Rangeland management practices among emerging livestock farmers in Gauteng province, South Africa

by

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Declaration

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I, Ngoako Lucas Letsoalo proclaim that the dissertation is my own study and that all the references that I quoted are designated and accredited in the list of references.

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Signature Date

Conference contributions

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N.L. Letsoalo, H.T. Pule, J.T. Tjelele, N.R. Mkhize, K.R. Mbatha. 2016. Farmers' knowledge of livestock and rangelands management practices in the Gauteng province, South Africa. Small-scale farmers' knowledge of livestock-rangeland management practices in the Gauteng province, South Africa. 51th Annual GSSA Congress, The Wilderness Hotel Resort and Spa, Wilderness, Western Cape, South Africa, 3-8 July 2016.

N.L. Letsoalo, H.T. Pule, J.T. Tjelele, N.R. Mkhize, K.R. Mbatha. 2015. Veld condition assessment of the grazing areas used by emerging farmers in the Gauteng province, South Africa. 50th Annual GSSA Congress, Royal Agricultural Showgrounds, Pietermaritzburg, KwaZulu-Natal province, South Africa, 19- 20 July 2015.

N.L. Letsoalo, H.T. Pule, J.T. Tjelele, N.R. Mkhize, K.R. Mbatha. 2014. The effect of livestock grazing systems on rangeland condition of the emerging farmers of Gauteng province, South Africa. Symposium of contemporary conservation practice, Fern Hill Conference Centre, Howick, KwaZulu-Natal, South Africa, 3-7 November 2014.

Abstract

In South Africa, communal and/or emerging farmers' rangeland condition and grazing capacities deteriorate, because grazing capacity is usually over-estimated due to lack of knowledge on veld and livestock production system by the farmers. Woody plants has encroached in the arid and semi-arid savannas and grasslands biomes many parts of world, including in southern Africa. This causes challenges to farm owners due to its negative effects on the herbaceous plant material, which offers a substantial part of forage for livestock production. Although the consequences of deteriorating rangeland condition on livestock production is understood, there is limited research on the impact of land ownership on rangeland condition. Furthermore, knowledge on how farmers manages their livestock and rangelands.

The objectives were to document the knowledge of emerging livestock farmers on livestock-rangeland management practices, and to determine the effects of land ownership and practices on rangeland condition. Firstly, we hypothesize that, emerging livestock farmers unknowingly manages livestock in isolation from their rangelands, and secondly, rangeland in private owned lands are relatively in good conditions compared to communal and leased lands.

Fifty (50) emerging livestock farmers (i.e. ruminants) in different vegetation types and district municipalities of the Gauteng province were selected using a snowball procedure. To investigate the knowledge of emerging farmers on livestock - rangeland management practices, the farmers were asked questions about their 1) demographic information, 2) livestock management practices and 3) rangeland management practices. To test the differences in farmers' demographic profiles, Chi-square statistics was employed. To determine the effects of land ownership on rangeland condition of the selected farms, rangeland condition among three land

ownership types was compared using ANOVA, and the relations between veld condition score (%) and herbaceous biomass production (kg DM/ha) was tested using Pearson's correlation analysis

The results revealed that, the emerging livestock farmer are dominated by males (68 %) compared to female (32%). Majority (66%) of the farmers are old aged (> 50 years) compared to middle aged (30% (31 – 50 years)) and young (< 30 years) farmers (4%). Farmers who did not receive any agricultural training were higher (74%) than farmers who had prior training (26%). Sixty-three percent of the farmers had knowledge and understanding of breeding and calving seasons of their livestock, with only 27% having no knowledge and understanding of breeding and calving seasons of their animals. Eighty-three percent of the farmers keep mixed livestock (cattle, sheep and goats) species and 17% only keep cattle. The mean cattle herd sizes were significantly lower 8.2 ± 7.16 compared to goats and sheep (15.5 ±11.2). Feed shortage was the major constrain to livestock production (46%) compared to diseases (26%), marketing (14%), stock theft (8%) and other (6%) constrains. Sixty-three percent of the farmers had knowledge and understanding of breeding and calving seasons of their livestock, with only 27% having no knowledge and understanding. Eighty-three percent of the farmers keep mixed livestock (cattle, sheep and goats) species and 17% only keep cattle. All of the farmers indicated that they did not conduct rangeland condition assessment (mainly due to lack of knowledge). All farmers did not have fodder conservation plan for their farms and highlighted that during dry season, forage is scarce for their animals. Majority (58%) of the farmers relay on government-drought relief programme compared to those who were supplementing (20%), selling their animals (14%) and those with no drought coping strategy (8%).

Vegetation was assessed using nearest plant technique. In total, 28 grass species were identified during field survey, of which n=23, n=4 and n=2 were perennials, annuals and short-lived perennial, respectively. The most commonly observed and very palatable grass species, *Digitaria eriantha* had the highest frequency on private lands (n=92 and the lowest on communal lands (n=51). There were no significance difference in grass species richness and basal cover among land ownership types ($P > 0.05$). There were significant differences in veld condition score, large stock units, grazing capacity and herbaceous biomass production among land ownership types ($P < 0.05$). Private lands had a significantly higher veld condition score (69.63%) than leased (56.07%) and communal lands (52.55%). The herbaceous biomass production was positively correlated to the veld condition score ($r = 0.159$; $P<0.005$). The outcomes of this study show that emerging livestock farmers in Gauteng province have little understanding of rangeland-livestock management practices. The current results further indicated that poor grazing practices such as overgrazing might be common on leased and communal lands due to farmers' lack of knowledge on rangeland management practices. This may lead to rangeland degradation thus negatively affecting livestock production and the livelihood of farmers who rely on farming as a source of income.

Key words: agricultural training, feed scarcity, grazing capacity, management practices, socio-demography, veld assessment

Dedication

To my parents, Matome and Kobela Letsoalo who have provided me with words of morals, prayers, wisdom and spiritual support and to my siblings Mosima and Thapelo.

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List of abbreviations

ARC	Agricultural Research Council
DAFF	Department of Agriculture Forestry and Fisheries
DM	Dry Matter
FAO	Food and Agriculture Organization of the United Nations
GDARD	Gauteng Department of Agriculture and Rural Development
LSU	Large Stock Unit
NERPO	National Emergent Red Meat Producers Organisation
RDM	Rand Daily Mail
RMRDT	Red Meat Research and Development Trust of South Africa
SAS	Statistical Analysis System
USAID	United States Agency for International Development

Chapter 1

Introduction

1.1. Background

Rangeland is where indigenous vegetation is predominantly grasses and shrubs/trees that are grazed and browsed or have the potential to be grazed and browsed by livestock and wildlife (Allen et al. 2011). Rangeland degradation is a progressive loss of herbaceous material often followed by woody plant encroachment (Bosch and Theunissen, 1992). Rangeland degradation causes a major ecological transformation of savanna and grassland ecosystems grazed by livestock (Spottiswoode et al. 2009) and wildlife. Approximately 70% of the African rangelands are already degraded (Hoffman and Ashwell, 2001).

Overgrazing of rangelands is one of the major causes of land degradation (Soliveres and Eldridge, 2014). In Africa, overgrazing is the prime cause of approximately 243 million hectares (49%) of land degradation (UNEP, 2015). In South Africa, an estimation of 25% of the land owned by government and rural communities is degraded (Ndandani, 2016). Emerging and/or communal rangelands are often characterised by high stocking rates and absence of any grazing management systems (Lesoli, 2008). As a result, this reduces rangeland and animal production, and economic viability of farms (Lesoli 2008; Thomas 2008). This is because animal production is directly correlated to the condition of rangelands (Van der Westhuizen et al. 1999).

In South Africa, land degradation is mostly due to overgrazing and increasing of human activities, particularly in marginal soil (Vetter, 2003; Kioko et al. 2012).

Overgrazing reduces palatable plants species, while increasing less palatable species (Kgosikoma et al. 2012). The overgrazing is often observed in the communal and/or emerging farming sector (Hardin, 1968), probably because there is no explicit land tenure agreement to make sensible for the farmers to spend on rangeland conservation (Kgosikoma et al. 2012). Overgrazing resulted in decreased herbaceous plant species composition and basal cover, while increasing bush encroachment and alien plant invasion (Vetter, 2013).

South African emerging livestock farmers, particularly in the communal and/or government lands are assumed to lack knowledge and skills to manage their land sustainably (Samuels, 2006). These farmers are found on marginal land that are prone to risk and where modern farming technologies are rarely practiced. New technologies favours modern agriculture, neglecting local and traditional knowledge (Altieri, 2002). The South Africa's national beef industry has identified attaining development in the profit and long-term viability of the emerging beef sector as the highest priority (RMRDT, 2008; DAFF, 2010. However, this improvement has not been fully achieved. This indicates some lack of understanding of the views of these farmers on rangeland and livestock management practices and perceptions. Perceptions of land users and their ecological knowledge on vegetation changes remain ignored, despite rangeland degradation (Reed et al. 2008; Roba and Oba, 2009), especially in pastoral systems. Abate et al. (2010) suggested that, recording indigenous knowledge of the use of natural resources might offer beneficial data for understanding conservation and sustainable use of natural resources. In South Africa, this information is not adequately documented (Samuels,

2006), thus inhibit the development of effective rangelands and livestock management practices that are site specific to the emerging farming communities.

1.2. Problem statement

In South Africa, rangelands are viewed as mostly overstocked, overgrazed, degraded and unproductive (Vetter, 2003). It is estimated that 60% and 30% of rangelands is in a poor and average condition, respectively, while only 10% is in a good condition (Dekker, 1998).

Generally, livestock production from communal and/or emerging farmers in South Africa is still a challenge due to poor management systems, high occurrence of diseases and poor rangeland conditions (Musemwa et al. 2012). Lack of knowledge on best livestock and veld management practices, an increase in human population and lack of land ownership exacerbates the problem (Lesoli, 2008). To understand rangeland improvement strategies that benefit emerging livestock farmers, is crucial to engage them in the identification of problems that they face and in finding possible solutions to those problems (Nqeno, 2008). However, these natural resource management strategies are poorly understood in South Africa, particularly in the emerging livestock farmers sector. Consequently, this lack of knowledge inhibits effective management of natural resources.

1.3. Objectives

1.3.1. To ascertain the knowledge of emerging livestock farmers on rangeland management practices in Gauteng province, South Africa.

1.3.2. To determine the effects of land ownership on rangeland condition among emerging livestock farmers in Gauteng province, South Africa.

1.4. Research hypotheses

The hypotheses to be tested in this study are;

1.4.1. Emerging livestock farmers unknowingly manages livestock in isolation from their rangelands.

1.4.2. Rangelands in private owned lands are relatively in good conditions compared to communal and leased lands.

Chapter 2

Reviewed literature

2.1. Introduction

Rangelands inhabit approximately 18% and 25% of the land area of the world and offer forage for nearly 360 and 600 million of cattle, and small ruminants (sheep and goats), which is approximately 9% and 30%, respectively, of the world's meat production (Cupido, 2005). The South Africa's land area (> 80%) is characterized as rangelands (Hoffman and Ashwell, 2001). Probably this has changed with new developments in the country. South Africa's rangelands are the main source of fodder for approximately 13.8 million cattle, 25 million sheep and 6.4 million goats (DAFF, 2011). The demand for livestock production is increasing due to increasing human population and rising in income (Kirkman and de Faccio Carvalho, 2003).

Growing population of humans and livestock plus agricultural conversion of communal rangelands to crop production have caused widespread of rangeland degradation (Spottiswoode et al. 2009). Degradation has affected between 10% and 20% of land worldwide, and 73% of the grazing land in the world has depreciated resulting in a loss of approximately 25% of its animal carrying capacity (van der Berg, 2007; Cupido, 2005). Other forms of degradation include, woody plants encroachment, which reduces herbaceous production and grass cover, thus negatively affecting farmers' livelihood (Spottiswoode et al. 2009). This woody plant encroachment is due to complex interaction of either natural or/and human-induced factors (Moleele et al. 2002; van Auken 2009).

