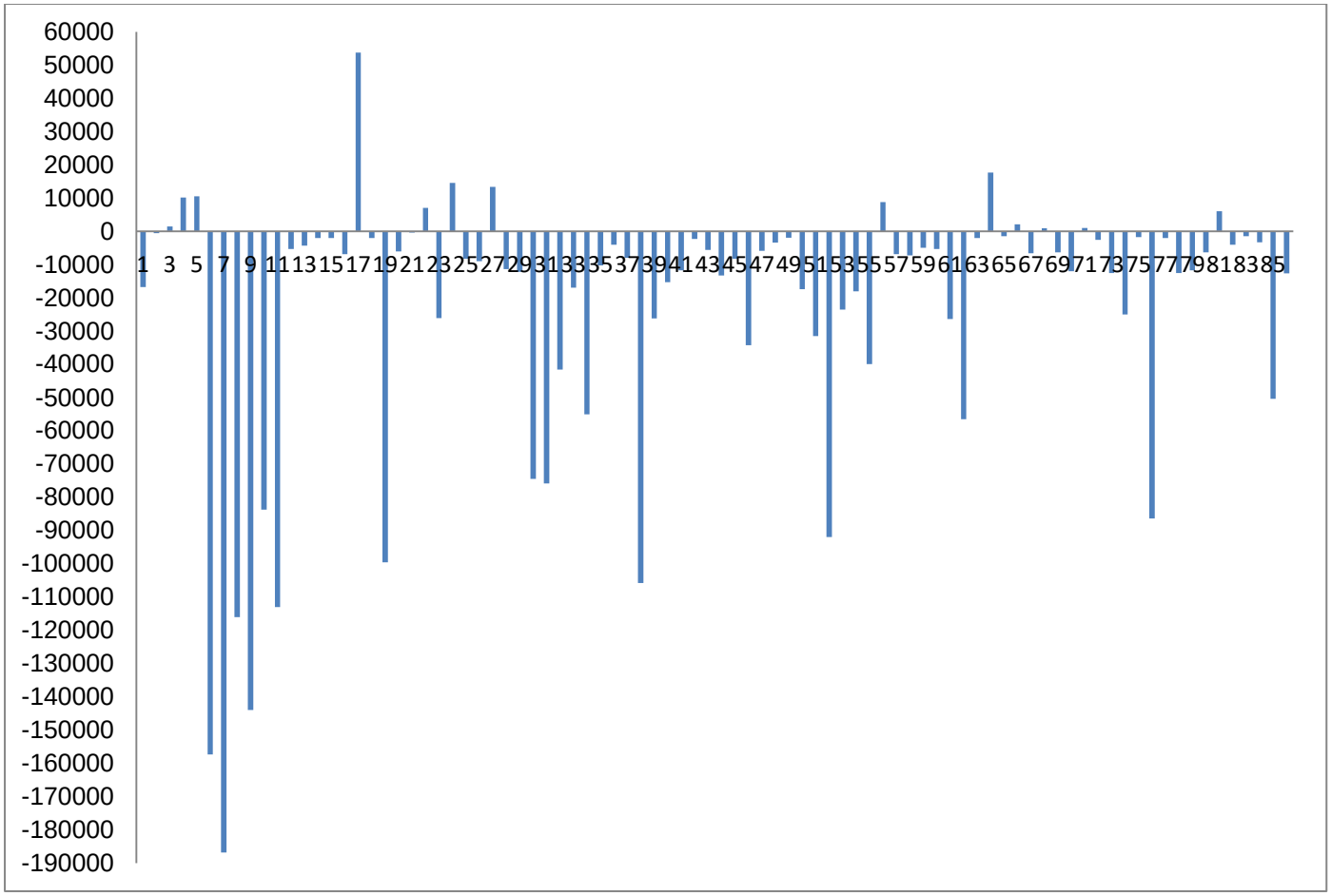

Figure 5.7: Distribution of profit or loss in Zambezi

5.4 Summary

The results reviewed that most respondents (48%) had secondary education, which is a significant factor in determining probability of adoption of improved agricultural management practices. 35% of the respondent's herd sizes ranged between 11 to 30 cattle, which was the highest and herd composition were mainly consisting of cows (34%), heifers (22%) and oxen (26%). The result also showed that most farmers did not necessarily fully implement most of the advanced livestock management practices such as: dehorning, deworming, tick control, supplementary feeding, licks, breeding seasoning and rangeland management. Of all respondents, only about 12% was making a meaningful profit from cattle production, the rest were making rather losses.

