An Investigation into the Waste Management Practices of Emerging Livestock Farmers: The case of the KwaZulu-Natal Midlands

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DECLARATION

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I, Sasha Sankar, Registration number 206508178, hereby declare that the thesis entitled:

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For my Nana.
You inspire my life.
RIP.

ABSTRACT

Livestock waste management is a growing global concern in terms of its contribution to climate change, environmental sustainability and quality of animal products. In South Africa, poor waste management is a chronic problem, yet it has not been an area of concern for the government, with the agricultural sector receiving the least attention. In communal and rural areas, livestock provides food and livelihood security for poor emerging farmers (small-scale producers or the second economy), in addition to monetary benefits. However, the lack of waste management infrastructure, coupled with insufficient hygiene translates into a sanitation problem, which could result in environmental health impacts and compromise the sustainability of the sector. However, studies conducted in Africa and Asia indicate less pessimistic scenarios, where emerging farmers have turned waste into resources by drawing on indigenous knowledge systems such as improved animal husbandry techniques and nutrient use efficiency from animal wastes, among other strategies. With the emerging livestock sector poised to transition into commercialization in South Africa, these constraints and opportunities provide the need for this study. The aim of the thesis is to evaluate current waste management strategies used by emerging livestock farmers in the KwaZulu-Natal Midlands, where livestock farming is practiced. The study used both qualitative and quantitative methods of data collection. In terms of the former, key informant interviews were conducted with industry professionals, considered to be relevant stakeholders in the waste management cycle from prevention to disposal. In terms of the latter, a sample of 50 emerging farmers was randomly surveyed using a questionnaire, in an attempt to address the interconnectedness of livelihoods, socio-cultural, environmental, health, economic, and technical spheres, considered relevant to assessing waste management practices in developing countries such as South Africa. The objectives of the study were therefore to illicit information from the emerging livestock farmers in terms of waste management practices and environmental impacts; waste management technology needs; the knowledge network that is used in waste management practices; the contribution of the industry to local food security; and the role of policy in the sustainability of the sector. The study utilized the sustainable livelihoods approach as a theoretical framework to gauge how waste disposal, management and re-use impact poor people's livelihoods. The key findings of the study indicate that cost and ease of implementation govern the waste management practices implemented by emerging livestock farmers. The rural regions of the KwaZulu-Natal Midlands are defined by vast distances in addition to a lack of municipal disposal services and waste

authority. This has led to burning and illegal dumping of waste on vacant sites. In contrast, the results indicate that farmers would be open to best practices provided that there are resulting benefits. For example, many farmers implemented composting as a means of recycling with the intentions of producing manure to fertilize crops. The study recommends that farmers be educated on the effects of improper waste management to understand the consequential threat to their livelihood security. In addition, emerging farmers require support with the implementation of sustainable husbandry practices, land remediation, slaughter practices and market access before they are capable of implementing proper waste management practices.

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LIST OF ABBREVIATIONS

A21	Agenda 21
BATAT	Broadening Access to Agriculture Trust
BEE	Black economic empowerment
BSE	Bovine spongiform encephalopathy
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DoA	Department of Agriculture
DRDLR	Department of Rural Development and Land Reform
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
EC	European Commission
EPA	Environmental Protection Agency
EU	European Union
FAO	Food and agriculture organisation of the United Nations
FMD	Food and Mouth Disease
FSG	Farmer Support Group
GDARD	Gauteng Department of Agriculture and Rural Development
GHG	Green House Gas
IFPRI	International Food Policy Research Institute
IWMP	Integrated Waste Management Plan
KZNDAE	KwaZulu-Natal Department of Agriculture and Environmental Affairs
KZNDAERD	KwaZulu-Natal Department of Agriculture, Environmental Affairs and rural development
LA21	Local Agenda 21
LRALD	Land Redistribution for Agricultural Land Development
MDG	Millennium Development Goals
NEM: WA	National Environmental Management: Waste Act (No. 26 of 2014)
NEMA	National Environmental Management Act (No. 107 of 1998)
NGO	Non-governmental Organisation
NWA	National water act
NWMS	National Waste Management Strategy

RSA	Republic of South Africa
SLA	Sustainable Livelihoods Approach
VSF Europa	Vétérinaires Sans Frontières Europa

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CHAPTER ONE: INTRODUCTION

1.1 Preamble

Agricultural waste management is an evolving discipline that is subject to policy, population dynamics, land use changes and individual farmer outlooks (Vanderholm, 1985:1). For centuries animal agriculture has been essential for global human existence (Nierenberg, 2005:7), not only providing a source of protein and essential nutrients but also acting as a source of income and monetary status to resource poor and traditional farmers. (Greenberg, 2010:1). The Food and Agriculture Organisation (FAO) states that "Traditionally, the livestock agricultural industry was supply driven, converting waste material and other resources of limited alternative use into edible products and other goods and services. However, since the livestock sector has become increasingly demand-driven, growth has been faster and the sector now competes with other sectors for natural resources" (FAO, 2013:1). Thus the "livestock revolution" (Herrero *et al*., 2011: 123), emerges with more intensified, technologically advanced, economical farming practices that threatens environmental and human wellbeing; and waste management approaches.

1.2 Rationale for the Study

The South African livestock sector has a unique dualistic nature in that there is a clear distinction between the commercial (formal) sector and the emerging (informal) sector (Spies, 2011:23). Unlike informal farmers, the commercial livestock farming sector has access to unlimited market opportunities, in addition to resources and infrastructure that enables them to breed and slaughter livestock; and deal with agricultural waste in a more efficient and sustainable manner. Despite research demonstrating that the encouragement of small scale farmers would have a more profound effect on local economies, food security and ecological preservation, existing South African policy still views the commercialisation of the livestock industry as a solution to improving the productivity of resources and the livelihoods of the rural poor (Vetter, 2013:3). Boozaaier (2009:7) defines a small scale farmer as "one whose scale of operation is too small to attract the provision of services he/ she needs to be able to significantly increase his/her productivity". In South Africa this definition commonly applies to rural farmers that in many cases keep livestock to support livelihoods defined by poverty. For the purpose of this study, small scale farmers, hereafter referred to as emerging farmers, makes

reference to those farmers who farm livestock to fund their households or as a business and have intentions to grow their farming operation to that of a commercial status.

Greenberg (2010:1) claims that South African agriculture is "built on the back of dispossession of the African population, and their social, economic and political marginalisation". This statement refers to apartheid segregation laws that were implemented with the purpose of breaking down traditional agricultural systems in order to ensure the success of a growing mining industry (Haringston *et al*., 2004:65) by confining black people to harsh agricultural zones with limited resources (Boonzaaier, 2009:5). Since the abolishment of apartheid, new policies such as the Agricultural land reform and black economic empowerment (BEE) have been enforced with hopes of correcting past injustices and empowering those that were previously oppressed. South African agricultural policy and legislation, such as the Fertilizers, Farm feed, Agricultural Remedies and Stock Remedies Act; the National Water Act (NWA) and the Agricultural resources conservation act, now govern the agricultural industry but does not acknowledge the presence of emerging farmers in terms of waste management (Vetter, 2013:3). Therefore after 20 years of democracy, South African farmers still face multiple dimensions of challenges that include: poverty, food insecurity; climate variability; and a lack of infrastructure and support from policy, amongst others.

According to Stroebel *et al.* (2011:186), livestock is "one of the fastest growing agricultural sub-sectors in developing countries, contributing to the livelihoods of an estimated 70% of the world's rural poor, and accounting for approximately 20% of the global trade of agricultural products". Agriculture and agribusiness have therefore become key sectors in reducing poverty in developing countries and has in South Africa, created an avenue to correct past injustices and alleviate poverty. Over 70 % of South African resource poor farmers live within harsh environmental zones (Mapiye *et al*., 2009:196). Therefore it is common for South African resource poor farmers to reply on a combination of crop farming and livestock husbandry to sustain their asset base (Vermeulen *et al*., 2012:137). Livestock agriculture is desirable to resource poor farmers as it is a low input system (Dovie *et al.*, 2006:26) that results in a range of useful products such as milk, meat, hides, manure, cash, energy and has socio-cultural uses (Mapiye *et al*., 2009:196). However, poor grazing, weak institutional capacity to manage common grazing resources, livestock diseases, drought and stock theft are major constraints on local livestock production which, together with the small average herd size and insufficient

grazing land, greatly limit the potential of improving income from sales (Bayer *et al*., 2004:14). Livestock husbandry therefore not only plays an integral part in the sustainability of traditional farming systems but also contributes to the sustainability of agricultural and food systems (Martinez *et al.*, 2009:5527).