The Food and Agriculture Organisation (FAO) of the United Nations cited by Stocking and Murnaghan (2001), states that land degradation is a temporal or permanent decline in the productive capacity of land. Hahn et al. (2005) defined degradation of land as the decline of biological and financial production caused by unsuitable practices of land use. Degradation of rangeland causes a decrease in the capability of the ecosystem to sustain animal production (Bekele and Kebede 2014). It reduces biodiversity and palatable grass species through increasing cover and density of unpalatable grass species and forbs (Kgosikoma 2011). Rangeland degradation decreases food security and increases poverty.

2.2. The effects of livestock grazing on vegetation and soil

Livestock and plants interact constantly within rangeland ecosystems (Amiri et al. 2008). Grazing of livestock is the principal land use in savanna and grassland ecosystems globally. Livestock grazing has been widely implicated in the degradation of rangeland ecosystems (McGranahan and Kirkman, 2013). Hoffman and Todd (2000) characterized land degradation in South Africa into soil and rangeland degradation. Changes in rangeland surface morphology and soil characteristics have drastic effects on rangeland primary productivity and livestock production (Payton et al. 1992). Vegetation change affects rangeland-based livestock production throughout the world (Snyman and du Preez, 2005). Changes in vegetation have been attributed to poor livestock management systems (Kgosikoma, 2011). Livestock grazing influences the structure of plant communities by removing plant tissues and, in turn changing botanical composition and species diversity. Rangelands tolerate grazing but extended grazing intensities will have

negative changes on plant species composition and reduce biomass of grass (van Auken, 2009). Consequently, overgrazing is the primary cause of veld degradation (Snyman and du Preez, 2005).

Overgrazing is a major problem in most of the rangelands in South Africa. Overgrazing pressure that accompanies an increase in the human and livestock populations (Amiri et al. 2008), leads to increase of unpalatable plants species and bush encroachment, subsequent changed botanical composition and soil moisture properties (Heitschmidt et al. 2005; Kraaij and Ward 2006). The fluctuations in the vegetation and soil due to negative effects result in reduced penetration of water and enhanced erosion, thus exacerbating the effects of drought (Teague et al 2004). Livestock selectively graze palatable herbaceous plants, increasing annuals and unpalatable herbaceous plants species and bushes, resulting in reduced species richness (Kgosikoma, 2011). The effects of grazing pressure caused reduced rangeland condition in the world with consequently a decline in forage quality and quantity (Kirkman and de Faccio Carvalho 2003).

Soil moisture holding capacity plays a significant role in vegetation establishment and sustainability of rangelands. Soil structure together with rangeland management practices ultimately influence the root development and re-establishment of range plants (Chaichi et al. 2005). The grazing of rangelands plants by livestock has concurrent consequences on the soil surface becoming more compacted, which in turn adversely affects the infiltration of moisture into the soil (Amiri et al. 2008). The present rangeland condition in most cases is a consequence of past management (Ferrero, 1991).

2.3. Relevant policy and grazing management systems

Policy provides the overarching framework that guides the investment of state resources – human and financial – and establishes implementation and research priorities (Vetter 2013). It is thus important that the allocation of these scarce resources be informed by the best available knowledge to ensure that it is effective. Agricultural policy and development programmes of rangelands in South Africa and Botswana promoted fencing of grazing camps and promoting rotational grazing to control grazing density (Vetter, 2003). Consequently, these promoted management plans based on high technical knowledge and not adapted to local conditions and knowledge.

In South Africa, agriculture has been relatively low priority since the demise of apartheid, with national and provincial agriculture accounting for less than 2% of the national budget (Vetter 2013). Various programs such as the land reform enjoys political support (Lahiff, 2006; Vetter, 2013), however, this has not translated into allocation of sufficient resources. Targets of transferring land and improving rural livelihoods and food security (Hall and Cliffe 2009), have not been achieved. There is lack of improvement plans and policies concerned with agriculture, land reform and rural development, as well as the smallholder farmers who make up the majority of users of rangeland (Cousins 2010; Greenburg 2010). Rangeland of commons have been particularly neglected (Vetter 2013).

In Africa, an effort to enhance livestock farming and grazing land management practices among communal and emerging farmers have failed (Allsopp et al. 2007). This is in part because ecological carrying capacity are not applicable in arid and semi-arid

systems (Allsopp et al. 2007). Agricultural support in South Africa is mainly intended for large-scale and commercial farming, offering little support to communal and/or emerging farming of crop or livestock (Vetter, 2003). The department officials are poorly trained, under-resourced, and their provided service hardly assist farmers (Vetter 2013). Livestock production from communal and/or emerging farmers is of a low priority compared to other forms of agriculture (Musemwa et al. 2012). Grazing management schemes initiated by government promoting rotational grazing and erecting fences are rarely successful because they ignore the farmers aims and challenges (Salomon, 2011).

2.4. Knowledge of farmers on livestock and rangeland resources management

In depth knowledge and perception of emerging farmers on livestock husbandry, rangeland management and their influence on natural resource use and livestock production have been recognized by several authors worldwide (Gwelo 2012). Emerging farmers use both individual as well as common knowledge to sustain their livestock production (Solomon et al. 2007). Emerging farmers' indigenous knowledge and perceptions influence decisions about use of rangeland resources and livestock production (Allsopp et al. 2007).

Local ecological knowledge held by local farmers is of high value as it represents centuries of farming experiences on how to manage limited resources under unfavorable environmental conditions (Bellon, 1995). Local ecological knowledge may complement existing scientific knowledge and assist in filling the gaps in scientific understanding of agricultural practices (Samuels, 2006). This understanding and perceptions often have

great influence on the systems of management embraced to exploit a particular system (Kgosikoma et al. 2012).

In South Africa, communal and/emerging farmers are denied knowledge, and are regularly considered as ignorant by extension services for not practicing rational grazing (Allsopp et al. 2007). Development agencies continued to overlook the indigenous knowledge and perceptions of emerging farmers. Past interventions that have disregarded the indigenous knowledge and perceptions of local farmers have not been successful. The grazing effects of both commercial and communal rangelands on vegetation conditions are well researched in South Africa (Heitschmidt and Taylor, 1991; Rutherford and Powrie, 2013). However, there are limited long-term research projects to compare veld conditions between rotational and continuous grazing systems, and different land ownership types. Thus, it is important to comprehend how emerging livestock farmers perceive veld condition and the degree of land degradation occurring on their lands. A study focusing on livestock-rangeland management practices is important to provide insight necessary for planning various rangeland interventions to be commenced, especially in the communal and emerging farming areas.

2.5. Ownership of Agricultural Land in South Africa

The right to land has always been important in South African history (van Zyl et al. 1996). Land reform is one of the ways in which past racial exclusions and inequalities are being addressed in the ‘new South Africa’. Currently, land reform, mainly in the form of land redistribution and the restitution of land to people that were forcibly expropriated during the apartheid period, is resulting in more land coming under communal tenure (Vetter et

al. 2006). Approximately 82 million hectares of communal farmland (86% of all farmland) was in the hands of white minority (10.9%) (Lahiff 2008). The majority (13 million) black people, poverty stricken, remained crowded in the former homelands, where land rights were unclear or contested (van Zyl et al. 1994). These areas are characterized by extremely low income and high rates of malnutrition and illiteracy (Scogings et al. 1999). In contrast, the white farmers (55 000 employ 1.1 million black workers) farm on 102 million ha (of which 15.6 per cent is arable) (van Zyl et al. 1994). The white farmers are served by a compressive and highly developed system. The black farmers are not as well served (Vink and Louw, 1990).

Currently, South Africa has a complex history of land tenure system, which comprises mainly of communal and commercial land tenure. The land practices differ markedly between the two land tenure systems (DAFF, 2014). Total leased land represented only 13% of the total land areas (Van Zyl, 1994). According to Hatting and Herzberg (1980), lease land are mainly farmers who already own land. Since, property rights are the foundation of the natural resources management and conservation, there is a need to understand the functionality of land tenure management system, particularly communal land tenure management (DAFF, 2014). This is important to produce data and analyses studies that will assist in development of veld management strategies that will benefit end-users.

2.6. Chapter summary

This chapter elucidate livestock production as a primary contributor in the economy of South Africa. It was expressed in the literature that eextensive livestock production, on communal rangelands or government rangelands, is of low significance compared to

commercial rangelands or privately-owned lands. Management interventions that were previously used by the emerging and communal livestock farmers can be used to increase the efficiency of forage and animal production. Farmers need to be aware of the nutritional variations of forages to support animal and financial growth, animal production and reproduction, while ensuring that their natural rangelands continue to provide adequate nutrients for their livestock. Grazing management systems attempt to manage grazers and grazing lands to preserve or advance ecosystem structure and functioning, while social and economic goals are achieved. To achieve these goals famers are required to integrate information from biological, social, economic and management disciplines to constantly amend management according to changing socio-economic and environmental conditions. In response, numerous grazing strategies have been developed to sustain and improve rangeland condition. However, to apply any of these strategies effectively the use of adaptive management that is centered on applicable scientific results, local knowledge and experience to respond to ever-changing circumstances is required.

Chapter 3

Farmers' knowledge of livestock and rangelands management practices in the Gauteng province, South Africa

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3.1. Abstract

Emerging livestock farmers keep increasing stocking rates despite the deteriorating rangelands conditions. This rangeland-livestock management practices raises questions about the farmer's knowledge on the basic principles of rangeland-livestock management. Fifty (50) emerging livestock (i.e. ruminants) farmers were interviewed using structured questions to investigate and document their; 1) demographic profile 2) traditional ecological knowledge on rangeland management practices, 3) constraints relating to livestock-rangeland management practices and 4) strategies employed to cope with drought. The response differences on structured questions among farmers were tested using Chi-square statistics. There were significant differences on gender, age, education, farming experience and agricultural training ($P < 0.05$). The results revealed that the emerging farmer livestock sector is male dominated with 68% compared to 32% female

farmers. Senior farmers with age of 50 years and above were significantly more (66%) than farmers aged between 31 – 50 years (30%) and younger (< 30 years) farmers (4%). Farmers who did not receive any agricultural training were higher (74%) than those who had training (26%). Feed shortage was the major challenge to livestock production (46%) compared to diseases (26%), marketing (14%), stock theft (8%) and other (6%) constrains. Ninety-eight percent (n=48) of the interviewed farmers did not conduct rangeland condition assessment. Farmers relying on government-drought relief programme were significantly higher (58%) than those who provided own supplementary feed (20%), those selling their animals (14%) during drought and those who did not have any intervention plans (8%) as their drought coping strategies. Chi-square test results showed that there was an association between major challenges to livestock production and demographic profile (gender, age and education) ($P<0.05$). Emerging livestock farmers in the Gauteng province have little understanding of rangeland-livestock management practices. A multi-disciplinary approach involving government officials, researchers and land users is required to ensure that farming practices aiming at improving and sustaining rangeland-livestock production are adopted by the these emerging livestock farmers.

Keywords: agricultural training, forage scarcity, grazing capacity, rangeland condition, socio-demography, questionnaire

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3.2. Introduction

Emerging livestock farmers own 5.5 million (35 to 40 percent) of the 13.8 million cattle in South Africa (RMRDT, 2008). Over 70% of the emerging livestock farmers in South Africa are subsistence in nature, most of which are farming on communal land, with limited financial resources and knowledge of livestock-rangeland management technologies (Muller and Shackleton 2014). In South Africa, there is a decline in grazing areas, especially in communal rangelands or emerging farms, owing to a variety of factors such as excessive stocking rates caused by increasing human and livestock numbers. In Gauteng province, urbanization reduces available grazing areas (Nkosi, 2010), with negative effects on livestock production, particularly among the communal grazing lands used by resource poor emerging farmers.