CHAPTER 6

FACTORS INFLUENCING ADOPTION OF IMPROVED LIVESTOCK MANAGEMENT PRACTICES

6.1 Introduction

This chapter presents and discusses the empirical results on the Factors influencing adoption of improved livestock management practices in Zambezi region. The chapter starts by presenting and highlighting the different independent variables (effects) and their influence on farmer's adoption of advanced agricultural management practices. It then continues to discuss the individual factors as well as placing the discussion in the broader literature. The chapter ends with a summary of the findings.

6.2. FACTORS INFLUENCING ADOPTION OF IMPROVED LIVESTOCK MANAGEMENT PRACTICES

The multi logistic regression model was used to analyse the factors affecting adoption of advanced agricultural technologies are presented in Table 6.3. Before explaining and discussing the results the theory behind the model that was used is explained. The McFadden's R squared is defined as 1-*l_mod/l_null*, where *l_mod* is the log likelihood value for the fitted model and *l_null* is the log likelihood for the null model which includes only an intercept as predictor (so that every individual is predicted the same probability of 'success'). Where the model is found to be really good, those individuals with a success (1) outcome would have a fitted probability close to 1, and vice versa for those with a failure (0) outcome. In this case through the likelihood calculation the likelihood contribution from each individual for the model will be close to zero, such that McFadden's *R squared* is close to 1, indicating very good predictive ability. When comparing more than two categories of multi-

logistic regression model; as a rule of thumb that a McFadden's pseudo *R-squared* ranging from 0.2 to 0.4 is accepted as a very good model fit.

Furthermore, *Cox-Snell and Nagelkerke* R^2 measure the percentage of variance explained by the regression model under different assumptions. Since R^2 cannot achieve a value of 1, Nagelkerke's R^2 was used as it has properties more similar to theR^2 statistic used in ordinary regression. Therefore in this study Cox-Snell R^2 with an assumption of small sample size and Nagelkerke R^2 with larger sample size in categorical data set were found to be 54% and 63% respectively; that means the model coefficient of determination was explained well (model summary). R-squared measures the proportion of the variation being explained by the model; an indication of the model's goodness-of-fit statistically (the regression model is a good fit of the data) as shown in Table 6.1

Table 6.1: Pseudo R-square

Cox and Snell	.547
Nagelkerke	.628
McFadden	.387

However, Table 6.2 (model fitting information) shows the hypothesis testing of the P-value is significant at 1%. This means that the dependent variable is influenced by the predicator variables and in other words there is linear relationship among the variables. Chi-squared test was also used to attempt rejection of the null hypothesis that the data are independent.

Also a chi-squared test was considered to test whether this was *asymptotically* true, meaning that the sampling distribution (if the null hypothesis is true) can be made to approximate a chi-squared distribution as closely as desired by making the sample size large enough. The chi-squared test was done to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories. For example, if the sample size is 80-91, the acceptance region for *T* with a significance level of 5% is between 10 and 34.

Table 6.2: Model Fitting Information

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	175.986			
Final	107.879	68.107	24	.000

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom. Table 6.3 presents the multi logistic regression model results on the factors affecting adaption rate of the improved livestock management practises by the farmers.

In this multi-logistic regression analysis, it estimated the model compared to ***"below average"*** as reference point; as indicated in Table 6.3 the model classification predication estimated at **56%, 76% and 63%** for below average, average and above average respectively.

When average **livestock management practise** compared, number of cattle and restoration found to be significant at 5%; whereas education only found significant at 10% only. However, intercept found to be significant at 5% with bigger estimated coefficient. This implying that the multi-logistic estimate for number of sales increase within the categories of average "**livestock management practise**" one unit compared below average category that will lead to increase in the management practise by 1.45 unit. This shows clearly number of cattle to introduce better management practise could be an incentive, however, it would have range land management distortion with number increment without proper animal husbandry practise.