The first Millennium development goal (MDG) aims to eradicate extreme poverty and hunger (Love *et al.,* 2006:731). Target 2 of the first MDG is to halve the proportion of people who suffer from hunger by 2015 (Love *et al*. 2006:731). The brown agenda, which extends from Agenda 21 (A21), adopts the stance that by improving environmental conditions in developing and Third World cities, these problems would be alleviated (Williams, 1997:18). The brown agenda focuses on satisfying the basic needs of people with the ambition of increasing their quality of life (Khan, 2014:2). In rural areas this means not only improving food security, housing facilities and access to education, but also preventing the degradation of natural resources and local ecosystems (Khan, 2014:2), on which rural communities are directly reliant upon; whilst aiding access to these resources in addition to local markets (Lee and Neves, 2009:7). Livestock waste management has over the last decade become an increasing source of concern in terms of environmental welfare. As a result of a growing global livestock industry, the impact that livestock agricultural on the environment is larger than previously expected. Literature considers that livestock agriculture plays a profound effect in deforestation; climate change; land use change; water pollution and thus the degradation of aquatic systems; soil degradation; and the depletion of natural resources (FAO, 2013:1). Fundamental waste management operations associated with small scale farming practices focus mainly around: manure and methane production from livestock; the management of feed that is not utilised or contaminated; and the disposal of livestock carcasses that have been contaminated and other slaughter wastes (Martinez *et al.*, 2009:5529).

The haphazard release of agricultural wastes into local environments has the potential to degrade natural resources. Of particular concern is the pollution of water sources with the facilitation of diseases and the role of livestock in climate change. Disposal methods of livestock excrement and other associated wastes produced in husbandry processes therefore need to be controlled and monitored. Within South Africa there is little information available or guidelines provided by local departments as to how these operations are or should be implemented at an emerging level. The lack of infrastructure in addition to a lack of capital,

inhibit emerging farmers from partaking in modern waste management practices. To this end many South African emerging farmers are forced to reply on traditional or otherwise most cost effective methods to deal with their livestock waste (Martinez *et al*, 2009:5529).

As a result of the human population becoming increasingly aware of health and environmental risks that stem from mass commercial livestock breeding (Hermansen, 2003:4), a positive gap in the market has developed in particular for small scale emerging farmers who breed livestock at a free range level (Scholten *et al.,* 2013:3). Referred to as organic farming, this method of livestock husbandry is largely consumer orientated, relying heavily on the demands from a market that does not wish to consume products that contain or were produced using antibiotics or hormones (Sundrum, 2001:208). Theoretically this creates increased opportunities for emerging farmers to make the transition from small-scale farming to commercial farming in a sustainable manner (Hermansen, 2003: 4). For the purpose of the study, livestock is limited to cattle, sheep, pigs, chicken and goats. In order to establish whether South African emerging farmers have the potential to satisfy this customer driven market, a sustainable livelihoods approach (SLA) was adopted within the study. According to Phiri (2009:19) the SLA emphasises "the need to promote solutions to poverty that are economically and environmentally sustainable and that recognise the importance of enhancing the asset base of the poor".

1.3 Study Premise

Currently, there is a great opportunity within the South African livestock industry that provides many opportunities for emerging farmers to stabilise their livelihoods and even make the transition into the commercial farming sector. The FAO (2013,1) however argues that the intensification of traditional farming methods is generally very difficult due to a lack of infrastructure, skills and market access. From an economic standpoint opportunities lie in the consumer demand for free range, higher quality products rather than the lower quality animal sourced products generally supplied by intensive farming institutions. In contrast, emerging farmers find it difficult to meet standards set by the consumers demand in addition to facing commercial competition and a lack of market access (Moyo and Swanepoel, 2010:7). Herein lies the need for research and support from organisations and government.

From a social and ecological standpoint, the success of emerging farmers could provide relief to natural resources and relieve stresses on communal livelihoods as well as national food security. Waste management plays an integral role in all aspects of livestock husbandry and crop production. The rural population of developing countries are directly reliant on their local natural resources. Therefore proper waste management is imperative in securing rural livelihoods. Globally, 998 million tonnes of agricultural waste is produced within a year (Chibundo, 2012:1). In developing countries, such as South Africa, 25% of agricultural waste is not utilized in a sustainable manner (Chibundo, 2012:1). A significant quantity of waste that has the potential to be reused (Sabiiti, 2011:3) is therefore disposed of unsystematically Agricultural waste is widely available, renewable, biodegradable and free (Sabiiti, 2011:3) and thus has the potential to be converted into a variety of energy rich products, such as biogas and fertiliser. The recycling, reuse and reprocessing of animal waste where possible assists in the maintenance of a healthy, sustainable agricultural environment that preserves resources, whilst avoiding threats to human and environmental welfare and aiding national food security. Soil degradation has been a concern of the cropping industry for decades, with an estimated loss of fertile top soil of more than 300-400 tonnes per hectare per year (GrainSA, 2014:4). Agricultural waste in the form of fertiliser can be employed to rehabilitate soil therefore assisting in crop production (Mkhabela, 2002:135). Unsuitable exposure of waste to soil conversely results in a loss of nutrients to local water bodies and the release of greenhouse gases (GHG) into the atmosphere, thus contributing to the degradation of water systems, climate change, and the collapse of future agricultural structures. Moreover, the improper on-site disposal of waste acts as a vector in the formation of infectious diseases that threaten livestock herds, human health and consequently food security (Yongabi *et al*., 2014:1).

1.4 Aim of Research

The aim of this study is to evaluate the existing waste management practices and their triple bottom line impacts on the emerging livestock industry in the KwaZulu-Natal Midlands. In doing so the sustainability of the livestock farmers in this area would be determined by focusing on the objectives mentioned in *1.5*.

1.5 Objectives

The objectives of this study are as follows:

- To investigate the waste management practices and environmental impacts of the emerging livestock industry in KwaZulu-Natal Midlands
- To determine the waste management technology needs of the emerging livestock industry
- To determine the knowledge network that is used in waste management practices of the emerging livestock industry
- To evaluate the contribution of the emerging livestock industry to local food security
- To determine the impact of policy on emerging livestock farmers and whether it supports or hinders their sustainability.

In order to appropriately approach these objectives the following questions need to be answered:

- What livestock do emerging famers keep?
- For what purpose are these species of livestock kept?
- How are their livestock slaughtered?
- What types of waste are emerging farmers faced with?
- How do they manage this waste?
- What traditional livestock farming methods to these farmers employ?
- Who currently provides assistance?
- Do emerging farmers provide animal sourced products to rural and urbanised areas within South Africa?

1.6 Outline of Chapters

Chapter two begins with an introduction into the conceptual framework: the SLA and the relevance of this framework to emerging farmers and waste management. Thereafter the chapter explores the importance of local sustainably on farm sites and how sustainability can enhance emerging farmer livelihoods with sustainable waste management. Section 2.4 defines animal waste in terms of South African policy and likewise attempts to define emerging farmers as they exist in the South African context. Thereafter waste management is introduced

with a description of the waste hierarchy in relation to wastes encounter during livestock farming activities (husbandry and slaughter). Section 2.5 describes the current waste management technologies that emerging farmers have available to them and the applicability of these methods to resource poor farmers. Chapter two thereafter goes on to elaborate on the policy that currently governs the livestock industry. The discussion focuses on land reform distribution; A21 and waste management policy, such as National Environmental Management Act No. 107 of 2008 (NEMA) and NWA. Section 2.7 describe the current effect that the emerging livestock sector has on local and nation food security by looking at the uses of livestock by resource poor farmers; the effect that livestock waste has on climate change and natural resources; the effect that waste management has on human and livestock health and finally the role of market access or lack thereof in food security. Thereafter, section 2.8 defines indigenous knowledge and discusses the importance of indigenous knowledge in terms of resource poor farmers.

Chapter three describes the characteristics of the study area by looking at its' economic profile, population characteristic, geological features, political history and the current waste management facilities available. Chapter four explains the methodology used to carry out the study. Section 4.4 discusses the development of the survey presented to the emerging livestock farmers in the KwaZulu-Natal Midlands following key informant interviews and secondary data collection. Chapter four thereafter explains the sampling procedure used in respondent selection and the means of data analysis. Finally chapter five discusses the data obtained from the survey results in conjunction with key informant interviews and secondary literature resources in respect to the objectives of the study.