There is a growing concern that stocking rates, particularly in the grazing lands used by emerging livestock farmers, are constant or increasing despite the deteriorating rangeland condition (Fynn and O'Connor, 2000). Forage shortage in the dry season institute the main problem on quality and quantity (Mapiye et al. 2009; Masikati, 2010), consequently leading to low livestock productivity. To develop livestock and rangelands management improvement strategies that benefit emerging livestock farmers, it is crucial to understand their perceptions and knowledge on livestock and rangelands management practices. This understanding could compliment scientific knowledge, thus contributing to the improved rangelands and livestock management practices (Kgosikoma et al. 2012), especially in the emerging sector.

South Africa experienced the worst drought around 1982. This drought resulted in significant livestock losses, especially for farmers without financial resources to buy

supplemental feeds and/or access to relief grazing (RDM News Wire, 2015). During the year 2007/2008, drought contributed to approximately 186 000 livestock mortalities in South Africa (DAFF, 2007). Rangelands are frequently subjected to seasonal droughts that may lead to instability in farming systems and necessities a high standard of risk management (Snyman, 2006). Several processes were presented to help affected farmers to better cope with drought disorders. The common one was the procurement and source of feeds at subsidised prices, depending on the status of a farmer (small, medium or large scale) (DAFF 2007).

Several authors worldwide recognised emerging livestock farmers' in-depth knowledge and perceptions on livestock husbandry, rangeland management and their influence on resource use and livestock production (Gemedo et al. 2006; Angassa and Beyene, 2003; Kassahun et al. 2008; Gwelo, 2012). In countries, such as Botswana, Ethiopia and South Africa, research revealed that communal or emerging livestock farmers have knowledge of rangeland management and how livestock optimize their foraging behaviour (Solomon et al. 2007; Kgosikoma, 2011; Gwelo, 2012). Integrating the local knowledge could advance the current knowledge of the structure involved in rangeland degradation (Roba and Oba, 2008; Dabasso et al. 2012) and subsequent loss of livestock productivity.

The objective of this study was to investigate and document Gauteng province emerging livestock farmers; 1) demographic profile 2) local ecological knowledge on rangeland management practices, 3) constraints relating to livestock-rangeland management practices and 4) strategies employed to cope with drought. We hypothesized that knowledge on livestock-rangeland management practices among

emerging livestock farmers in Gauteng province will be affected by their level of education and types of agricultural training.

3.3. Materials and methods

3.3.1. Study area

The project was conducted in Gauteng province, situated in the north-eastern part of South Africa (latitude 27°30 ' and 29°00' E, longitude 25°00 ' and 26°30' S). The survey sites are in the agricultural hubs of the City of Tshwane Metropolitan Municipality, Ekurhuleni Metropolitan Municipality, Sedibeng District Municipality (Midvaal and Emfuleni) and the West Rand District Municipality (Mogale city, Merafong city, Randfontein and Westonaria) (Figure 3.1).

The vegetation of Gauteng province is classified into grassland and savanna biomes, comprises 71 % and 29 % respectively. The Central Sandy Bushveld (SVcb 12) and Marikana Thornveld (SVcb 6) veld types are the most common of the nine veld types, including 6.3% and 5.8%, respectively, of the savanna biome. The grassland biome comprises of eight different veld types, with the Soweto Highveld Grassland (Gm 8), Carleton Dolomite Grassland (Gh 15) and Rand Highveld Grassland (Gm 11), veld types covering the greatest surface area of Gauteng province by 32%, 16% and 11%, respectively (Mucina and Rutherford, 2006).

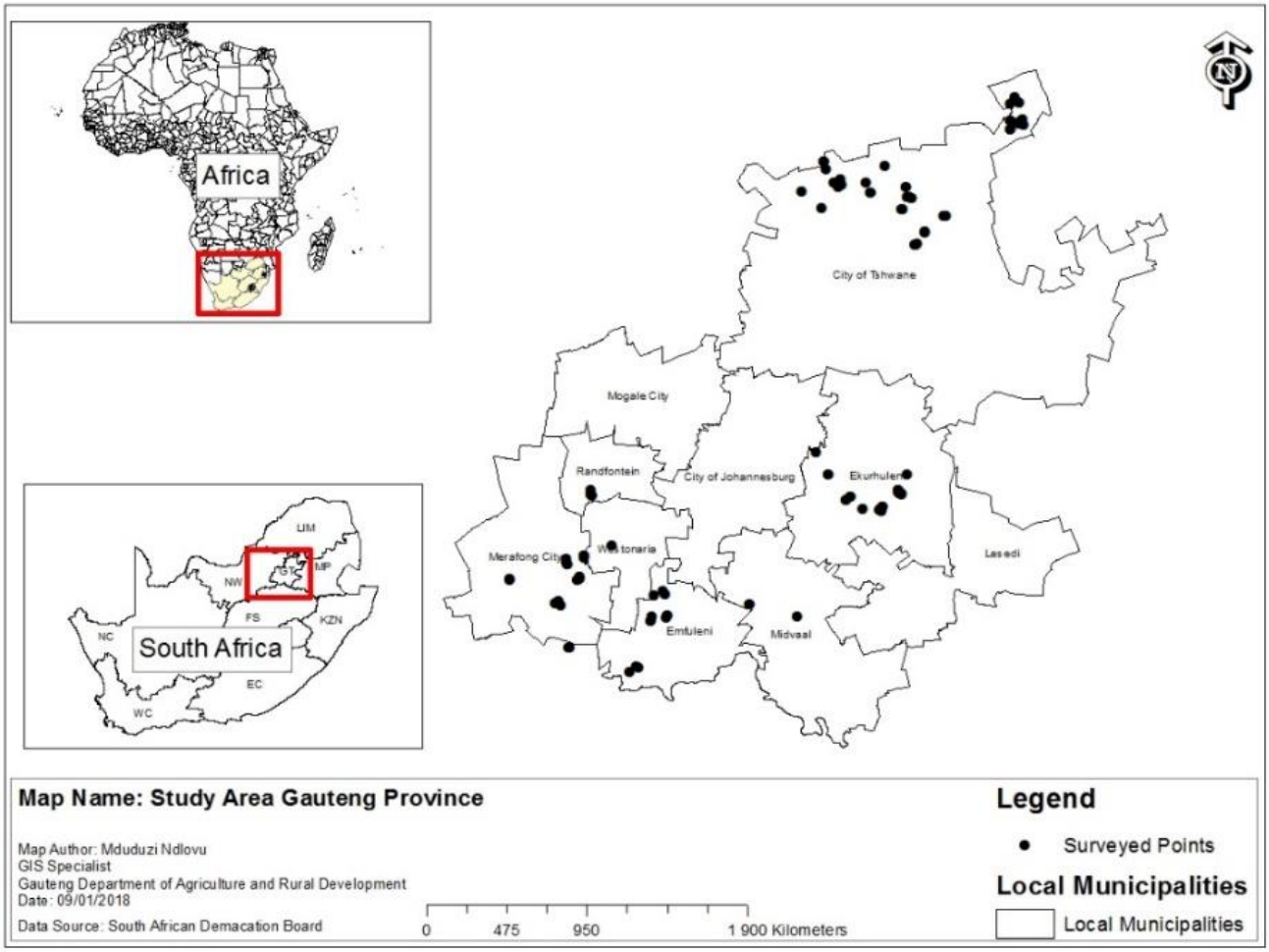

Figure 3.1: Map of Gauteng province showing the location of the emerging livestock farmers where questionnaire and vegetation surveys were conducted

Gauteng province receives a mild climate, characterized by warm, moist summer and cool dry winter. It receives average annual rainfall of 668 mm (Dent et al. 1989), varying from 900 mm in the higher laying areas to 556 mm in the northern and southern areas (lower laying) of the province. The rainfall in this province falls almost exclusively in summer (October to March) months. The eastern and central parts, receives a lower mean annual temperature of around 15.0°C. The daily mean temperature varies from as higher as approximately 21.2°C in summer (January) to lower as 9.8° C in the winter (July)

months. The province experiences an average of 30 days of frost per annum. Altitude ranges from approximately 1900m above sea level on the east and west high laying areas to 1 525 m in the southern parts of the province (Reinecke, 1983).

3.3.2. Selection of farmers

Fifty emerging livestock farmers were selected randomly from different district municipalities and veld types in the Gauteng province. These included both male and female farmers who possessed a minimum of 10 Large Stock Units (LSU) or animal/s unit equivalent, as long as they were ruminants (goats, sheep, and/or cattle). A meeting was held with officials from the Gauteng Department of Agriculture and Rural Development (GDARD) to introduce the purpose of the study before selection of farmers. For this study farmers with age of more than 50 years were grouped as senior farmers, aged between 31 – 50 years as middle aged farmers and younger farmers were 30 years of age and below.

3.3.3. Questionnaire data collection

Data on 50 individual emerging livestock farmers was collected using structured questionnaires and trained enumerators. The structured questionnaires allowed the researcher to address specific objectives and minimise differences between individuals interviewed by having standardised questions (Bryman, 2004). The farmers were requested to sign consent forms before the enumerator could proceed with the interview. The consent forms served as proof and reassurance that the farmers agreed to participate and that their personal information will be used only for this study. The participants were allowed not to continue with the study when they wish to.

The questionnaires were structured into four sections, which sought both closed and open-ended responses on farmers; 1) demographic profile 2) traditional ecological knowledge on livestock and rangeland management practices, 3) constraints relating to livestock-rangeland management practices and 4) strategies employed to cope with drought. The farmers were requested to respond to each question using a five – point (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree, scaled response) scale (Likert, 1932). This scale is especially useful in quantifying and comparing the attitudes of respondents, and the results can be standardized and contrasted.

3.3.4. Statistical analysis

Social data was analysed using SAS statistical software package (SAS, 2006). Fishers' Chi-square statistics was used to test for differences on demographic (gender, age, educational level and agricultural training and farming constrains) profiles among the Gauteng emerging livestock farmers. The differences in demographic profiles among farmers were declared significant at $P < 0.05$. Descriptive statistics such as means, percentages, range and standard deviation were employed.

3.4. Results

3.4.1. Demographics profile of farmers

The majority (n=34; 68 %;) of the emerging livestock farmers were males as compared to the females (n=16; 32%), with farmers' ages ranging between 28 and 74 years. The mean household size of the farmers was 5 ± 2 people. Senior aged (> 50 years) farmers were significantly more (n=33; 66%) than middle (31 – 50 years) aged (n=15; 30%) and

younger (< 30 years) farmers (n=2; 4%). The mmajority (94%) of interviewed farmers had some form of formal education, with 58% of them reached high school level, 22% reached tertiary level, 14% reached primary and 6% no formal education. Sixty-eight percent of farmers were members of farmer's organisation and 32% were not members. Most farmers (85%) relied on both livestock species and mixed crops farming, whereas the remaining 15% depended on livestock production only. Seventy-four percent of the farmers did not receive agricultural training in livestock production and/or rangeland management compared to only 26% of the farmers who received prior agricultural training.

3.4.2. Knowledge on livestock management and practices

Sixty-three percent of the farmers had knowledge and understanding of breeding and calving seasons of their livestock, with only twenty-seven having little or no knowledge and understanding of breeding and calving seasons of their animals. Eighty-three percent of the farmers kept mixed livestock (cattle, sheep and goats) species and 17% only kept cattle only. The mean cattle herd sizes were significantly lower 8.2 ± 7.16 SE compared to small stock (goats and sheep) which had a higher mean herd size of 15.5±11.2 SE. Only 2% of farmers owned game species. All farmers knew their cattle breeds and numbers. The most common cattle breed owned are; non-descript/crossbred (60.6%), Nguni (20.1%) and Brahman (19.3%). Forty-eight percent (n=24) of the farmers knew the diseases that are prevalent in their farming areas, and used prophylactic vaccines to prevent animal diseases, while 36% (n=18) relied on the advice from the state veterinarian for diseases in the area and for vaccination. Sixty-two percent of the farmers had livestock records and 38% did not. Seventy-eight percent (n=39) of farmers bought

their livestock, 16% (n=8) received livestock through government funded projects and 6% (n=3) inherited their livestock. The results for livestock market accessibility are illustrated in Figure 3.2.