The multi-logistic estimate that education found to be one parameter average categorised farmers managed to be better from the category of below average group; however, it was found only significant at 10%; however, this implying that one

unit increase in education with this category would eventually lead to increase the adoption rate by 1.35 unit.

Another parameter compared average and below average was restoration found to be significant at 5%; since those who indicated not implementing restoration was 83% compared to those who do restore was 17%. The multi-logistic regression estimated negatively that mean should the number of those do not implement restoration reduced by one unit; will eventually lead to increase the "**livestock management practise**" by 3 units compared to below average category. As indicated intercept in other word other factors which are not captured in this study found to be very elastic and negatively related and also significant at 5%.

Table 6.3: factors affecting adoption of improved livestock management technologies

Parameter Estimates							
L.MGT.PRAC[a]		B	Std. Error	Wald	df	Sig.	Exp(B)
AVERAGE	Intercept	-19.281	8.015	5.787	1	.016	
	AGE	2.423	1.851	1.713	1	.191	11.278
	HHS	-.314	.922	.116	1	.733	.730
	EXP	1.131	.835	1.835	1	.176	3.100
	No_Sales	1.040	1.129	.848	1	.357	2.828
	No_cattle	1.454	.769	3.571	1	.049	4.280
	GENDER	.703	1.183	.353	1	.552	2.021
	EDT	1.368	.810	2.854	1	.091	3.929
	FARM_ADV	.382	2.016	.036	1	.850	1.465
	Finance_Ass	-.193	.865	.050	1	.823	.824
	No_Adj_Range_Land	1.915	1.345	2.029	1	.154	6.788
ABOVE	Intercept	-22.756	9.585	5.637	1	.018	
	AGE	2.290	2.189	1.095	1	.295	9.879
	HHS	.226	1.168	.037	1	.846	1.254
	EXP	-.028	1.012	.001	1	.978	.972
	No_Sales	1.813	1.211	2.240	1	.134	6.130
	No_cattle	2.169	.853	6.463	1	.011	8.747
	GENDER	.853	1.418	.362	1	.548	2.347
	EDT	1.997	.949	4.424	1	.035	7.368
	FARM_ADV	3.319	2.334	2.022	1	.155	27.634
	Finance_Ass	1.433	1.060	1.830	1	.176	4.193
	No_Adj_Range_Land	2.776	1.469	3.571	1	.059	16.061

6.3 Factors affecting adoption of improved livestock management technologies

The adoption rate for the farmers was divided into three categories which are as follows: below average, average and above average. From the results what can be deduced is that the adoption of the introduced agricultural technologies by communal farmers in Zambezi region is subdued. In terms of adoption rate 54.7% of the respondents averagely adopted some of the technologies with 16.3% of the respondents having adopted below average of the technologies, while only 29.1% adopted above average. This implies that a lot has still to be done in order to increase adoption to above average. The following factors were found to be significant and positively influencing the adoption of advanced agricultural technologies: educational level, financial assistance, total cattle owned and farming advice received. Of all factors, total number of cattle owned by the farmer was highly significant at 95% confident level in adopting livestock management practices or advanced agricultural technologies and financial assistance was the second most significant at 95% confident level. The rest of factors were significant at 90% confident level.

Table 6.4: model classification prediction

Classification				
Observed	Predicted			
	Below average	average	above	Percent Correct
Below average	9	6	1	56.3%
average	3	33	7	76.7%
above	2	8	17	63.0%
Overall Percentage	16.3%	54.7%	29.1%	68.6%

Table 6.5: factors affecting adoption of improved livestock management technologies

Likelihood Ratio Tests				
Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	115.982	8.103	2	.017
AGE	109.718	1.839	2	.399
HHS	108.362	.483	2	.785
EXP	111.457	3.578	2	.167
No_Sales	111.009	3.130	2	.209
No_cattle	117.077	9.198	2	.010
GENDER	108.304	.425	2	.809
EDT	112.826	4.947	2	.084
FARM_ADV	112.352	4.473	2	.057
Finance_Ass	113.985	6.106	2	.047
No_Adj_Range_ Land	112.494	4.615	2	.100