1.7 Conclusion

This chapter provided an introduction to the study. Emerging livestock farmers face a combination of challenges on a daily basis. To date however, little research has been conducted surrounding the management strategies of farmers within KwaZulu-Natal, particularly in terms of the waste management practices employed by emerging farmers. With the growth of the livestock industry, the risks posed to environmental and human health with the excess production of livestock waste is expected to increase at an alarming rate. Despite this, agricultural waste management practices have also not been given much attention in terms of

South African policies and guidelines, leaving resource poor farmers to make use of haphazard, easier disposal methods that jeopardise the sustainability of local agricultural systems. The importance of the sustainability of emerging farming systems can be seen at a local level within rural communities and the condition of surrounding ecosystems and at national level in terms of food security.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of the literature on which this study is based. The first section of this chapter looks at the SLA as it applies to South African emerging farmers. Alary *et al. (*2001:26) estimates 162 million resource poor emerging livestock farmers exist in Sub-Saharan Africa. To date however, very little research has been done that considers the challenges they face and their management practices holistically (Vatta *et al.,* 2011:26). This chapter provides insight into the waste management practices available to small-scale farmers; the effects that the livestock industry has had on environmental and human well-being by evaluating the importance of sustainable livestock husbandry practices, agricultural policy; and the potential effects of improper waste management on national food security, climate change and natural resources.

2.2 Conceptual Framework: The Sustainable Livelihoods Approach

A livelihood is considered sustainable when it can deal with and recover from stresses whilst preserving and enhancing its assets and capabilities, without compromising natural resources (Scoones, 1998:5). According to Chambers and Conway (1991:92), "Sustainable livelihood approaches emphasize the need to promote solutions to poverty that are economically and environmentally sustainable, and that recognize the importance of enhancing the asset base of the poor". Based on this, the SLA looks at the role that assets play in the development of livelihood strategies that would alleviate poverty and in turn increase a household's resilience to risks (Randolph *et al.*, 2007:2790). Scoones (1998:3) suggests that in order to analyse sustainable livelihoods one must ask, "given a particular context, what combination of livelihood resources result in the ability to follow what combination of livelihood strategies?" In addition, how do institutional processes influence implementation strategies to achieve a desired outcome (Scoones, 1998:3)? For example (Figure 2.1), the livelihood strategy adopted by a household is influenced by the livelihood asset portfolio available. Given the vulnerability context, the livelihood strategies adopted determines the success of the livelihood outcomes. If the adopted strategies are carried out successfully, this will lead to outcomes that feed back into the

livelihood system and strengthen the asset-base (Masanjala, 2006:1033) therefore increasing the resilience of the livelihood (Ulrich *et al.,* 2012:242). Moreover, policies and institutions have the potential to strengthen or stress livelihood strategies and the livelihood asset base portfolio with the employment of policies and community support (Lowe and Schilderman, 2001:2).

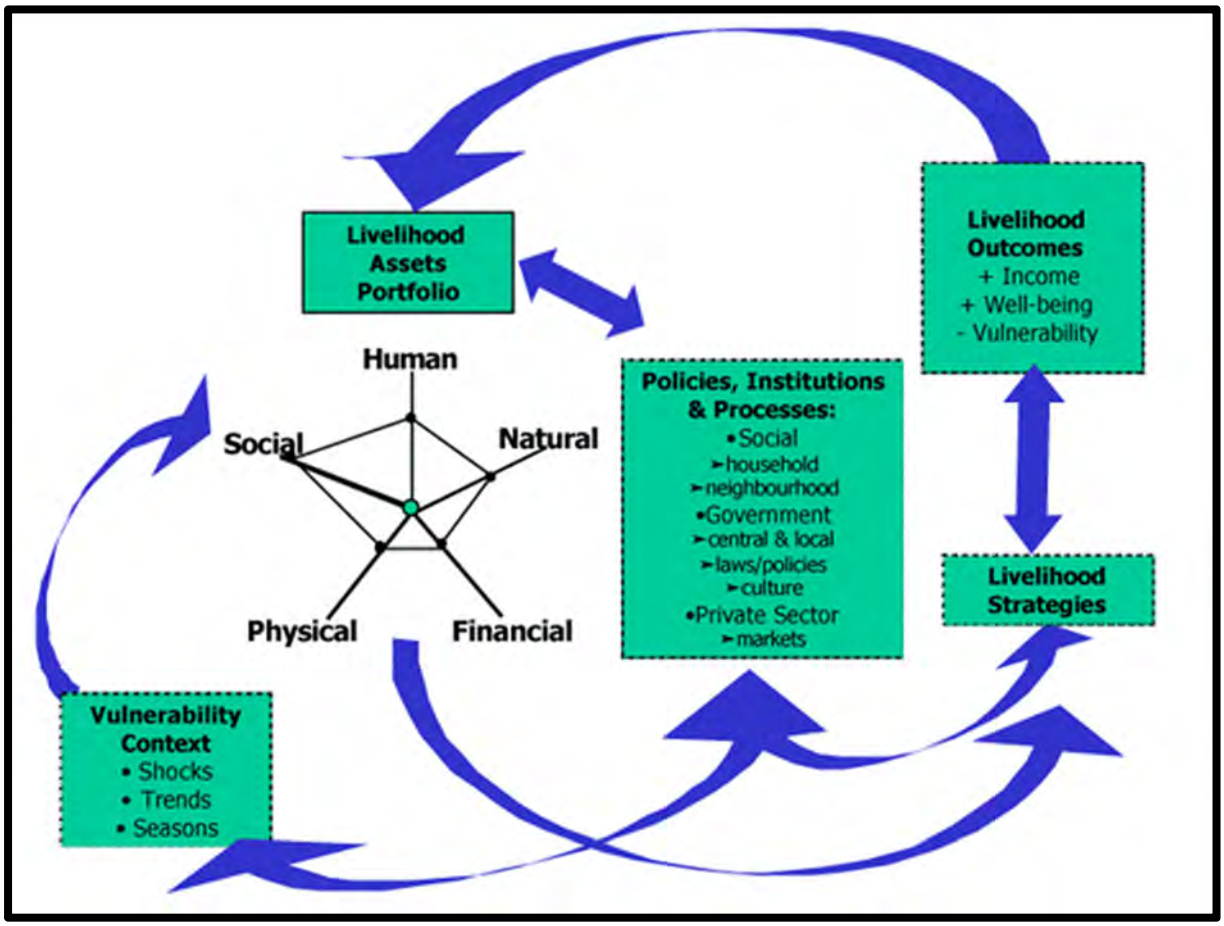


Figure 2. 1. Sustainable Livelihoods Approach
(Lowe and Schilderman, 2001:2)

Livelihood assets play a fundamental role in the sustainability of a livelihood as it determines the productive activity as well as the capacity of the household to recover when faced with challenges. The asset base of a livelihood is made up of (Masanjala, 2006:1033):

- Human capital (for example, education, skills, traditional knowledge and level of health);
- Financial assets (for example, savings, credit and cash);
- Social capital (for example, cooperatives, networks and connections);

- Physical capital (for example, agricultural assets, tools, technology and infrastructure); and
- Natural capital (for example, natural resources).

According to Phiri (2009:55), the manner in which a household or community apply their assets outlines local indigenous knowledge. Within the context of the study, livestock as an asset can improve upon all the five capital livelihood assets highlighted in figure 2.1 (Randolph *et al.,* 2007:2790). For instance, human capital increases with the added nutrition that livestock provide. Livestock also acts as financial capital which farmers may sell or use to produce products for cash therefore acting as a financial asset of insurance. Livestock ownership within most South African communities enhances social capital as a result of traditional practices (Randolph *et al.,* 2007:2790). Moreover, larger herds enhance physical assets (Randolph *et al.,* 2007:2790) and the production of manure by livestock, increases soil fertility thus improving natural capital (Randolph *et al.,* 2007:2790).

Livelihood insecurity is generally associated with vulnerability (Ulrich *et al*., 2012:242), which in terms of the SLA, refers to the potential of individuals, households, and communities to cope with continuous external and internal shocks (Randolph *et* al., 2007:2790). Ulrich *et al. (*2012:242) defines resilience as "the capacity to tolerate disturbance without the livelihood collapsing and the ability of local actors to cope with stresses and shocks". Stresses and shocks applied to a livelihood can be defined as external and internal shocks. External shocks include extreme weather shocks; disease; seasonality changes such as prices and employment opportunities; and critical trends which include demographics, environmental and economic trends (Serrat, 2010:3). Internal shocks are those that occur due to a lack of resources, such as water, which inhibit the ability of an entity to cope (Serrat, 2010:3).

There are a variety of shocks faced by emerging farmers that influence their livelihood vulnerability. Shocks include animal pest control, food insecurity, population growth, outbreaks of animal diseases as well as rapid changes in socio-economic, political and ecological conditions, which in turn affect livestock sales (Ulrich *et al.,* 2012:241). The effects of improper waste management can result in a variety of shocks that are potentially detrimental to agricultural systems. The contamination and degradation of natural resources through the release of waste into the environment affects crops and livestock production directly. Furthermore, improper waste management increases the risk of sickness and disease, increasing

vulnerability to rural livelihoods (Yongabi *et al.*, 2014:1). Should a household choose to manage their waste in a sustainable manner, they are likely to save on agricultural cost and create an additional income stream therefore improving their asset base and the resilience of their livelihood.