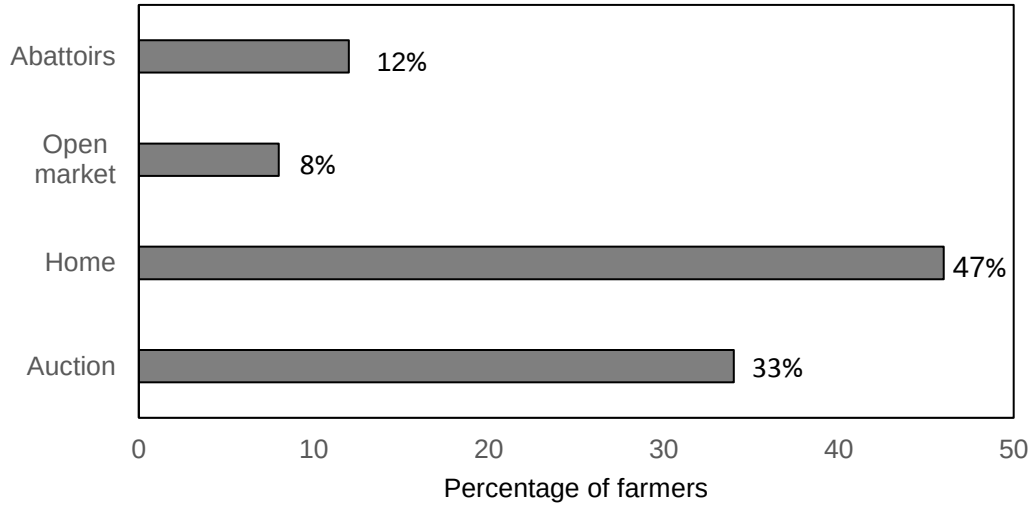

Figure 3.2: Market access for emerging livestock farmers in Gauteng province (n=50)

3.4.3. Major constrains to livestock production

Farmers highlighted several challenges as constraints to livestock production. Forty-six percent of the farmers reported feed shortages as an important constrain to livestock production (Table 3.1).

Challenge/ Constraint faced	% of farmers faced with Challenge or Constraint	Pearson Chi-square (*p*) values of the association between challenges faced and farmers demographic profile			
		Gender	**Age**	**Education**	**Agricultural training**
Feed shortages	46	0.016***	0.632	0.565	0.812
Diseases	26	0.018***	0.637	0.192	0.814
Marketing	14	0.106	0.758	0.010***	0.895
Theft	8	0.415	0.074	0.072	0.942
Other	6	0.457	0.764	0.971	0.397

The types of constrains limiting livestock production among emerging livestock farmers of Gauteng province (n=50). *** Significant at (P < 0.05)

3.4.4. Rangeland management and veld condition

The results on rangeland management and veld condition assessment revealed that 2% (n=1) of the emerging livestock farmers had grazing management plans, while 98 % (n=49) of the farmers did not have grazing management plans. Seventy percent (n=35) of these farmers did not apply prescribed burning and veld condition assessment practices. Sixty-eight percent (n=34) of these farmers indicated that they did not know grazing capacity and the stocking rate of their, while, 24% (n=12) knew. All farmers did not have fodder conservation plan for their farms and highlighted that during dry season, forage is scarce for their animals. Fifty-six percent (n=28) of the farmers mentioned evidence of decrease in grazing capacity on certain parts of their rangelands and that bush encroachment was the main cause of rangeland degradation, while 30% (n=15) mentioned signs of animal condition as evidence that rangeland deterioration. Fifty-two percent of the farmers confirmed that their grazing lands are encroached with woody

trees. Fifty percent of these farmers understood little about veld condition assessment (Figure 3.3).

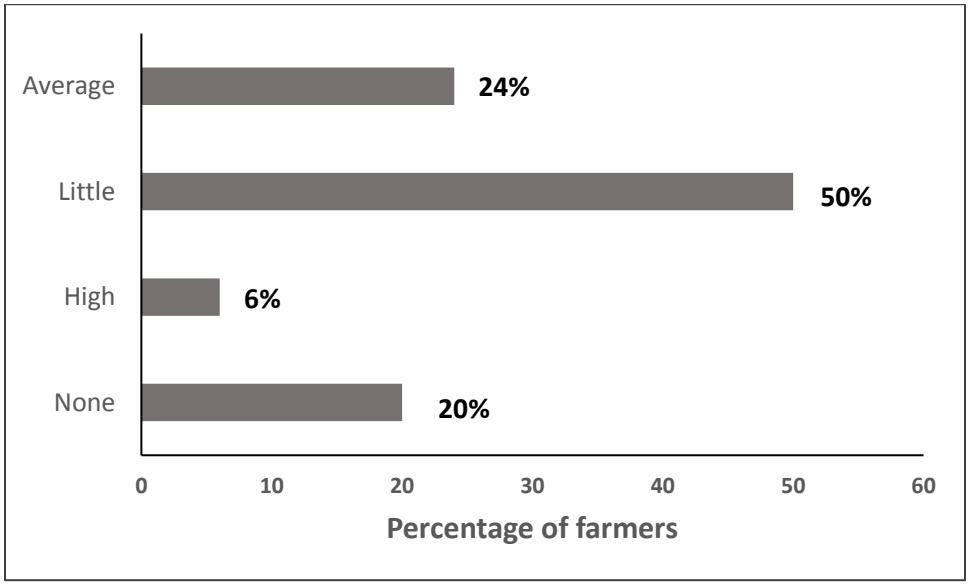

Figure 3.3: Knowledge on veld condition assessment among emerging livestock farmers of Gauteng province (n=50)

The results showed that 68% (n=34) of the farmers considered their rangeland to be free from soil erosion, while 18.7% considered their rangeland to have soil erosion and 12% did not know whether their veld had soil erosion or not.

3.4.5. Drought coping strategies

Fifty-eight percent of emerging livestock farmers received assistance from government compared to those providing supplementary feeding (20%) and selling their animals (14%) to cope with drought conditions (Figure 3.4).

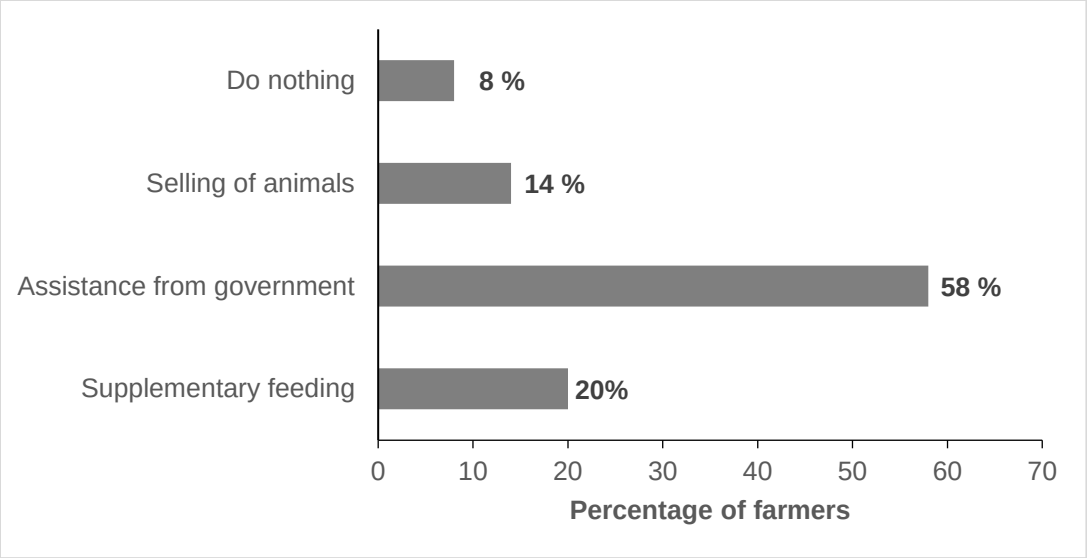

Figure 3.4: Drought coping strategies practiced by Gauteng emerging livestock farmers

3.5. Discussion

Males (68%) dominated Gauteng emerging livestock farming sector over females (32%). This highlight the need for women to participate in livestock production. In Africa, women carry out most of agricultural activities (FAO, 2011), but large-stock such as cattle are largely owned and taken care of by males. This confirm the results of this study, with the ratio of livestock, particularly cattle farming in Gauteng province in favour of men over women.

The fact that most of the livestock farmers in Gauteng province were older (≥51 years), indicated that youth participation in livestock farming is a challenge. Consistent with our study, numerous studies have also indicated that youth is not interested in agricultural activities (Tafere and Woldehanna, 2012; Swarts and Aliber, 2013). Poor youth participation in livestock farming or agriculture in general, implies a breakdown in indigenous skills transfer from the elders to the youth as suggested by other studies

(Lesoli, 2011). Consequently, posing a challenge to the future of agriculture succession plans, specifically when elderly farmers leave agriculture for retirement (Chepape et al. 2011; Matabane et al. 2015). There is a need to provide training to women and youth, especially from peri-urban areas such as in Gauteng province on aspects of livestock-rangeland management practices. This will ensure sustainability of livestock-rangeland productivity, while contributing to food security and poverty alleviation, especially among women and children. Expatiated entrance to information through training and giving women and youth responsibilities on farm operations both at household and community level, can improve their participation in agriculture and agri-business (NERPO, 2000).

Most of the Gauteng emerging livestock farmers had high school education levels, as such are considered literate (Stats SA, 2011). This creates opportunities to understand and adopt rangeland–livestock management technologies (Moyo et al. 2013). However, it remained relatively unknown whether the Gauteng emerging livestock farmers understand and adopt rangeland management practices. It is of great importance in this study to understand if the level of education by the emerging livestock farmers influences among others, the profitability of their enterprises.

The results also further revealed that most (n=27; 54%) of the Gauteng emerging livestock farmers are on communal land as oppose to private and lease lands. Most livestock farmers in South Africa are in communal areas. However, Mpandeli and Maponya (2014), observed that, except for Limpopo province, where majority of farmers own land. In South Africa, efforts are being made for farmers to own land through Land Reform program. However, the problem is that emerging livestock farmers who recently received farming lands do not have the required experience to make decisions and

manage their farms, nor do they possess the depth of knowledge that is required to run a farming project successfully (Harvey, 2006). One suggested solution to this problem is the implementation of a mentorship programme regard to land reform. However, this was not realised due to different challenges that beset land reform in different areas of operation (Jacobs, 2003).

The results of the current study indicated that cattle numbers were lower than numbers of goats and sheep. However, cattle are the most valued livestock species among emerging livestock farmers because of their numerous roles within society (Delali et al. 2006). Generally, cattle farming is the principal livestock subsector, contributing about 25-30% of the total agricultural yield per year in South Africa. Beyene et al. (2014) found that cattle are kept mainly for breeding, milk, meat and social security in South Africa. Raising of diverse livestock species by emerging and communal livestock farmers is a common practice in Africa, including South Africa (Ndikumana et al. 2001; Montshwe, 2006; Musemwa et al. 2008; Abate et al. 2010). Herd diversity is a strategy for effective and optimum use of vegetation because animal species differ on their feeding habits (Abate et al. 2010). Keeping different livestock species are treasured for various reasons, including maintaining cash flow (Behnke and Scoones 1992).