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

6.3.1 Education

Education attained by the farmer was found to be significant at 10% and positively influence the decision by the farmer to adopt the newly introduced management practices. This means that an increase in the level of education will lead to an increase in the probability of a farmer to adopt the new advanced livestock management practices. This works through the fact that as farmers become more educated they become better placed to understand the importance of advanced livestock husbandry and their effect on cattle productivity and ultimately to the quality of the cattle, thus in the long run stimulating farmers' livestock market participation. The study's finding are consistence with those of Musaba (2010) who found that as the level of education of a farmer increases the higher the likelihood they were to adopt an advanced agricultural technology. In that study, Musaba (2010) found that highly educated farmers were more likely to adopt agricultural techniques such as dehorning, supplementary feeding, castration and vaccination, compared to those with lower education level who adopted very few techniques just like those in the study who fall into the below average category. The education operates through capacitating the farmer to gather information and make informed decisions on adoption of new technology. It could be that the educated farmers are better placed even to understand the significance of the new technologies and ways of farming compared to less educated ones. For that reason it would be easier for a highly educated farmer to consult and thereby adopt these new ways of livestock husbandry. Thus it can be concluded that an increase in the education level of the farmers will lead them to increase their adoption rate of the new farming technologies.

6.3.2 Financial assistance

Access to financial assistance was also found to be significant at 5% and positively influenced the probability of a farmer adopting advanced livestock management practices. Financial access in terms of bank loans enable farmers to purchase

livestock farming implements and other necessities, such as feeds, licks, vaccines and castration equipment. Having access to finance will empower the farmer to purchase some of the needed technologies as well as infrastructure that will enable utilization of the technologies.

From a study by Anang, Sipilainen, Backman and Kola (2015), in Northern Ghana farmers who accessed loans were able to afford technologies which they used to improve livestock production. Similar conclusions were arrived at by Adu-Gyamfi and Ampofo (2014) that farmers who accessed loans from banking institutions were able to adopt advanced technologies for livestock husbandry. This implies that access to finance by rural communal farmers is important as it enables them to improve their farming activities.

6.3.3 Total number of cattle owned

The number of cattle owned by a farmer was found to be significant at 5% and positively influenced the probability of a farmer adopting new livestock management technologies. This implies that the more cattle a farmer has, the higher the probability that the farmer will adopt advanced livestock husbandry practices. The explanation could be that as the number of livestock for a farmer increases this will also lead to an increase in chances for farmers to sale some of the livestock. From the sales proceeds then the farmer may invest part of it in feeds, licks, tick controlling and vaccination. The utilization of the new technology will enhance the quality of the livestock and consequently the value they will fetch at the market hence the cycle will continue as each will give positive feedback loop thereby deepening utilization of the new technologies. The sale of some of their cattle will avail cash to buy the livestock production inputs which will subsequently positively affect livestock production. This concurs with findings by Rahman (2007) who found that pig farmers who adopt new technologies were directly influenced by the herd size. Mafimisebi *et al* (2006) also established that cattle farmers with large herds are more inclined to adopt advanced technologies than those with small herds of livestock.

6.3.4 Farming advice

The results also established that advice received by a farmer was significant at 10% and positively influence the probability of a farmer adopting advanced agricultural technologies in their cattle production practices. Advice received by the farmers enhances understanding of the importance of providing licks to the cattle, and eventually leads to increased probability of the farmer to provide the licks. In other words the more advice on livestock production a farmer receives the more the farmer is inclined to adopt these new livestock production technologies. This could be due to the fact that the increase in advice sessions the more confident the farmer will be in terms of understanding the importance of the new technologies and hence the adoption. This was also established by Musaba (2010) who found that farmers who were exposed to more frequent advice sessions by the extension service providers in Oshana, Ohangwena, Oshikoto and Omusati in North Central Namibia adopted improved agricultural practices faster than farmers who did not receive the advice. Similar finding was also found by Kaliba (1997) in central Tanzania who found that farmers who received advice frequently provided supplementary feeds to their livestock unlike those who did not receive the extension advice.