Livelihood strategies is the accumulation of undertakings that generate a livelihood (Masanjala, 2006:1034). Orr and Blessings (2001:1327) divides livelihood strategies into three broad categories namely; "agricultural intensification or extensifictaion", which is based on the use of natural resources such as livestock or water; "livelihood diversification", which involves a household indulging in a variety of activities to improve their standard of living, and "migration" which occurs when family members leave their resident household to secure a feasible income. Masanjala (2006:1034) argues that strategies have the ability to be either be proactive or reactive and therefore characterises them as either "accumulative strategies" or "adaptive strategies" respectively. Accumulative strategies aim to generate an income and the flow of assets whereas adaptive strategies focus on the distribution of risk and income so as to create a situation that would result in a resilient livelihood (Masanjala, 2006:1034). The livelihood strategy adopted by a household or community is based upon the threats encountered; the assets available to cope as well as the institutional environment within which it exists (Randolph *et al*., 2007:2790).

According to International Food Policy Research Institute (IFPRI) adaption takes place at macro and micro levels (Below *et al.,* 2010:1). At a national or macro level, adaption practices are introduced by non-governmental organisations (NGO); Government; and private corporations to deal with agricultural concerns (Below *et al.,* 2010:1). At a micro level or local level, farmers deal with local seasonal climatic variations, socioeconomic factors and agricultural production systems (Below *et al.,* 2010:1). Agricultural adaption is rather dynamic as it is based within various contexts, such as climatic, technological and socioeconomic, and largely based on the decisions that farmers make (Below *et al.,* 2010:1). For example, emerging farmers in South Africa are generally established in harsh climatic regions, which makes cropping difficult (Mapiye *et al.*, 2009:196). Indulgence in livestock husbandry in addition to cropping to cope is therefore a common occurrence within the rural areas of South Africa (Mapiye *et al.*, 2009:196). The degree of complexity of the adaption strategy can however vary from a simple change in feeding management to the construction of infrastructure such as an

irrigation system or a dam ((Below *et al.,* 2010:5). IFPRI classifies adaption practices into five categories, namely: "farm management and technology; farm financial management; diversification on and beyond the farm; government interventions in rural infrastructure, the rural health care services, and risk reduction for the rural population; and knowledge management, networks and governance" (Below *et* al., 2010:5). It is however common for a community or individual to adopt more than one livelihood strategy to relieve their vulnerability context (Masanjala, 2006:1034).

Unlike sectorial approaches, which select a particular area of economic activity to focus on, SLA takes into account an integrated approach to obtain a holistic view and insight into the needs of the household, the combinations of resources they are exposed to and require, and the importance of social and human capital (Krantz, 2001:25). The SLA also looks at the development of these strategies providing insight into how people make decisions within their circumstances and the potential success of strategies implemented by co-operatives (Krantz, 2001:26). Livelihood assets, strategies and outcomes are largely dependent on the institutions and policy dimension (that is, transformation structures) (Serrat, 2010:5). Institutions implement polices (also known as processes) that influence the participation that households and communities receive at a governmental, industrial and communal level (Serrat, 2010:5).

Randolph *et al. (*2007:2790) describes three strategies that may be employed by emerging livestock farmers to produce successful outcomes and increase resilience. The first strategy focuses on the benefits that livestock provide in terms of enhancing livelihood assets and therefore buffering the risks that would be faced with the development of the farm; while the second strategy encourages the specialisation and intensification of livestock farming to increase productivity and therefore income (Randolph *et al.*, 2007:2790). The final strategy focuses on improving market opportunities by creating incentives that would increase sales (Randolph *et al.*, 2007: 2790).

The main disadvantage of the SLA lies in the manner in which poverty is defined. A reliable definition of poverty is not essentially based on income alone (Ulrich *et al.,* 2012:424). Poverty may be defined in terms of the social status within a community, the distance the household is from a city or using a "poverty line" which is based on their income and food sufficiency (Krantz, 2001:27). Phiri (2009:51) suggests that rural poverty be viewed as a "human condition

where people are unable to achieve essential functions in life". Poverty eradication therefore lies in rural households progressively seizing control over survival resources (Phiri, 2009:51). Within South Africa, small-scale farmers make up more than half of those that suffer from hunger and poverty (Love *et al*., 2006:732). Ulrich *et al. (*2012:241) therefore assert that "securing rural livelihoods and well-being in the rural area of Africa continues to be challenged by dynamic socio-ecological conditions and low adaptive capacities".

2.3. Sustainable Development

According to Moyo and Swanepoel (2010:1), globally livestock support 1.3 billion people living in developing countries. In addition to dominating the economies of developing countries, livestock agriculture play a significant role in reducing the socio-economic risks of cropping; climate change; environmental preservation and rehabilitation; and food security. This section therefore explores the role of livestock husbandry and waste management in the creation of sustainable agricultural systems.

2.3.1. Background

Early literature surrounding Sustainable Development generally dealt with the economic sector and issues such as job creation (Kates *et al.,* 2005:11). Attention thereafter shifted towards human development with the development of values and goals that would improve upon global life expectancy rates, education and equality and thus the development of a society that would emphasize the value of relationships internationally, locally and within communities (Kates *et al.,* 2005:11). According to the Brundtland Declaration of 1987 the definition of Sustainable Development is (Golini and Kalchschmidt, 2011:1): development which meets "the needs of the present without compromising the ability of future generations to meet their own needs".

At the 2002 World Summit on sustainable development a quantification model that is currently well accepted by industry was introduced as being the "triple-bottom-line" or "the three pillars" of Sustainable Development (Kates *et al.,* 2005:12). The three pillars are the economic dimension, the social dimension and the environmental dimension as represented in the World Summit motto "People, Planet, Prosperity" (Moldan *et al.,* 2011:4). According to Nurse (2006:3) the economic dimension aims "to strike a balance between the costs and benefits of economic activity, within the confines of the carrying capacity of the environment" so that

resources will be available for use by future generations. Economic sustainability deals with various kinds of capital; man-made, natural, human and social and therefore looks at economic growth of countries without inhibiting the ability of future generations to access natural resources (Moldan *et al*., 2011:5). Social sustainability is possibly the most important in terms of long term sustainability. (Vallance *et al.*, 2011:342). Torjman (2000:2) adopts the following stance on social sustainability; "human well-being cannot be sustained without a healthy environment and is equally unlikely in the absence of a vibrant economy". Environmental sustainability is arguably the cornerstone of Sustainable Development giving priority to ecological degradation (Nurse, 2006:3). There are four criteria that surround environmental sustainability (Moldan *et al.,* 2011:6):

- The use of renewable resources shall be done so efficiently so that they can be regenerated in the long term;
- Non-renewable resources shall be used so that their use can be off set with other sources;
- The release of hazardous substances and pollution that is released into the environment should not exceed their assimilative capacity; and
- Avoid irrevocable actions.

Although sustainable development does aim to strike a balance between these three dimensions it is primarily an anthropocentric idea. This stems from the premise that basic human needs (psychological, survival, safety, love and esteem) need to be satisfied before a person acts unselfishly (Moldan *et al.*, 2011:1).

Even though it has taken some time for this discipline to be accepted, in recent years the interest in sustainability has gained ample momentum, with many policy programmes and literature showing that the integration of science and development are an integral part of achieving sustainability. (Komiyama and Takeuchi, 2006:2). For example, the South African Working for Water campaign integrates research and management to eradicate and control alien plant species therefore preserving water catchments and soil productivity (Burns *et al*., 2006:380). To implement sustainability science as a function of sustainable development it is necessary to make linkages between science, environmental needs and society to obtain a deeper insight into the interactions between nature and society at various geographic scales (Swart *et al*., 2004:138). This is supported by the Millennium Ecosystem assessment, which according to Shackelton *et al. (*2011:2), emphasises that human well-being is dependent on ecological

systems. With increased pressure being put on the Earth's resources by human population growth, social and economic domains are at risk (Shackelton *et al*., 2011:2). Kates *et al. (*2005:12) and Swart *et al. (*2004:138) propose that there are eight core questions that help provide better advice to decision makers. The questions are as follow:

- "How can the dynamic interactions between nature and society—including lags and inertia -be better incorporated in emerging models and conceptualizations that integrate the Earth system, human development, and sustainability?
- How are long-term trends in environment and development, including consumption and population, reshaping nature-society interactions in ways relevant to sustainability?
- What determines the vulnerability or resilience of the nature-society system in particular kinds of places and for particular types of ecosystems and human livelihoods?
- Can scientifically meaningful "limits" or "boundaries" be defined that would provide effective warning of conditions beyond which the nature society systems incur a significantly increased risk of serious degradation?
- What systems of incentive structures—including markets, rules, norms and scientific information—can most effectively improve social capacity to guide interactions between nature and society toward more sustainable trajectories?
- How can today's operational systems for monitoring and reporting on environmental and social conditions be integrated or extended to provide more useful guidance for efforts to navigate a transition toward sustainability?
- How can today's relatively independent activities of research planning, observation, assessment, and decision support be better integrated into systems for adaptive management and societal learning?
- How can the future be scanned in a creative, rigorous and policy-relevant manner that reflects the normative character of sustainability and incorporates different perspectives?"