Although crossbreeds are dominating among emerging farmers, programme causes reduction of genetic diversity and general vigour in future generations of the crossbreds (Scholtz et al. 2008; Nqeno, 2008). However, there are also positives about cross breeds. These positives include adaptability and diseases tolerance of cross breeds, relative to pure breeds. It is important to breed with animals that are adapted to

local conditions, especially emerging farmers because of the nature of their farming environment.

It was found in this study that most (n=22; 44%) of Gauteng farmers sell their livestock at home (private sales). According to Nkosi and Kirsten (1993), this is the most common option for selling animals by emerging livestock owners. This method is important in the livestock marketing of the emerging farmers (Musemwa et al. 2008). These findings confirmed studies conducted in the Eastern Cape province, where majority of emerging livestock farmers sold most of their animals at their homes (Musemwa et al. 2008). In rural areas of South African, it is difficult for emerging livestock farmers to participate in commercial markets due to various constraints (Wynne and Lyne 2003). Efforts of these farmers to sell their livestock in formal market are affected by poor infrastructure and high operation costs (Wynne and Lyne, 2003). Private sales provide a unique livestock marketing ground such as for customary and religious celebrations, funerals, weddings, and investment (USAID, 2003; Musemwa et al. 2008). In most cases, emerging livestock famers get relatively low prices for their animals through formal marketing channels. Low live weight, poor body conditions and old age of cattle have also been cited as the reasons why smallholder cattle fetch low farm gate prices (Montshwe, 2006). Several studies by NERPO and IDT (2005) reported that most emerging farmers' cattle are too old and lean yet they demand high prices for them.

Most of the emerging livestock farmers stressed feed shortages in both quality and quantity as the most important constrain that posed a threat to livestock production. This is a common observation among emerging livestock farmers, which confirm the findings by other researchers (Masimba et al. 2011; Devendra et al. 2000). Shortages of feed is

worse during the dry season, causing a loss in animal condition (Mapiye et al. 2009). For the Gauteng emerging farmers, land shortage, increased human and livestock population worsened feed shortages. There are, however, prospects to improve nutrition requirements of livestock. For instances, provision of local feed supplements, growing pasture and fodder crops, and training of farmers on rangeland-livestock management.

The fact that only 2% of the Gauteng emerging livestock farmers had grazing management and fodder flow plan, might be part of the reason for the poor state of their grazing lands found in this study. This agrees with previous research suggesting that knowledge and skills might be minimal among emerging livestock farmers on rangelands management (Boyazoglu, 1997). The lack of grazing management and fodder flow plan is caused by various factors such as lack of knowledge and training. In a personal engagement with the farmers, part of the reasons farmers did not assess veld condition was lack of land ownership, understanding and efficient support from extension and advisory services. Abule et al. (2007) found that 80% of farmers in Borana, Ethiopia relied on their indigenous knowledge to manage their livestock and rangelands, which is consistent with the results obtained in the current study. The current results further indicated that poor grazing management practices such as overstocking may be prevalent among emerging livestock farmers of Gauteng province because of farmers' lack knowledge on rangelands-livestock management practices. It is therefore, important to train farmers on grazing management and fodder flow planning to help them improve the condition of their grazing areas in Gauteng province. This will further ensure that animal conditions and the livelihood of the emerging farmers are improved.

The study showed that a higher percentage (58%) of Gauteng emerging livestock farmers depended on the government for assistance during drought. This is similar to the findings of Mpandeli and Maponya (2014) who reported that livestock farmers in Limpopo province depended of the government for assistance during drought. This could potentially discourage farmers to adopt risk-minimizing strategies in their farming practices. Greater awareness to sensitize and encourage Gauteng emerging livestock farmers to engage in drought risk reduction measures is needed.

3.6. Conclusion

The study found that, male dominated the Gauteng emerging livestock farming sector. The involvement of the young generation and women is limited and most if the emerging livestock farmers have high school education. The results of this study further revealed that emerging livestock farmers are faced with challenges related to feed shortages, animal diseases and marketing. The poor sharing of knowledge, skills and information is exacerbated by imperfect collaboration among emerging farmers, extension officers and researchers. Gauteng emerging livestock farmers should be trained on the sustainable use and management of rangelands resources for enhanced livestock production. Furthermore, continuous monitoring and improvement of rangelands resources is a key to the success of the Gauteng emerging livestock farming. Veld condition assessment methods should be developed for emerging farmers based on several indicators to ensure sustainable animal production and marketing of agriculture by various sectors. This is a serious challenge facing agriculture in this country.

Chapter 4

Current range condition in relation to land ownership types among the emerging livestock farmers in Gauteng province, South Africa

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4.1. Abstract

Rangelands are major feed resource for livestock farming in South Africa, despite undergoing different forms of degradation. These forms of degradation are a result of inappropriate veld and livestock management practices such as excessive stocking rates. While information on judicious veld management is available, their adoption is still unsatisfactory and seems to depend partly on the type of land ownership by farmers. The objectives of this study were to; 1) compare rangeland condition (species richness, basal cover, veld condition score, and herbaceous biomass) among three land ownership types (leased land, communal land and private land), and 2) determine the relationships between veld condition score (%) and herbaceous production biomass (kg DM/ha). Vegetation was assessed at fifty farms under different land ownership types using nearest plant technique. A one-way ANOVA was used to compare differences ($P < 0.05$) in

species richness, basal cover, veld condition (%) large stock units, grazing capacity and herbaceous biomass production among the three grazing systems. A correlation analysis was undertaken between veld condition scores and herbaceous biomass production. There were significant differences on veld condition score and biomass production among land ownership ($P<0.05$). However, there were no significant difference on grass species richness and basal cover among land ownership types *(*$P>0.05$)*. In total, 28 grass species were identified during field survey, of which n=23, n=4 and n=2 were perennials, annuals and short-lived perennial, respectively. The most commonly distributed and highly palatable grass species, *Digitaria eriantha* had significantly higher frequency under private owned lands (32.3 %) compared to communal owned lands (12.3%). Private lands had a significantly higher (69.63%) veld condition score than leased (56.07%) and communal lands (52.55%). Biomass production was significantly higher (± S.E.) 2 990.30 ± 214 kg DM/ha on private owned lands, compared to leased lands 2069.85 ± 196 kg DM/ha and communal lands 1 331.04 ± 102 kg DM/ha. Biomass production was positively correlated with rangeland condition ($r = 0.159$; $P < 0.005$). The results suggested that rangeland conditions on communal and leased lands are in moderate condition than those on private lands. However, future research should explore viable strategies for monitoring rangeland conditions in communal and leased land in Gauteng province.

Keywords: Grazing, herbaceous biomass, management practices, species richness

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4.2. Introduction

Rangelands cover about 75% of total land area of South Africa (Smet and Ward, 2006), and support half of the national livestock herd of cattle, goats and sheep (Moyo et al. 2010). In recent decades, rangelands are often subjected to different forms of degradation (e.g. invasion of invasive and poisonous plants, and bush encroachment (Smit, 2004; Ward 2005; Moyo et al. 2012). These forms of degradation are mainly driven by inappropriate management practices such as excessive stocking rates (Kotze, 2013). Furthermore, plant species composition of rangelands has changed, thus potentially undermining the ability of rangelands to provide optimal forage for supporting animal production (Gusha et al. 2017).

In the Gauteng province, farming is practiced under different land use types such as on private owned farms, communal lands and on rented or leased farms (GDARD Strategic Plan, 2010-2014). The main differences between the land ownerships is related mainly to rights to grazing land, management of grazing resources and the outputs (Kotze, 2013). Privately owned farms (own land) are farms owned by private individual/s or government, or organisations. These farms are usually well developed, capital orientated and largely market oriented. The availability of adequate infrastructure such as fencing for a camp system and watering points allows for rotational grazing. This system is mostly employed by land users on privately owned land and consists of alternating periods of use and rest, to promote vegetation growth (Kgosikoma et al. 2012). On private owned farms, stocking rates are more conservative and adjusted to ensure sustainable veld and livestock production (Kapu, 2012; Kotze, 2013).

Communal lands are grazing areas not owned by individuals but belong to the whole communities and all members have equal access to available resources. In communal grazing areas, there are often unclear rules governing how grazing lands should be managed (Andrew et al. 2003). The grazing areas are shared and used by the community, without any rangeland management interventions (Samuels, 2006). They differ distinctly from private farms in their production systems, objectives and property rights (Kotze, 2013). The objectives of livestock production are not limited, and include draught power, dung, financial income, meat, milk and socio-cultural factors (Moyo et al. 2013). Communal grazing areas are usually continuously grazed except during the dry seasons, when animals can forage on both crop residues and forages from rangelands (Vetter, 2013; Gusha et al. 2017). Scholtz et al. (2013) stated that, lack of property rights reduces the financial value of communal rangeland due to uncontrolled stocking rates and absence of coordinated application of appropriate livestock-rangeland management principles.

According to DRDLR (2013a), agricultural land leases refer to lease arrangements that provides for the use of property at agricultural level. Furthermore, this means the right to hold or use property for a fixed period at a given price, without transfer of ownership, based on the written contract. Much of South Africa's rangelands are state owned and/or rented to farmers who often have little incentive to manage it sustainably (Milton, 1995). Majority of the farms are rented to farmers with available camps, which provide opportunity to practice rotational grazing systems with ease. However, some farms do not have camps, which makes it difficult for farmers to practice rotational grazing or apply proper rangeland management (Morokong, 2016). One of the condition of awarding

leased farms is to keep correct stocking rate and grazing capacity of the farms (Tshenkeng, 2009. However, farmers often ignore these conditions, since most farms are overstocked. Although, the correct stocking rates are included in the lease contract, most emerging farmers on leased land do not implement this practise. As such, it is important for government to enforce these rules (Tshenkeng, 2009).

Livestock management systems can apply substantial change on the diversity, composition, structure, and development of rangeland communities (Kgosikoma et al. 2012). In South Africa, most rangelands are moderately to seriously degraded (Snyman, 2003) and as a result the vegetation composition is dominated by unpalatable species such as woody plants and forbs (Tjelele et al. 2012), which resulted in a decline in grazing capacity. The reduction in carrying capacity of rangelands is important due to its major impact on the sustainable livestock production, with major economic implications. According to Westhuizen et al. (2005), objective rangeland condition assessment should be carried out periodically to monitor the trends in vegetation conditions. The changes observed should be used in the plan of rangeland management to ensure sustainable livestock and rangeland productivity.

Veld (rangeland) condition is a main aspect on biodiversity in rangeland ecosystems because it is the health state of the veld (Tainton, 1999). The potential to produce forage and to sustain optimal livestock production depend on rangelands status. Lack of understanding of the status and production potential of the rangeland can result to implementation of wrong grazing management methods such as overstocking. Overgrazing is the most important reason for rangeland degradation (Saayman et al. 2014).

Despite intensive scientific efforts in different parts of South Africa (Vetter et al. 2006; Gwelo, 2012), the database is not sufficient regarding the density and frequency of forage species. Proper understanding of the impacts of different land use systems on rangeland status is essential to maintain productivity and biodiversity (Sternberg et al. 2000; Mohammed and Bekele, 2010). Furthermore, information on the links between land tenure and current veld condition is vital to consider the relationship between animal health, animal performance and livelihoods of emerging livestock farmers (Gusha et al. 2017).

The objectives of this study were to; 1) compare rangeland condition (species richness, basal cover, veld condition score, grazing capacity and herbaceous biomass) among three land use types (leased land, communal land and private land), and 2) determine the relationships between veld condition score and herbaceous biomass.