6.4 SUMMARY

The chapter presented and discussed the results, starting with the discussion on the factors influencing adoption of newly introduced advanced agricultural technologies. The chapter ends with a brief conclusion about the rate of adoption of the newly introduced technologies. The results from Econometric analysis using the multi logistic regression model showed that adoption of the improved agricultural management practices was positively affected by: educational level, financial assistance, total cattle owned and farming advice, Education attained by the farmer and financial assistance were highly significant at 95% confident level in adopting livestock management practices. The rest of factors were significant at 90% confident level.

The study results reviewed an average adoption of newly introduced livestock management practices. Fifty per cent of the respondents adopted average of the seven management practices, and 30% adopted above average, while 19% adopted

below average. The adoption rate is way subduing, and requires major improvement in order to increase the percentage of adoption to above average.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

7.1 INTRODUCTION

This chapter draws the main conclusions and suggests recommendations based on the findings from this study. The main aim of the study was to explore the effect adoption of GIZ introduced livestock management practices on cattle production in the Zambezi region. The study investigated the households' socio-economic characteristics and its impact on adoption of newly introduced agricultural technologies, and off-take rate in the region. The specific objectives of the study were to: conduct a situational analysis of the livestock management practices in Zambezi region and to examine factors influencing adoption of the newly introduced livestock management. A total of 86 respondents were used in the case study.

7.2 Situational analysis of the livestock management practices in the study area

What can be concluded from the situational analysis of the livestock management practices in the study area is that a lot is still to be done to educate the farmers on the issue. This is evidenced by the fact that 90% of the respondents still have not yet embraced fully the importance of agricultural technologies such as dehorning, rangeland management, deworming, and provision of licks, supplementary feeds and breeding seasoning. The farmers could be making uninformed decisions on their farming operations because they do not keep records of their activities. Despite record keeping being one of the important inputs in farming decisions making more than 90% of the respondents do not keep farm records. Lack of proper record keeping could explain why only 12% of the respondents made profit from cattle sales, while majority made losses due to expenses related to livestock management. While livestock population figures are sufficient to meet formal cattle market demands with proper husbandry practices, off-take remains very low as only 1.5% of all the cattle owned were sold through the formal markets.

The other conclusion to be made is that there is a strong tendency by farmers to sale mostly old cattle which is in contradiction to the requirements of the formal markets which prefers heifers and young steers. These findings have implications for a successful cattle rearing and the livestock market in the region. The low number of farmers practicing advanced agricultural technologies is a concern that should be addressed by stakeholders in order to arrest the situation

The study therefore recommends that the project should intensify training on livestock management and improvement as well as setting up micro lending for livestock farmers and empowering local agro dealers to supply the needed technologies. This can be achieved through putting together loans tailor-made for communal farmers. The study further recommends infrastructure development; invest more in infrastructure development and capacity building of local institutions to manage the infrastructure. Farmer exchange programs should be carried out, by exposing farmers to other local communal farmers who have fully implemented the new technologies and are successfully farming and making profit from cattle enterprise in order for lesser adopters to see the importance of adoption of the advanced technologies.

In order to increase off-take rate, the study recommends that communal farmers should be educated about risks involved in keeping large stock, such as loses caused by diseases outbreaks and drought. Farmers should be educated about the relationship between cattle age and prices offered by formal markets, so that they change their tendency of mostly selling old cattle. Furthermore farmers should be educated to view cattle farming as an enterprise, rather than form of wealth store and status in society. The study further recommends organized sales closer to the farmers can be a possible solution as it may reduce transaction costs thereby encouraging more farmers to sale and from the sale they can see the essence of new livestock management practices.

7.3 Factors affecting adoption of improved livestock management technologies

The study results have shown that various factors are influencing adoption of newly introduced agricultural technologies. Educational level, financial assistance, total cattle owned and farming advice affected adoption rate of the introduced technology. Education attained and total numbers of cattle owned by the farmer were highly significant at 95% confident level in adopting livestock management practices. The rest of factors were significant at 90% confident level. The study reviewed an average adoption of improved livestock management, which represented 50% of the respondents. This could imply that low level of education coupled by lack of training is hampering sustainable livestock production as well as size of livestock sold.