2.3.2. Sustainable livestock farming

Livestock play a crucial role in the sustainability of agricultural systems not only by feeding on crop residues and other feeds, which would not otherwise be utilised, converting them into a source of food such as milk or meat, but by also by providing soil enrichment and a source

of energy in the form of labour (Martinez *et al.,* 2009:5527). de Wit *et al. (*1994: 220) describes the following as criterion that may be used to evaluate the sustainability of a livestock production system:

- Potential population supporting capacity;
- Land area utilization for agriculture;
- Degree of equity in food distribution;
- Net annual soil loss;
- Nutrient balances and losses;
- Water availability and utilization;
- Water utilization;
- Soil organic matter;
- Fossil energy utilization; and
- Drug utilization

According to Greenpeace (2012:5), as of 2000 the global livestock sector utilizes 72% of all productive agricultural land on Earth and therefore has a significant impact on habitat biodiversity, land use change, nitrogen and phosphorus cycles, and climate change. This being said, livestock production is only one of the contributors to the collapse of the Earth as a system. In order to act as a political tool in combating the challenge of Earth system governance, the planetary boundaries (Figure 2.2) were created (Biermann, 2012:4). These boundaries attempt to set prescribed biophysical limitations for human development (Galaz *et al*., 2012:1) that estimate the stability of the Earth's planetary systems (Greenpeace, 2012:5). If exceeded it is proposed that the Earth as a system will be disrupted and thus enter a different state (Biermann, 2012:4). The systems included thus far (Figure 2.2) are:

- Stratospheric ozone depletion;
- N cycle;
- P cycle;
- Global freshwater use;
- Change in land use;
- Biodiversity loss;
- Atmospheric aerosol loading;
- Chemical pollution; and
- Climate change.

Livestock production plays an integral role in the intensification of four of these nine factors, namely, biodiversity loss; land use change; nitrogen and phosphoruscycles and climate change (Greenpeace, 2012:5). Three of these boundaries (climate change, instability of the nitrogen cycle and biodiversity loss) have already reached their threshold (Figure 2.2) (Hone, 2012). Many countries and NGOs have thus since, complied livestock husbandry guidelines so as to not only relieve stress on the planetary boundaries but also promote more sustainable farming systems.

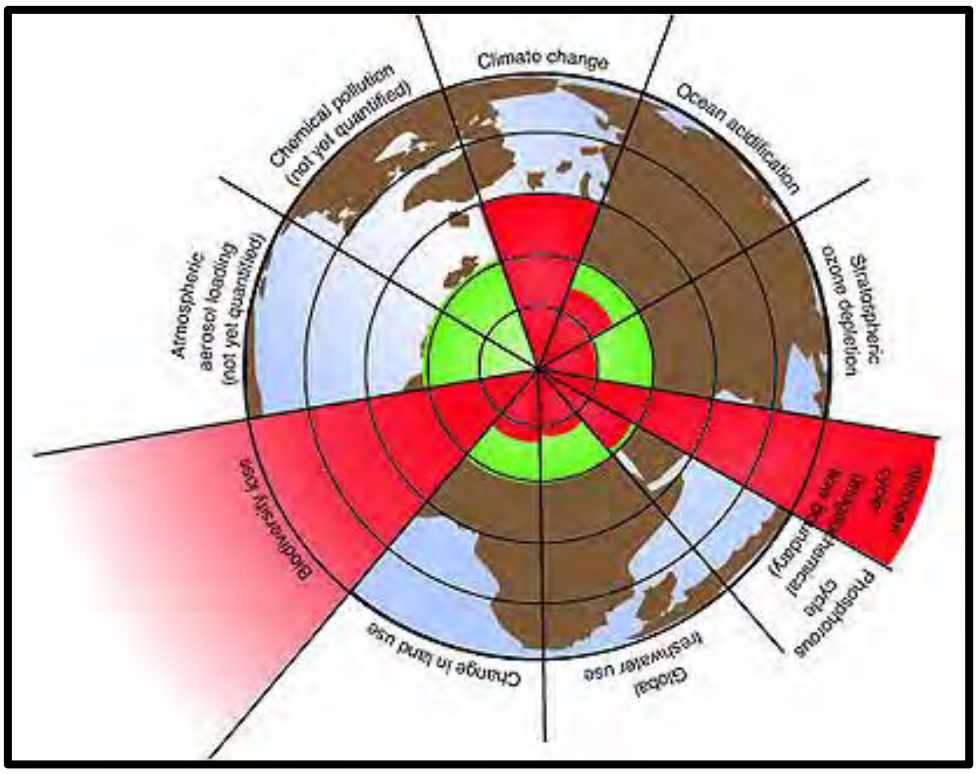


Figure 2. 2. The nine planetary boundaries (Hone, 2012).

In the case of emerging farmers there are many effective and simple manners in which to avoid the negative consequences that arise from the poor management of the above criteria. For example: through the proper usage of livestock manure. Through appropriate utilization of livestock manure, nutrients are being recycled thus closing the nutrient cycle and avoiding problems such as hygiene risks, soil heavy metal overload and soil contamination, thus ensuring the preservation of resources for future agricultural practices (Petersen *et al*., 2007:181). According to Moyo and Swanepoel (2010:2), livestock provides a "diversification strategy for resource poor farmers" by acting as buffer and thus reducing vulnerability

associated with agriculture. In addition to a harsh environment, emerging farmers are faced with adapting to a rapidly changing industry and a diverse market.

2.4. Livestock waste management and environmental impacts

The Department of Agriculture and Rural Development (DARD) (2009:11) defines waste management as a "broad field, which includes the generation, storage, transport, treatment and ultimate disposal of all types of waste streams". Agricultural waste refers to the by-products obtained from agricultural activities (Sabiiti, 2011:3) that are generally organic in nature and therefore biodegradable and energy rich (Sabiiti, 2011:3). Agricultural waste is therefore an important resource which if not managed properly, easily interrupts local ecosystems. This study considers all wastes that emerging farmer's encounter, including chemical pesticides.

2.4.1. Animal Waste

While there currently exists no official definition of "animal waste" within South African legislative documents, there are however definitions for the terms; "animal product"; "animal" and "waste". Section 1 of the Meat and Safety Act 40 of 2000 defines animal product as "any by-product obtained from the carcass of an animal other than meat thereof" (Republic of South Africa- RSA, 2000:2). Similarly, section 1 of the Animal Diseases Act 35 of 1984 defines "animal" as "any mammal, bird, fish, reptile or amphibian which is a member of the phylum vertebrates, including carcass of any such animal" (RSA, 1984:2) and the National Environmental Management: Waste Act No. 59 of 2008 (NEM:WA), prior to 2014 amendments, defines -"waste" as "any substance, whether or not that substance can be reduced, re-used, recycled and recovered:

a) that is surplus, unwanted, rejected, discarded, abandoned or disposed of;

b) which the generator has no further use of for the purposes of production;

c) that must be treated or disposed of; or

d) that is identified as a waste by the Minister by notice in the Gazette, and includes waste generated by the mining, medical or other sector, but—

i. a by-product is not considered waste; and

ii. any portion of waste, once re-used, recycled and recovered, ceases to be waste." (RSA, 2008:17).

Based on these definitions, the study proposes that the definition of "animal waste" is as follows:

> Any substance of any mammal, bird, fish, reptile or amphibian which is a member of the phylum vertebrates, including carcass of any such animal, whether or not that substance can be reduced, re-used, recycled and recovered –
>
> (a) That is surplus, unwanted, rejected, discarded, abandoned or disposed of;
>
> (b) which the generator has no further use of for the purpose of production;
>
> (c) that must be treated or disposed of; or
>
> (d) that is identified as a waste by the minister by notice in the Gazette, and includes waste generated by other sector, but-
>
> i. a by-product is not considered waste; and
>
> ii. any portion of waste, once re-used, recycled and recovered, ceases to be waste.

Animal wastes exist in the solid, liquid and gaseous phases. Waste is considered to be in a liquid form when the moisture content is more than 96% and in a solid form at levels less than 84% (Mijinyawa and Dlamini, 2006:4). When the moisture content ranges from 85 to 96%, waste is considered to be a slurry (Mijinyawa and Dlamini, 2006:4). Solid and liquid waste includes the carcass and parts of dead animals such as bones; hides; blood; feathers; contaminated water; excess or contaminated feed; and manure (Haines, 2004:283), whereas gaseous waste is produced by respiration and fermentation processes and lost soon after they are produced (Sabiiti, 2011:4).