4.3. Materials and methods

4.3.1. Study area

The study was carried out in the Gauteng province, which is situated in the north-eastern part of South Africa (latitude 27°30 'and 29°00' E, longitude 25°00 'and 26°30' S). The vegetation of Gauteng province is broadly classified into two biomes; the grassland and savanna, comprising 71% and 29%, respectively, of Gauteng province surface area. The savannas of Gauteng province comprises nine different veld types. However, the Central Sandy Veldtype (SVcb 12) and Marikane Thornveld (SVcb 6) veld types are the most common, comprising 6.3% and 5.8%, respectively. The grassland biome of Gauteng province comprises eight different veld types, of which Soweto Highveld Grassland (Gm

8), Carleton Dolomite Grassland (Gh 15) and Rand Highveld Grassland (Gm 11), veld types covers the greatest area; 32%, 16% and 11%, respectively (Mucina and Rutherford, 2006).

Gauteng province has a mild climate, characterized by warm, moist summer and cool dry winter. Rainfalls almost exclusively in summer (October to March) with mean annual precipitation of 668 mm, varying from 900 mm in the central higher laying areas to 556 mm in the lower laying northern and southern areas of the province (Dent et al. 1989). Average annual temperature varies from approximately 19.3˚ C in the north to 16.0˚C in the south of the province. The eastern and central areas, however, has a lower mean annual temperature of around 15.0˚C. The daily mean in January and July is approximately 21.2˚C and 9.8˚C, respectively. The province experiences on average 30 days of frost per year during the winter months (June-August). Altitude ranges from approximately 1 900 m above sea level on the east-west high laying areas to 1 525 m in the southern parts of the province.

The geology of the Gauteng province includes the rock type's dolomite, chert, quartzite, granite, diabase, shale and andesitic lava. The most important land type classes are Ab, Bb, Ba, and Ib. The Ib land types are often associated with ridge areas and Ab, Ba and Bb land types with flat, slightly undulating landscapes. The main soil series present are Mispah and Glenrosa which have an A horizon clay content ranging from 10% to 30% (Soil Classification Working Group, 1991).

4.3.2. Site selection

Fifty livestock grazing farms, participated in questionnaire and vegetation surveys were classified into different land ownership types (private land, communal areas and

leased/rented land). This classification resulted in 8, 32 and 10 emerging livestock farmers on private owned lands, communal lands and leased lands, respectively. Private farms (PVT) are farms owned by private individual/s or government or organisations. Communal grazing land (COM) is an area that is shared and used by the entire community, while leased grazing lands (LSD) provides the use of property at agricultural level, the right to hold or use property for a fixed period of time at a given price, without transfer of ownership, on the basis of the written contract.

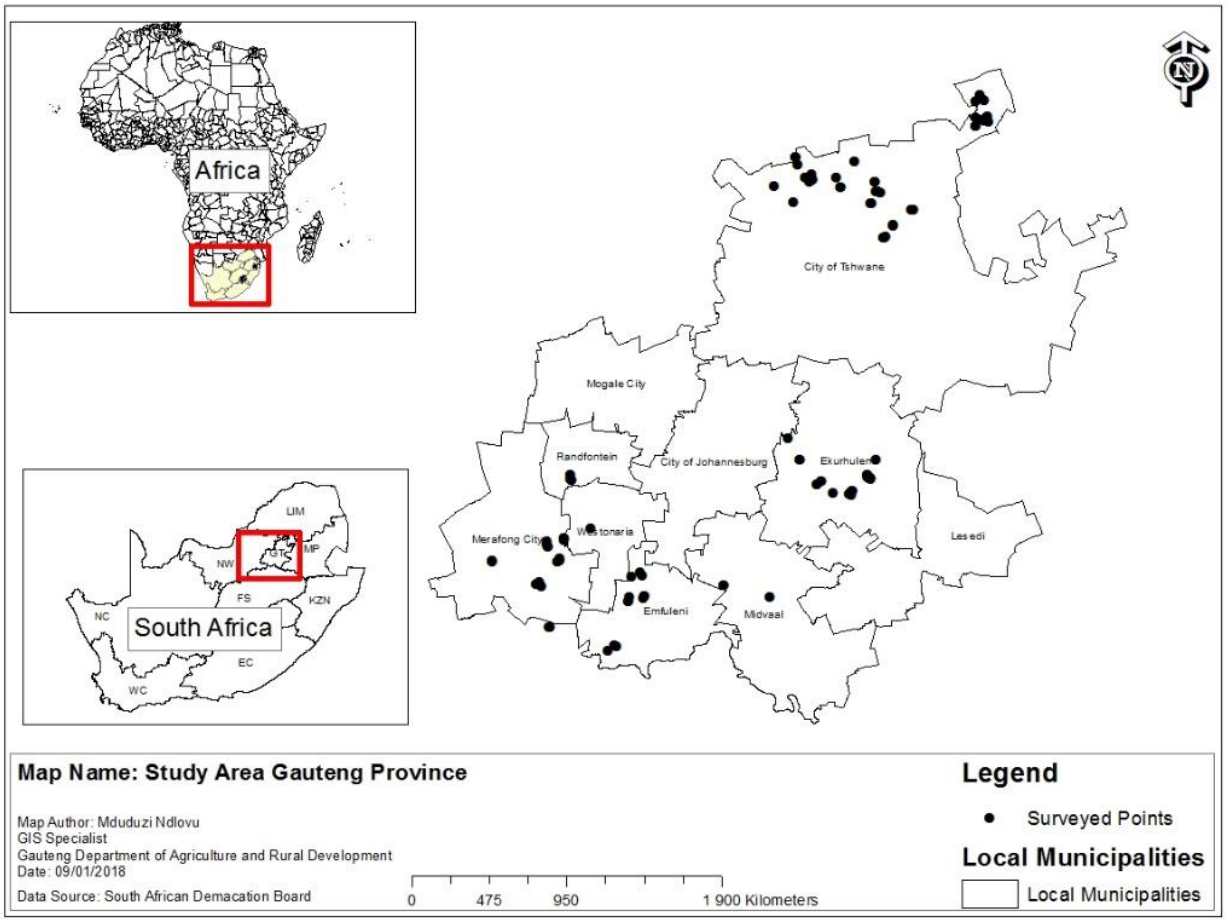

Figure 4.1. The farms where the vegetation survey was conducted in different Gauteng district municipalities

Prior to selection of the sites, a meeting was held with officials from Gauteng Department of Agriculture and Rural Development (GDARD) to introduce the purpose of the study and to select farmers from their database.

4.3.3. Data collection

Data on rangeland condition were determined using both ecological index method (nearest plant species technique) and cover abundance method (plant number scale) following Hardy and Tainton (1993) and Westfall et al. (1996). The vegetation parameters determined were species richness, grass composition, basal cover, grazing capacity and grass dry matter production (kg DM/ha). The herbaceous species richness and composition was determined using species count. At each observation point, the nearest herbaceous plants within a radius of 300 mm, were recorded. Non-grass species were noted as forbs. When no plant species were observed within the 300 mm radius, the point were recorded as “bare ground”. Bare soil was recorded if no grass plants occurred within 30 cm radius of the point. This indicated plant density (Mentis, 1984), that is an additional parameter for recording changes in rangeland status (Danckwerts and Teague, 1989).

Grass species were assigned to one of three categories in terms of their response to grazing pressure. Decreaser species decrease when rangeland is under- or over-grazed, Increaser I species increase when rangeland is underand/or selectively grazed, and Increaser II species increase when rangeland is overgrazed (van Oudshoorn, 1999; Trollope et al. 2014). Grass species were also assigned a forage factor (on a scale of 0 to 10) based on their relative potential to produce nutritious forage for grazing ungulates (Trollope, 1990). The forage factor was used to calculate range condition scores.

Basal cover was estimated done following the method prescribed by Trollope, (1989). Furthermore, percentage basal cover, grass DM yield and grazing capacity, were determined for each of the studied rangeland sites.

The formula proposed by Moore et al. (1985), modified by Moore and Odendaal (1987) and Moore (1989), was used for grazing capacity estimation. The equation is as follows:

$$Y = d / (DM \times f) / r,$$

where Y is the grazing capacity (ha LSU^{-1}), d the number of days in a year (365), the total grass DM yield (kg DM/ha), f the utilisation factor and r the daily grass DM required per LSU (2.5% of body mass). The grazing capacity was expressed using hectare per Large Stock Unit (ha LSU^{-1}). A Large Stock Unit is an animal with a mass of 450 kg, which gains 0.5 kg day–1 on forage with a digestible energy percentage of 55% (Meissner, 1982). It was estimated that animal will consume 10 kg of forage dry matter daily. The utilisation factor used was 0.35 (Moore 1989).

4.3.4 Data analyses

ShapiroWilk's test was used to test data for normality and data were log-transformed to achieve normality before analyses. A one-way ANOVA was used to test for significant differences ($P < 0.05$) in species richness, basal cover, veld condition (%), large stock units, grazing capacity and herbaceous biomass production among the three land ownership types. A correlation analysis (Bailey 1995), was undertaken between veld condition scores and herbaceous biomass production. Parameters were declared

significant at 95% level of confidence. Descriptive statistics such as means, percentages, range and standard errors were also employed.

4.4. Results

In total, 28 grass species were identified during field survey, of which n=23, n=4 and n=2 were perennials annuals and short-lived perennial, respectively (Table 4.1). Most species occurred in three-land ownership types, although in different proportions. *Digitaria eriantha* had the greatest frequency under the private owned land (PVT) (32.3 %) and the lowest in the communal owned lands (COM) (2.3%). *Elionurus muticus,* a wiry grass of poor forage value (van Oudtshoorn, 1999), was the dominant grass species in COM.

The COM had a higher (n =12) grass species richness compared to PVT and LSD had n =10 and n= 9, respectively. Basal cover was low and similar on all three land-ownerships (4.2%) ($P > 0.05$) (Table 2).

Table 4.2 Life form, palatability and abundance of grass species based on mean values in three land ownership types. PVT= Private farms, COM= Communal grazing land, LSD= leased grazing lands

Species	Life form	Palatability	Abundance		
			PVT	COM	LSD
Alloteropsis semialata	P	LP	r	C	r
Andropogon eucomus	P	LP	r	+	r
Aristida congesta	SP	PP	+	+	
Aristida sp	A	PP	+	r	
Bewisa biflora	P	HP		+	r
Brachiaria serrata	P	HP	r	r	r
Chloris virgata	A	MP	C		
Cynodon dactylon	SP	MP	C	r	r
Digitaria eriantha	P	HP	D	C	C
Elionurus muticus	P	PP	+	r	
Eragrostis chloromelas	P	LP	r	r	r
Eragrostis curvula	P	MP	C	r	r
Eragrostis gummiflua	P	MP	+	+	r
Eragrostis plana	P	PP	r	r	r
Eragrostis rigidor	P	MP	+	+	C
Heteropogon contortus	P	MP		D	r
Hyparrheria filipendula	P	MP	+	r	
Hyparrheria hirta	P	PP	+	C	C
Melinis repens	A	PP	r	+	r
Monocycibium uriciformis	P	HP	+	+	C
Perotis patens	A	LP	r	+	r
Pogonarthria squarrosa	P	LP		+	
Setaria sphacelata	P	HP		r	r
Sporobolus africanus	P	PP	r	+	+
Themeda trianda	P	HP	+	r	+
Trachypogon spicatus	P	MP	+		
Trichoneura grandiglumis	P	LP	r	+	r
Urochloa mosambicensis	P	MP	+	+	

[1] A, annual; P, long-lived perennial; SP, short-lived perennial

[2] HP, highly palatable; MP, moderately palatable; LP, poorly palatable; PP, very poorly palatable

[3] D, dominant (> 20%); C, common (>10–20%); r, rare (> 2–10%); +, present (< 2%)

There was a significant difference (P<0.05) on veld condition score, large stock units and grazing capacity among the three land ownership types (Table 4.2). Veld condition score was the highest in the PVT (69.63%) compared to LSD (56.68%), and COM (52.55%). The grazing capacity was twice lower on COM (10.15 ha/LSU^{-1}) compared with PVT (4.12 ha/LSU^{-1}) and LSD (4.47 ha/LSU^{-1}).