The study therefore recommends that CLDP project and The Government through the Ministry of Agriculture, Extension Services to educate and train more farmers with secondary and tertiary education about advanced technologies and their advantages, and then use farmer to farmer training approach to trickle the knowledge down to other farmers, who in this case would be below average adopters. Financial assistance was a significant factor at 95% confident level; therefore, the study recommends that tailor-made loans/grants should be availed to the communal farmers. In term of agricultural advice, the study recommends that extension and veterinary services should be strengthened by ensuring that extension officers are well distributed and well equipped with necessary resources, which will enable them to increase their coverage in terms of the numbers of farmers they reach. Extension officers should give timely and professional advice on overall management practices by been subject specialists. The study further recommends that in order to increase number of sales by farmers, incentives should be paid to farmers who sale cattle at rightful age and quantity as the formal market requires, this should encourage communal farmers to sale more, and generate income in order to offset costs involved in adoption of new technologies.

7.4 Areas for further investigation

The study further recommends that studies should be carried out to cover other aspects that are left out of this study, but might have an influence on the livestock industry in the region and NCAs at large. Therefore, the study recommends that further studies on the factors affecting farmers' decision to sell their cattle, choice of market channels and uses of livestock by the farmers should be explored further.

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APPENDICES

1 Pseudo R-Square

Cox and Snell	.547
Nagelkerke	.628
McFadden	.387

2 Model Fitting Information

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	175.986			
Final	107.879	68.107	24	.000

The likelihood ratio tests shows the contribution of each and every parameters; significant unique contributions to the model (at 5% and 10%) are those highlighted by yellow

3 Likelihood Ratio Tests

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	115.982	8.103	2	.017
AGE	109.718	1.839	2	.399
HHS	108.362	.483	2	.785
EXP	111.457	3.578	2	.167
No_Sales	111.009	3.130	2	.209
No_cattle	117.077	9.198	2	.010
GENDER	108.304	.425	2	.809
EDT	112.826	4.947	2	.084

FARM_ADV	112.352	4.473	2	.107
Finance_Ass	113.985	6.106	2	.047
No_Adj_Range_Land	112.494	4.615	2	.100
REST	121.034	13.155	2	.001
Fen_off	108.413	.533	2	.766

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

4 parameters estimation for the Livestock management practise

Parameter Estimates

L.MGT.PRAC[a]		B	Std. Error	Wald	df	Sig.	Exp(B)
AVERAGE	Intercept	-19.281	8.015	5.787	1	.016	
	AGE	2.423	1.851	1.713	1	.191	11.278
	HHS	-.314	.922	.116	1	.733	.730
	EXP	1.131	.835	1.835	1	.176	3.100
	No_Sales	1.040	1.129	.848	1	.357	2.828
	No_cattle	1.454	.769	3.571	1	.049	4.280
	GENDER	.703	1.183	.353	1	.552	2.021
	EDT	1.368	.810	2.854	1	.091	3.929
	FARM_ADV	.382	2.016	.036	1	.850	1.465
	Finance_Ass	-.193	.865	.050	1	.823	.824
	No_Adj_Range_Land	1.915	1.345	2.029	1	.154	6.788
	REST	-3.033	1.295	5.482	1	.019	.048
	Fen_off	.592	1.604	.136	1	.712	1.808
ABOVE	Intercept	-22.756	9.585	5.637	1	.018	
	AGE	2.290	2.189	1.095	1	.295	9.879
	HHS	.226	1.168	.037	1	.846	1.254
	EXP	-.028	1.012	.001	1	.978	.972
	No_Sales	1.813	1.211	2.240	1	.134	6.130
	No_cattle	2.169	.853	6.463	1	.011	8.747
	GENDER	.853	1.418	.362	1	.548	2.347
	EDT	1.997	.949	4.424	1	.035	7.368
	FARM_ADV	3.319	2.334	2.022	1	.155	27.634
	Finance_Ass	1.433	1.060	1.830	1	.176	4.193
	No_Adj_Range_Land	2.776	1.469	3.571	1	.059	16.061
	REST	-4.986	1.752	8.096	1	.004	.007
	Fen_off	-.377	2.065	.033	1	.855	.686

a. The reference category is: Below average.

5 model classification prediction

Classification

Observed	Predicted			
	Below average	average	above	Percent Correct
Below average	9	6	1	56.3%
average	3	33	7	76.7%
above	2	8	17	63.0%
Overall Percentage	16.3%	54.7%	29.1%	68.6%