2.4.2. Emerging farmer

In South Africa, the livestock industry is made up of commercial farmers; emerging farmers and subsistence farmers. Emerging and subsistence farmers make up the informal sector, or emerging farming sector, however differentiation of the two is not always clear. The terms are often interchangeable (Greenberg, 2010:1) as informal farmers are as diverse in size as they are in their husbandry and cultivation practices (Vétérinaires Sans Frontières Europa -VSF

Europa, 2012:9). Davenport and Gambiza (2008:514) differentiate between subsistence farmers and emerging farmers in that subsistence farmers have a limited knowledge as well as financial and management skills and therefore partake in household production with low amounts of commercial activity. The Agricultural Development Agency, in contrast argues that there are three types of farmers present within the informal livestock farming sector: distressed farmers (farmers who are in financial distress and are in jeopardy of losing their land); entrant farmers (farmers who are making a profit from agricultural activities however still face significant challenges in being sustainable) and emergent farmers (farmers that are involved or work in co-operation or with commercial farmers to make the transition to the commercial sector) (Agricultural Development Agency, 2011:3). Emergent farmers are seen as a transition phase for those farmers who want to produce marketable products and who would eventually own their own land for commercial farming purposes (Davenport and Gambiza, 2008:514).

The common feature of subsistence and emerging farmers lies in the intra-generational transfer of farming practices and knowledge (VSF Europa, 2012:9). Making the transition from an emerging farmer to a commercial farmer has proved difficult within South African context (Boozaaier, 2009:8). FAO (2013:2) attributes this difficulty to a lack of market access and infrastructure that defines traditional agricultural systems. Historical social suppression of indigenous farmers has resulted in a lack of know-how and experience in agricultural production methods; and a lack of physical resources such as infrastructure, equipment and capital (Boozaaier, 2009:8). Emerging farming is however, in most parts of the world, still considered family farming. This rings true in the case of South Africa, where the majority of rural farmers indulge in farming activities to sustain their own households and livelihoods. VSF Europa (2012:8) describes emerging farming as “a type of production/ system that bears the imprint of the structural link between economic activity and family structure”. Here the farmer and family members are usually the owner of the farm and the integral decision maker, taking sole responsibility for farm management and work organisation (VSF Europa, 2012:9).

2.4.3. Waste hierarchy

The most popular method of waste disposal adopted internationally is to send waste directly to landfill however the appropriate waste management system according to Arvanitoyannis (2008:3) and the National Waste Management Strategy (NWMS) (Department of

environmental affairs- DEA, 2011:15) , should be for waste to be managed using the waste hierarchy (Figure 2.3), which is as follows:

1. Waste reduction;
2. Reuse for original purpose;
3. Recycle and reuse of material;
4. Composting;
5. Biological treatment;
6. Incineration with energy recovery;
7. Incineration without energy recovery; and
8. Landfilling

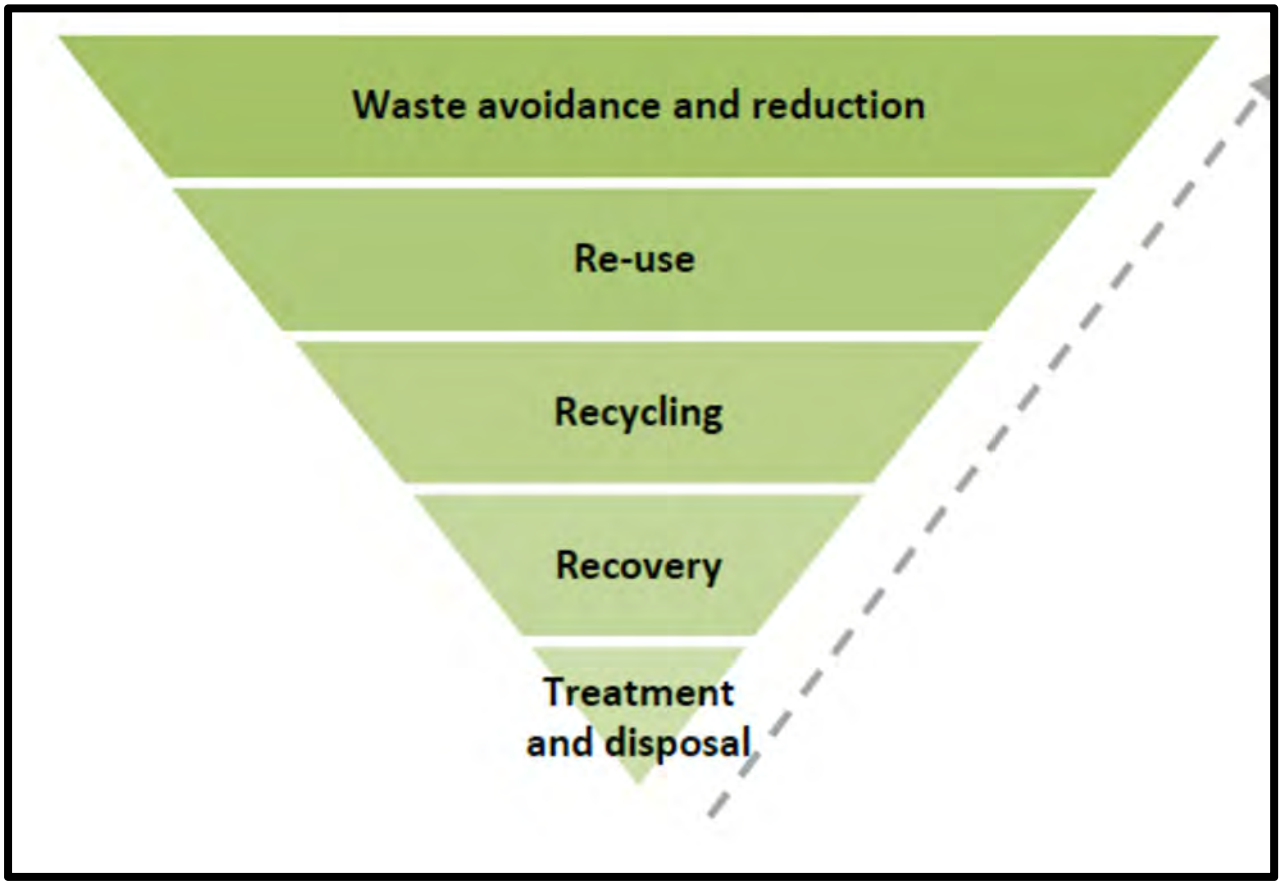


Figure 2. 3. The waste hierarchy
(DEA, 2011:18).

Despite landfilling being the final step and last resort in the waste management hierarchy, it is the most popular disposal method, used globally as it was incorrectly perceived to be the most cost effective means of disposal (Arvanitoyannis, 2008:47). In recent years, the cost of

landfilling has increased in South Africa due to a decreasing number of landfill sites. Furthermore, land scarcity for landfills has been compounded by an increase in the population, and thus an increase in municipal and industrial waste (Arvanitoyannis, 2008:47). In many countries livestock waste is not accepted on landfill sites to avoid water contamination and vermin infestations (Environmental Protection Agency- EPA, 1999:15). In South Africa however, under government notice GNR 634 of 2013: Waste Classification and Management Regulations, non-infectious animal carcasses are classified as general waste and are therefore, according to GNR 636 of 2008: National Norms and standards for disposal of waste to landfill, eligible for disposal to landfill (DEA, 2013:19).

Livestock plays a significant role in terms of recycling as they essentially convert waste food products, which would not otherwise be used, into consumables and other valuable products (Godfray *et al.,* 2010:816). Recycling and the reuse of waste involves the reuse of something in a dissimilar or similar manner, respectively, after its initial function has been completed (Arvanitoyannis, 2008:50). This not only reduces the use of natural resources but also in most cases saves costs incurred to households and industry while reducing the quantity of waste that would be sent to landfill and indiscriminately discarded into the environment.