Table 4.2: Mean and standard error (mean ± S.E) of species richness (n), basal cover (%), veld condition score (%), large stock units (n) and grazing capacity (ha/LSU^{-1}) for rangelands sites in PVT, COM and LSD. Different letters are significantly different (P < 0.05)

	Land ownership types		
Parameters	**PVT**	**COM**	**LSD**
Species richness (n)	10.0±0.49^{a}	12.0±0.79^{a}	9.0±0.69^{a}
Basal cover (%)	4.1±1.5^{a}	4.4±0.5^{a}	4.3±0.4^{a}
Veld condition score (%)	69.63±5.01^{a}	52.55±1.13^{b}	56.68±3.11^{b}
Large stock units (n)	50.5±2.16^{a}	92.36±12.91^{b}	55.07±1.68^{a}
Grazing capacity (*ha/LSU^{-1}*)	4.12±1.00^{a}	10.15±1.26^{b}	4.47±1.08^{a}

PVT= Private farms, COM= Communal grazing land, LSD= leased grazing lands.

Significant differences (P<0.005) on mean herbaceous biomass yield were observed among the land ownership types during the study (Figure 4.2). The lowest yield (< 2000 kg ha^{-1}) was recorded on the COM compared to PVT (> 2500 kg ha^{-}1).

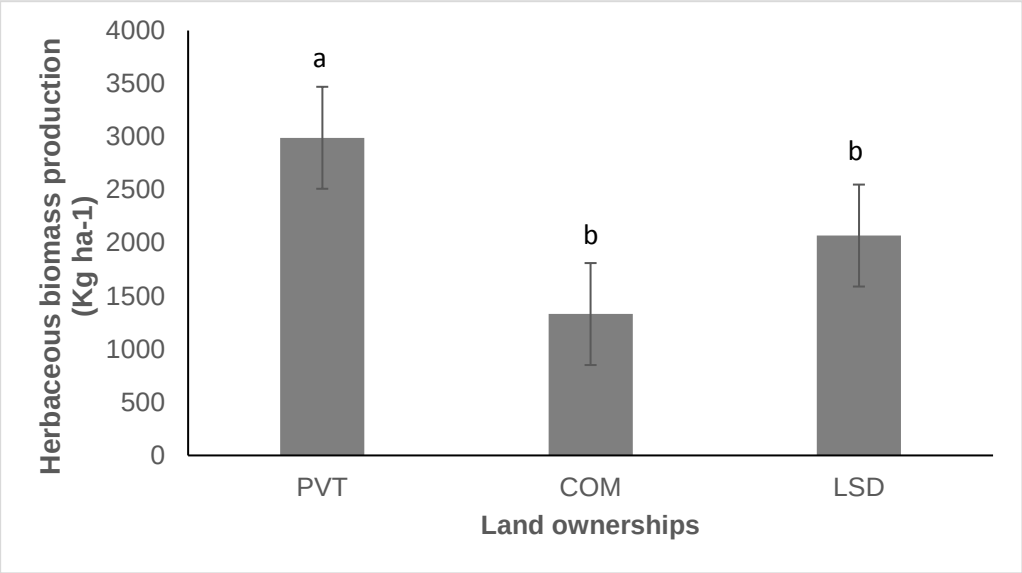

Figure 4.2. The mean herbaceous biomass production recorded at the three-land ownership among emerging livestock farmers of Gauteng province. Different letters indicate a significant difference (P < 0.05)

Biomass production was positively correlated with veld condition score (r = 0.159; P < 0.05) (Figure 4.3).

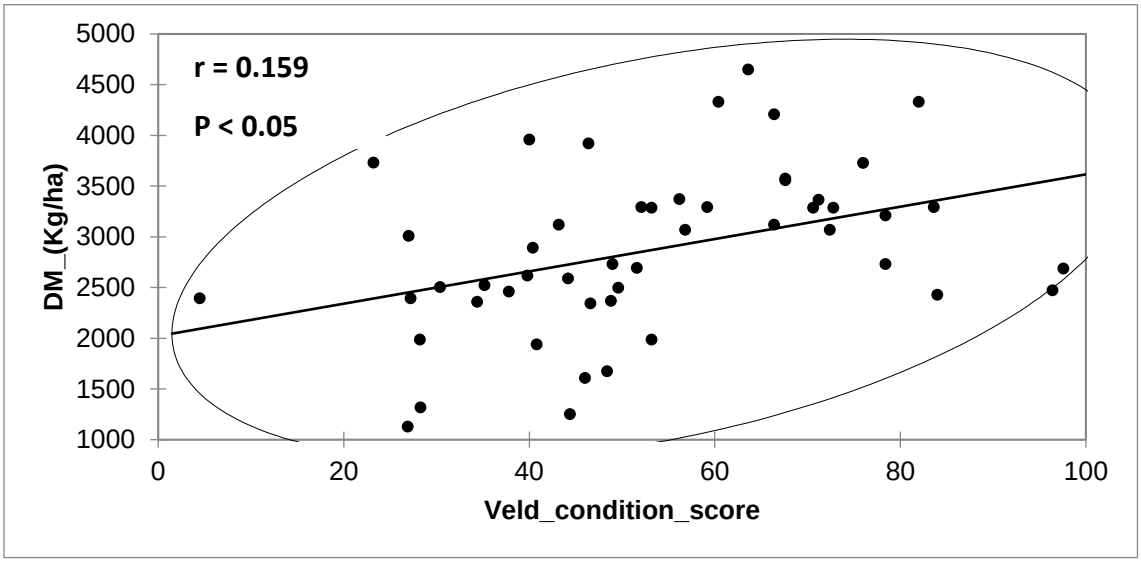

Figure 4.3. The overall correlation between veld condition scores and herbaceous biomass production in the grazing areas used by Gauteng emerging livestock farmers

4.5. Discussion

Based on the degradation audit (Hoffman and Ashwell, 2001), we expected to find differences in grass composition between three land ownerships, with a higher proportion of less acceptable or less productive pioneer species in the COM. However, this was not the case. The transect data showed that COM had the highest fraction (n=5) of palatable grass species than PVT and LSD. In the COM, such findings are direct evidence that repeated foraging of the similar palatable plants did not lead to loss of palatable plant species as observed by Beeskow et al. (1995). However, *C. dactylon and Aristida spp,* which are of low value, are a common sign of disturbance/overgrazing and was significantly higher in the COM. These species are difficult for livestock to graze and, suggest that the quantity and quality of forage on communal rangeland has been markedly impaired, even if presence of palatable species has not been affected (O'Connor et al. 2010). These results are not constant with the envisaged poor rangeland condition in COM systems, where no rangelands management principles are practiced with heavy and continuous grazing, and higher stocking rate (Vetter, 2013). Heavy grazing is thought to be inevitable in communal ownership of a resource where individual benefit is maximised at the expense of the community (Hardin 1968; Vetter et al. 2006).

The basal cover percentage indicated the proportion of the ground that is covered. The basal cover of a rangeland in excellent condition is expected to be greater than 12% (Abule et al. 2007). The basal cover was non-significant ($p<0.005$) for all three-land tenures and were very low with PVT at 4.1%, 4.4% for COM and 4.3 % for LSD. Many various reasons can influence low basal cover and increased soil loss from the surface. The most significant aspects are overgrazing (O'Connor et al. 2001), fluctuation in rainfall

(Tefera et al. 2007), poor grazing practices (Abule et al. 2007), drought (Gemedo et al. 2006) and high tree densities (Dean et al. 1999). Rainfall can be the overriding driver of plant productivity, composition and structure in environments with very low and unpredictable rainfall, with grazing having a negligible long-term effect on vegetation characteristics (Vetter et al. 2006).

Veld condition score differed significantly (P>0.005) between PVT and other two land ownership types. Considering that 100% is considered rangeland in optimal condition, PVT is clearly in a good condition (69.63%). In the COM and LSD sites, the rangeland condition was classified as moderate 52.55% and 56.68% respectively and did not differ significantly. The presence of palatable species on the COM did not necessarily indicate good rangelands as found in this study. Although COM had some higher desirable species, however, these sites were dominated by *C. dactylon, E. plana* and *A. congesta,* which affected the veld condition score when calculated. These grass species are unpalatable and thus have low grazing value (van der Westhuizen et al. 2005; Van Oudtshoorn, 2002).

The grazing capacity found in this study varied greatly from study of Morokong (2016), who reported a higher grazing capacity in communal areas of Matatiele, Eastern Cape province, South Africa. The grazing capacity was lowest in the COM (10.15LSU/ha) and highest in PVT (4.12LSU/ha). The grazing capacity is far lower than the mean grazing capacity of the Gauteng province that is 6.8 LSU/ha (Avenant 2018). Differences in grazing capacity could probably be attributed to the lower standing biomass in COM areas. The PVT and LSD generally had higher standing herbaceous biomass than COM rangelands. The aboveground herbaceous biomass recorded in this study was higher

than those recorded in semi-arid African rangelands, such as in Tanzania (Selemani et al. 2013) and in Lesotho (Moyo et al. 2010). Teague et al. (2009) reported that if biomass yield falls below 1500kg/ha, rangeland is not in a good condition. This indicates that COM is not in good condition. Animal production is restricted by low aboveground biomass (Rubanza et al. 2007). Heavy grazing intensities such as 10 LSU/ha observed at COM tends to reduce herbage yield (Mphinyane et al., 2008) through defoliation and trampling (Savadogo et al. 2007).

The biomass production was positively correlated with rangeland condition ($r = 0.159$; $P<0.005$). These results were in agreement with the findings of Gemedo (2004) at Borana in Ethiopia. This suggested that, rangelands in fair or poor condition produced less forage than those in good condition. However, lower biomass yield does not equate to lower productivity (de Bruyn, 1998). Therefore, different approaches to ensure quick recovery and sustainable rangeland production should be investigated.

4.6. Conclusion

It can be concluded that there was significant difference in species composition, veld condition score, grazing capacity and biomass yield between three land ownership types. This emphasised the ease with which false perception are created and maintained since communal rangelands are generally believed to be in poorer state of health. In this study, the communal rangelands had a lower grazing capacity and biomass yield but there is still a high presence of desirable species.

From this study, it is clear that the rangeland condition is not as bad as it appears in the communal rangelands. However, it is not the intention to create the impression that all is

well, because some areas are indeed in a poor or degraded condition. These may indicate that in some instances the ecosystem could be gradually deteriorating. All farmers/users of natural resource of the country share it with the previous, present and future generations and do not have exclusive rights to it. Hence, future research should explore different approaches that could be implemented by emerging livestock farmers in communal rangelands.

Chapter 5

General discussion, conclusion and recommendations

5.1. Introduction

In southern Africa, rangelands provide assorted and dynamic ecosystems that sustain livestock, game and wildlife production (Gwelo 2012). However, there is an increasing decline in grazing areas in communal rangelands or emerging farms owing to a variety of factors including excessive stocking rates. In Africa, scientists and policy formulating experts have ignored community knowledge and skills when implementing policies, developing plans to enhance livestock production, and rangeland management practices (Vetter 2003). The observed problems are the consequences of many years of interaction of social and ecological environments (Allsopp et al. 2007). To better understand social and ecological environments, the study was conducted to investigate 1) the knowledge of emerging livestock farmers on livestock-rangeland management practices, and 2) determine the effect of land ownership on rangeland condition among Gauteng emerging livestock farmers.

5.2 General discussion of results

A total of 50 emerging livestock farmers (i.e. ruminants) were selected from different vegetation types and different district municipalities of the Gauteng province. The selected farmers were interviewed using a structured questionnaire, which was divided into: 1) demographic information, 2) livestock management and 3) rangeland management In Chapter 3 tested the hypothesis that emerging livestock farmers unknowingly manages livestock in isolation from their rangelands. The results of the questionnaire survey revealed that farmers lacked in–depth knowledge of livestock and

rangeland management practices. Education and agricultural training did not seem to have an effect on the traditional methods neither did it influence livestock– range management practices. Therefore, we accept the hypothesis as farmers' mange livestock in isolation from their rangelands.