The impact of emerging farming operations on environmental degradation, even though considered negligible in comparison to commercial farmers, will increase as the result of the exponential growth of livestock production. Stroebel *et al*. (2011:186) states that to cope with increased demand for livestock products, the Southern African livestock industry is required to expand at an average rate of 4.2% annually. Keeping farm waste to a minimum will therefore reduce the risk of pollution and reduce the costs incurred to the farming industry, both formal and informal. Furthermore, the implementation of waste management best practices as a livelihood strategy has the potential to improve upon the asset base of rural livelihoods with the production of energy rich materials such as: charcoal; biogas, bio diesel and raw materials such as fodder (Sabiiti, 2011:3). According to Fletcher (undated) and United States Department of Agriculture (2014:394), the types of wastes that farmers are faced with include: dung; urine; feed waste; used plastic silage wrapping; chemical containers; medical packaging; green waste such as grass cuttings; unused chemical dip; used veterinary products; animal carcasses; and other slaughter waste which includes blood, feathers, hide, organs, bones, hoofs and horns. These wastes although degradable, are hazardous to local environments in significant quantities

and therefore need to be dealt with in a particular manner to reduce environmental pollution and sustain natural resources (Qian *et al*., 2013:1). The former Department of Water Affairs and Forestry (DWAF), currently known as the Department of Water Affairs (DWA), therefore requires under the NWA the registration of all private non-commercial farmers in order to keep a record of where sites are located; determine how various types of waste are being disposed of; determine how much waste is produced; analyse the efficiency of each site; and evaluate the potential environmental and health risk that could affect the surrounding areas (DWAF, 2001:1).

Proper waste management practices are further emphasised in cases where the accumulation of waste or even the use of inappropriate disposal methods can act as a substratum for disease causing microorganisms that contaminate soil, water and air, thus disrupting ecosystem functions and ultimately affecting human and animal health (Chandy, undated:8). Proper waste management also alleviates stresses on the environment asserted by other industry sectors. For example, in China, the use of excess rice straw that would otherwise be burnt because of a lack of proper disposal practices can be used alternatively as a bulking agent in the composting process to absorb excess leachate (Qian *et al*., 2013:1).

2.4.4. Livestock agricultural waste

As a result of an increased demand for animal sourced products over the last decade, the number of livestock has increased three fold globally, faster than that of the human population (Aneja *et al*., 2012:92). According to Champness (undated), livestock management by definition, includes aspects of animal health, animal welfare, biosecurity and traceability. Livestock management is therefore an integrated system that needs to be looked at holistically to achieve a sustainable operation. The most significant contribution to local ecological impact is the number of livestock present on a farm site and the manner in which they are managed (Todd *et al*., 2009: 21). Majority of rural waste is organic and therefore scavenged and recycled for either animal feed or compost (Couth and Trois, 2010:2337). For the purpose of this study waste is loosely divided into on-farm waste, which includes waste encountered during husbandry activities, and slaughter waste (Table 2.1). This section discusses these wastes and their potential environmental impacts in three sub-sections: feed waste; slaughter wastes; pest control; manure and waste sludge.

Table 2. 1. Livestock waste

On-farm waste	Slaughter waste
Feed waste	Blood
Sludge	Waste water
Manure	Entrails
Carcasses	Contaminated meat
Pesticides	Feathers
Methane	Skin
Feathers/ hide	Bone and horns
Organic kraal bedding (saw dust or grass)	Hair
	Hooves
	Carcass trimmings

2.4.4.1. Feed waste

One of the most researched sectors of livestock management is grazing management, which according to the Todd *et al.* (2009:21), is the long-term maintenance of rangeland productivity whilst maximizing livestock productivity. In South Africa natural grazing lands constitutes as the main feed source to the livestock industry both formal and informal (KwaZulu-Natal Department of Agriculture and Environmental Affairs-KZNDAE, undated). The importance of proper management of grazing fields lies in the maintenance of plant biodiversity, which is currently a pressing global issue. The White paper of Agriculture states that it is predominantly rural biodiversity that is vulnerable to the spread of alien and genetically modified plant species that are employed as feed by the formal livestock industry sector (Department of Agriculture-DoA, 1995: 12).

According to White Paper (DoA, 1995: 12), the current agricultural challenges faced by farmers in terms of the environment do not differ from other countries. South African soils are fragile in that erosion caused by bad management practices and the use of excessive pesticides and fertilisers have had negatives effects on soil and water resources that will continue to affect local biodiversity if not managed sustainably (DoA, 1995: 12). The Karroo Consortium (2009:14) argues, with the use of the non-equilibrium theory, that livestock management has no effect within arid and semi-arid areas such as KwaZulu-Natal. The non-equilibrium theory considers that livestock numbers are kept low in informal agricultural systems as a result of extreme drought effects (Todd *et al.,* 2009:14) and other livelihoods threats therefore preventing extensive damage to local ecological systems.

In grazing management there are many factors that come into play, making it a very complex undertaking. KZNDAE (undated) defines pastures as "forage species that are cultivated for livestock feed". It is vitally important that farmers consider factors such as grass type; the type of animal that will exist in the feedlot; seasonality; climate; as well as the chosen purpose of the livestock to determine what they will be grazing on, as these factors have a significant effect on the product quality and the nature of waste that results. Grazing management also involves the consideration of the size of the feedlot and the movement of animals with regards to the grazing management system, to provide the best fodder and avoid the erosion of the landscape (KZNDAE, undated). Todd *et al*. (2009:21) states that a grazing system is defined by "the frequency and length of occupation of the animal flocks within the different camp on a farm". The stocking rate of livestock or "the number of animals per unit area which are maintained on a farm" also plays a fundamental role in providing the correct amount of nutrition for livestock as well as care for the landscape (Todd *et al*., 2009:21) and waste management strategies, as it aids in the distribution of nutrients to sediment.

One of the most popular grazing systems used by KwaZulu-Natal local farmers both in the commercial and informal sectors is rotational grazing. Rotational grazing involves dividing pastures into smaller range units within which livestock are periodically moved (Lapointe *et* al., 2000:262). According to Di Grigoli *et al.* (2012:S31) and Lapointe *et al*. (2000:262) the advantages of the use of rotational grazing are that it:

- Increases the growth and longevity of vegetation biomass;
- Distributes the usage of the pasture by livestock;
- Facilitate the regrowth of vegetation;
- Allows to the cutting and storage of excess forage;
- Reduces exposure of livestock to gastrointestinal parasites; and
- Maintains forage at the vegetative stage thus at their most digestible phase.

Best practice strategies recommend the fencing of feedlots and property to allow for control of livestock in addition to the prevention of the theft of livestock. Furthermore, the erection of fencing aids in the application of chemical dips; the castration of male livestock to prevent unwanted pregnancies and reduce aggression levels; and in the regulation of herd structure (KZNDAE, undated).

During the dry season grazing does not supply livestock with the necessary nutrients and feed supplements are required (Palmer and Ainslie, 2006:13). To cope with feed shortages South African commercial livestock industries have resorted to planting specialised crops and even import fodder (Palmer and Ainslie, 2006:14). Turlington, (2014) reported that in 2013, 150 million tonnes of livestock fodder was manufactured in the United States for the sole purpose of supplying the livestock sector. Rural farmers in contrast rely on crop residues to sustain their livestock during winter months and droughts (FAO, 2006:13). Crop residues include wastage obtained during the reaping of crops, for example discarded cabbage leaves; produce that has not sold; and produce that has been damaged or is of poor quality (KZNDAE, undated). The contamination of feed occurs through exposure to livestock excretion (manure and urine), environmental pollution (from pesticides, industrial chemicals and heavy metals) and the activities of insects and microbes (D'Mello, 2004:107). If consumed, the contaminants facilitate the creation of infectious diseases. In the case of heavy metals, bioaccumulation poses a threat to human health when the meat of livestock or livestock products, such as milk, is consumed (D'Mello, 2004:107).

2.4.4.2. Carcasses and slaughter by-products

Slaughterhouses are an integral part of the livestock industry, but are also a potential source of hazardous waste (Dar, 2014:116). Wastes generated at slaughter houses include, blood; innards; bone; feathers; hide; waste water; sludge and flesh (Table 2.1). Although environmental impacts are limited to the immediate surroundings, the release of waste into water sources is of sizeable concern given that it is the key cause of environmental pollution produced by abattoirs (Molapo, 2009:16). On-site technological operations, are similar to the principles recommended for implementation by commercial abattoirs within South Africa. For example, by simply placing trays to catch floor drop and spills; by employing mops to mop up waste rather than using continuous hosing during cleaning practices; by treating waste water or recovering solid waste from on site; and composting, one creates opportunities to recycle and preserve water resources while saving costs (EPA Victoria, 2012). Applying the principles of these simple methods will effectively decrease pollution. In a study conducted by Dar (2014:117) in Nigeria it was found that it is ultimately the attitudes of slaughter house employees that proved to be the downfall of waste management in local slaughterhouses. In the study, 70% of slaughterhouse employees allowed waste water to be discharged into local

water bodies without treatment (Dar, 2014:117). Furthermore, employees had dumped carcasses and meat in open fields, increasing the risk of disease (Dar, 2014:117).