The findings that emerging livestock farmers in the Gauteng province practiced farming under different land ownership types necessitated the second study. Chapter 4, which compared rangeland condition (species richness, basal cover, veld condition score and herbaceous biomass) among three land ownership types (leased land, communal land and private land), and 2) determine the relationships between veld condition score and herbaceous biomass. Fifty grazing areas under different land ownership types were assessed using nearest plant technique, irrespective of the veld types. Chapter 4 tested the hypothesis that rangelands in private owned lands are relatively in good conditions compared to communal and leased lands. This hypothesis was accepted, as private lands were in good condition than communal and lease lands that were in moderate condition. Overall, the results of this study imply that the communal grazing areas are equally as productive as the private owned farms and leased farms counterparts, despite differences in species composition, veld condition score, grazing capacity and biomass yield. The data presented here therefore challenges the assumptions and perception about the condition, productivity and sustainability in COM.

5.3 Conclusion

There is a need for training of farmers, particularly the emerging livestock farmers on rangeland and livestock management. Land ownership did not affect rangeland condition, but lack of knowledge on rangeland management by the farmers was observed.

Rangeland management would be effective if government could support indigenous rangeland management knowledge and traditional methods through recognizing and empowering the local management institutions by including them in development planning. The challenge to government and scientists is to determine the sustainability of communal land use and, if necessary, then to develop sustainable community-friendly land use options.

5.4. Recommendations

There is a need to find ways for youth to gain interest in livestock production and rangeland resources management because they represent future farmers of the world. Focussing on the youth therefore, in programs that stimulate sustainable agricultural development, could improve social capital, reduce risk, and stimulate economic growth. The training of farmers and agricultural advisors on rangeland management using basic (simple techniques e.g. visual assessment) is essential. More efforts are also needed for the integration of indigenous knowledge with modern conservation approaches in planning and implementation is crucial with the full participation of the emerging livestock farmers. It is also recommended that government should intervene with appropriate rangeland recovery interventions to prevent communal and leased lands from further decline.

5.5. Future research

Further research should consider the following:

a. This study only investigated farmers' knowledge on livestock and rangeland management and practices. Therefore, there is still opportunity for further study to

investigate herdsman knowledge on livestock and rangeland, as they are also involved in farm activities.

b. Given the fact that majority of emerging livestock farmers lack knowledge on rangeland management, what efforts and/ or plans can be developed to address this problem?

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Appendixes

Appendix 1: Questionnaire

Rangeland condition assessment and fodder flow planning for the emerging farmers of the Gauteng province of South Africa

Questionnaire reference number: _____

Enumerator's name: _____

Date of interview (DD/MM/YY):____/_____/_____

Name of farm:_____

District Municipality: _____

GPS Reading: S_____

E_____

Farming Enterprise/s: _____

Farm size: _____

Veld type: _____

Personal and Confidential data

The Gauteng Department of Agriculture and Rural Development (GDARD) fund this project. It is aimed to assess the rangeland condition and fodder flow planning for the emerging farmers of the Gauteng province, South Africa.

The outcome of this study will be shared with the farmers, to assist with the management of the farm. The personal information of the interviewed farmer will be used only for the purpose of the project and will remain confidential.

Note: * You have a right not to answer some of the questions and to withdraw from the project at any time.

A. Household demographic information

A1. Race: African

African		Coloured		Indian		White	

A2. Gender:

Male		Female	

A3. Marital status:

Single		Married		Engaged		Widow/widower		Separated/ divorced		Living together	

A4. Home language

Sesotho		IsiZulu		Tshivenda		Sepedi		Xitsonga	

A5. Size of household _____

A6. Age of farmer:

<30		30-40		40-50		>50	

A7. Level of education:

Primary		Secondary		College		University		Post-graduate	

A8.Training in Agriculture:

Formal		Non-formal	

A9. Main source of income:_____

A10. Farm position:

Owner		Co-owner		Worker		Other	

A11. Farming experience:

<5 years		6-10 years		6-10 years		11-15 years		16> years	

A12. Do you belong to any farmers' organisation?

Yes		No	

B. Livestock Management

The purpose of this questionnaire is to obtain an accurate picture of how you personally perceive your livestock and general veld condition.
Please read each statement carefully and choose an answer that best describes your feelings.

B1. Type and number of livestock owned:

Type of livestock	**Total number of animals**	**Years owned**
Goats		
Sheep		
Cattle		
Poultry		
Other :		

B2. How long have you been keeping livestock: _____

B3. Grazing system:_____

B4. How did you acquire your livestock: _____

B5. Other source of income other than livestock: _____

B6. I know the breeding season of my cattle

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

B7. I know calving season of my cattle.

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

B8. My cattle are in good condition throughout the year.

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

B9. I know the cattle breed/s I am farming with.

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

B10. Stock theft limits farm profit margins.

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

B11. I know disease prevalent in my farming area

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

B12. I have livestock management plan.

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

B13. What constraints do you experience in rearing the animals?

Management		Feed		Marketing		Other	

B14. Where do you sell your animals?

Open market		Auction		At home		Other	

C. Veld Management

The purpose of this questionnaire is to obtain an accurate picture of how you personally perceive your veld and its condition.
Please read each statement carefully and choose an answer that best describes your feelings.

C1. I have a veld management plan.

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

C2. Farm grazing capacity and stocking rate are known.

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

C3. Farm size or size of the grazing land for livestock is known .

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

C4. I know grasses growing on my farm / grazing areas.

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

C5. There is fodder production plan for your animals .

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

C6. There is always food available for my livestock.

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

C7. I conduct veld condition assessment of the farm or grazing area

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

C8. I prepare fire breaks to prevent accidental fires.

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

C9. At what time of the year would you experience a shortage of grazing?

_____

C10. What could be the cause of the shortage?

_____

C11. What is the source of water for your animals? (Tick one or more)

Borehole		Dam/ pond		River		water well		Spring		others	

Specify: _____

C12. Do you have a problem of water for livestock drinking?

Yes		No	

C13. How would you describe the condition of the grazing?

1) Deteriorating- very poor condition little grass	
2) Deteriorating- poor condition but some grass	
3) Fair- reasonable amount of grass	
4) Good- plenty of grass	
5) Very good improving	

6) I don't know	

C14. What has led to this current condition?

Grazing		Burning		Soil depth		Climate variation (e.g. drought)		Bush encroachment		others	

C15. How would you gauge your knowledge on veld management?

_____

_____

C16. Where did you gain this knowledge from?

_____

C17. Have you ever had any training on veld management?

Yes		No	

C18. What kind of training would you like to receive?

_____

_____

D. Drought coping strategies

The purpose of this questionnaire is to obtain an accurate picture of how you personally perceive your farm and farming condition during drought times.
Please read each statement carefully and choose an answer that best describes your feelings.

D1. I know the annual rainfall received by my grazing lands.

1= Strongly Disagree	2= Disagree	3= Slightly disagree	4= Neither agree nor disagree	5= Slightly agree	6= Agree	7= Strongly agree

D2. How do you cope with drought?

1= Do nothing	2= Sell animals	3= Depend on government	4= Supplementary feeding

Appendix 2: Consent form

CONSENT FORM

Livestock-rangeland management practices among emerging livestock farmers of Gauteng province, South Africa.

Dear Mr/Mrs/Miss/Ms _____ Date……../..……../2015

NATURE AND PURPOSE OF THE STUDY

To improve the state of health of rangelands/veld in ways that we hope will improve lives of majority of emerging farmers depending directly and/or indirectly on natural resources such as veld to support their livelihoods. The objectives of this study are to 1) investigate and document the state of knowledge about veld and livestock management practices among the Gauteng emerging farmers, and 2) how livestock grazing systems influences rangeland condition in Gauteng province, South Africa.

RESEARCH PROCESS (thorough and clear description of all data gathering processes that will take place)

Part 1: Interview with individual participants (farmers)

1. The study requires your participation in interviews to discuss farming practices that are adopted in the Gauteng province.
2. The interview will be led by a project leader (Mr. N.L. Letsoalo).
3. The interview offers you an opportunity to express your opinion on subjects related to livestock and rangeland management.
4. There are no correct or wrong answers and all opinions will be valuable and considered.
5. You do not need to prepare anything in advance.

Part 2: Veld condition assessment

1. The farmer will be requested to show the research team around the farm and/or provide an aerial map of the farm.
2. Homogenous veld type units will be surveyed within the farm.
3. A combination of ground based techniques, employing agronomic approach (cover abundance) and ecological approach (Step point) will be used to assess the vegetation condition of the rangelands used by the farmers in the above study.

CONFIDENTIALITY

The opinions of the farmer /participant are viewed as strictly confidential and only members of the research team will have access to the information. No data published in dissertations and journals will contain any information thorough which farmer /participant may be identified. Your anonymity is, therefore ensured.

WITHDRAWAL CLAUSE

I understand that I may withdraw from the interview/project at any time. I therefore participate voluntarily until I request otherwise.

POTENTIAL BENEFITS OF THE STUDY (brief as in the research proposal)

The research will provide evidence on the state of natural resource (veld), particularly amongst the emerging farmers in the Gauteng province. Consequently, providing avenues for adopting management strategies that will sustain both veld and livestock productivity, thus ensuring food security amongst millions South Africans living in the province.

In short, this project will help farmers match fodder supply to their livestock demand with minimal costs. It will also create awareness among farming communities in Gauteng regarding sustainable use of the rangelands.

INFORMATION (contact information of the supervisor)

If I have any questions concerning the study, I may contact the supervisor, Prof KR Mbatha, at the Department of Agriculture and Animal Health, Florida Campus, Unisa, Tel: 011 670 9054.

CONSENT

I, the undersigned …… (Full name) have read the above information relating to the project and have also heard the verbal version, and declare that I understand it. I have been afforded the opportunity to discuss relevant aspects of the project with the project leader, and hereby declare that I agree voluntarily to participate in the project.

I indemnify the university and any employee or student of the university against any liability that I may incur during the course of the project.

I further undertake to make no claim against the university in respect of damages to my person or reputation that may be incurred because of the project/trial or through the fault of other participants, unless resulting from negligence on the part of the university, its employees or students.

I have received a signed copy of this consent form.

Signature participant:…….

Signed at …… on ……

WITNESSES

1.....

2.....

Appendix 3: Correlation between veld condition scores and herbaceous biomass production amongst Gauteng emerging livestock farmers.

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
Veld_condition_score	50	0	50	4,500	97,600	53,368	20,123
DM_(Kg/ha)	50	0	50	1129,156	4650,406	2872,424	805,226

Correlation matrix (Pearson):

Variables	Veld_condition_score	DM_(Kg/ha)
Veld_condition_score	**1**	**0,398**
DM_(Kg/ha)	**0,398**	**1**

Values in bold are different from 0 with a significance level alpha=0,05

p-values:

Variables	Veld_condition_score	DM_(Kg/ha)
Veld_condition_score	**0**	**0,004**
DM_(Kg/ha)	**0,004**	**0**

Values in bold are different from 0 with a significance level alpha=0,05

Coefficients of determination (R^2):

Variables	Veld_condition_score	DM_(Kg/ha)
Veld_condition_score	**1**	0,159
DM_(Kg/ha)	0,159	**1**

Appendix 4: Pictures taken at different land ownership types

a) **Picture 1: Veld condition assessment at leased land (Taken by Mr G Pule, 27/11/2016)**

b) **Picture 2: Veld condition assessment at Private land (Taken by Mr N Letsoalo, 05/11/2016)**

c) **Picture 3: Veld condition assessment at communal land (Taken by Mr N Letsoalo, 11/12/2016)**