Large volumes of liquid waste in the form of waste water and blood are generated daily during slaughter operations (Roberts and De Jager, 2010:55). The contents of the waste water discharged vary in content and according to Robert and De Jager (2010:57), may contain health hazards in the form of nitrogen bacterial pathogens, which are disease causing microorganisms (Dictionary.com, 2015), such as salmonella, parasite eggs and amoebic cysts. In addition, the discharge of waste into water sources reduces the dissolved oxygen within water bodies, whilst increasing nitrogen and phosphorus levels, impacting aquatic ecosystems (Molapo, 2009:16).

According to the DWA (DWAF, 2001: 2), there were no known abattoirs in South Africa that use a closed system in which water is reused as it is too costly to implement. Abattoirs therefore discharge their waste water, which Roberts and De Jager (2010:57) estimates, may be up to 841,000 litres of water per day, into municipal sewers. The purification of such waste is consequently the responsibility of municipal and local authorities (Roberts and De Jager, 2010:58). Effluent is however required to meet the standards specified by the DWA before being discharged into municipal systems (DWAF, 2001: 2). Part 2, section 19 of the uMgungundlovu District Municipality Water Bylaws states that within the uMgungundlovu District municipality it is the site owners responsibility to "take and maintain approved measures to prevent the entry into the water supply system and part of the water installation on his or her premises; of a substance that may be harmful or a danger to the health or well-being of any human or other living organism or may adversely affect the portability of water or its fitness for use" (uMgungundlovu District Municipality, 2009:19). Effluent specifications required by the DWA are as follows (DWAF, 2001:3):

- Chemical Oxygen Demand ≤ 3000 to 5000 milligram per litre (mg/L)
- Total Suspended Solids ≤ 500 mg/L
- pH 6 to 10.

To achieve these levels pre-treatment is therefore required in addition to good housekeeping to minimise waste. Pre-treatment processes recommended by the DWA include (DWAF, 2001:3):

- Solids separation or screening;
- Fat or oil removal by flotation or skimming;
- Primary settling;

- Protein recovery;
- Waste effluent balancing
- pH correction;
- Ultra filtration; and
- Reverse osmosis.

As stated in the South African Meat Safety Act No. 40 of 2000, abattoirs are solely responsible for converting live animals into meat (RSA, 2000:5). There are however provisions for the traditional slaughter of livestock on a farm site within the Meat Safety Act (RSA, 2000:5). The Meat safety Act No 40 of 2000 defines meat as "those parts of a slaughtered animal which are ordinarily intended for human and animal consumption and which have undergone any processing other than deboning, cutting up, mincing, cooling or freezing and includes meat that has been treated with a substance that does not substantially alter the original characteristics thereof" (RSA, 2000:5). Section 7 of the Meat Safety Act (RSA, 2000:6), states that

"(1) No person may

(a) Slaughter any animal at any place other than an abattoir;

(b) Permit the slaughter of any animal at any place under his or her control unless the place is an abattoir; or

(c) Sell-or provide meat for human consumption unless it has been slaughtered at an abattoir.

(2) (a) Subsection (1) does not apply to slaughter for own consumption or for cultural or religious purposes."

The Gauteng Department of Agriculture and Rural Development (GDARD) released in 2009 a set of guidelines referred to as "guideline manual for the management of abattoirs and other waste of animal origin". The purpose of this document is to provide the South African abattoir industry with waste management recommendations facilitating environmental and human safety. A summary of waste management recommendations made is as follows (GDARD, 2009:24, 41):

1. Soft organs, in the form of stomachs, intestines, lungs, carcass trimmings, reproductive structures etc., which are not utilised for food, floor sweepings, drainage trappings, and condemned meat, should all together be processed through rendering into meat/bone meal or used for the feeding of crocodiles;

2. Hard organs, such as horn and hoof can likewise, though separately, be processed into horn/ hoof meal though rendering operations, used as fertiliser, or used as pet-chew toys or gelatine;
3. Blood is a protein and nutrient rich liquid. When exposed to dirt, putrefaction occurs. This process decreases the usefulness of the blood by causing thickening. South African regulations prohibits the drainage of blood into municipal systems as it overloads and clogs the system. Blood should ideally be sterilised and dried into blood meal and used in animal feed. In cases, where a few number of animals are slaughtered, GDARD guidelines recommends that blood be cooked in a tank to facilitate coagulation. Excess liquids should thereafter be drained and the coagulated mass dried for disposal to landfill;
4. Gut contents and manure collected in lairages, "a place where livestock are housed temporarily" (Salman *et al.,* 2008:8), and kraals can be composted to produce fertiliser, or used as a substrate in biogas production;
5. Feathers or pig hair can be used to produce protein meals; and
6. "Hands, feet and some internal organs are sold as food items in Far Eastern countries".

Indigenous cattle of South Africa are an untapped resource in terms of hide suppliers (Mapiye *et al*., 2007:492). Musemwa *et al.* (2008:244) supports this statement, stating that hides or livestock skin were in the past exported but existing communal farmers have neglected the leather industry as a result of a lack of skills therefore failing to provide large volumes of quality product to a demanding market. The leather industry now considers African produced leather supplied by rural emerging farmers as low quality that has inherent flaws that result from tick bites; scratches; inappropriate brand marks; and horn rakes (Mapiye *et al*., 2007:492). Furthermore, the handling, storage and preservation facilities in rural areas are considered primitive (Mapiye *et al*., 2007:492) and are not able to meet market need. To eradicate these discrepancies the KZNDAE has recommended to local livestock breeders that livestock should be dehorned in order to avoid damage to skins (KZNDAE, 2010:1). In addition, farmers are advised during the slaughter process, to stun livestock in the forehead before slitting the jugular and cutting a vertical line down the centre of the body to avoid unnecessary damage to the fragile hide (KZNDAE, 2010:1). Once the hide is removed from the carcass, it should be cleaned before the blood and meat has dried out. This should be done on concrete or cement areas to avoid leaching and to prevent grass stains (KZNDAE, 2010:1). The best method of

preservation of hides is salting (KZNDAE, 2010:1). During the salting process, coarse salt is spread on the meat side of the hide and rubbed in before being left to rest in a cool place (KZNDAE, 2010:1) for a minimum period of 5 days (GDARD, 2009:27). The salt draws out excess moisture and protein-filled fluids from existing flesh (GDARD, 2009:27). Resulting effluent therefore has a significant salinity and biochemical oxygen demand as well as high levels of fluoride (sodium fluoride is contained at 1% and is used as a bactericide), which is not suitable to be discharged into local ecosystems (GDARD, 2009:27). Effluent should be separated in evaporation ponds and classified as solid waste for recycling (GDARD, 2009:27). During storage, it is important to lay skin on a flat surface as the leather will crack in places where it is folded (KZNDAE, 2010:2). To avoid damage from rodents and other pests, hides may be sprayed with insecticides (KZNDAE, 2010:2).

2.4.4.3. Pest control

The use of pesticides within South Africa is controlled by the Fertilizers, Farm feed, Agricultural Remedies and Stock Remedies Act (No 36 of 1947). Neither this Act nor the guidelines recommended by KZNDAE however provide guidance to South African emerging farmers with regard to the collection and storage of excess pesticides. On a commercial scale, the disposal of pesticides is governed by the Hazardous Substance Act, (No. 15 of 1973), the Fertilizers, Farm Feeds, Agriculture Remedies and Stock Remedies Act (No. 36 of 1947) and NEMA.

Poor livestock health management, a lack of know-how on drug usage and the husbandry of livestock breeds has made pest management a significant problem, particularly in terms of tick control in KwaZulu-Natal (Moyo and Masika, 2009:517). In general parasites take on a vertebrate as a host, transmitting a variety of pathogens and thus increasing the mortality rate of livestock through blood borne diseases such as anaplasmosis, babesiosis, erhrlichiosis (Moyo and Masika, 2009:517) and tick worry, which results in cattle becoming weak and losing blood (de Castro, 1997:79) Parasites, such as ticks, furthermore reduce meat quality; milk production; livestock fertility (Marufu *et al.,* 2011:172). Pests also create wounds which make livestock more susceptible to infection and decreases the value of hides (de Castro, 1997:79). According to Moyo and Masika (2009:518), anaplasmosis is of great concern within South Africa, with 99% of cattle being at risk, thus creating significant instability to emerging livelihoods.

The cost of pesticides plays an integral part in tick management. Prior to the abolishment of apartheid, dipping services were mandatory and free to farmers however post-apartheid, this was eliminated as it was presumed uneconomical to dip indigenous species (Bayer *et al*., 2004:17). Farmers therefore began to purchase their own chemical dipping solutions either as a pour on, plunge or a spray-on (Bayer *et al*., 2004:18). The policy on dipping has changed recently yet again with the re-establishment of dipping tanks by government in an attempt to re-establish livestock development groups (Bayer *et al*., 2004:18).

In South Africa the preferred method of external parasite control is dipping. According to the KZNDAE guidelines, the purpose of dipping livestock is to minimise production losses from ticks and flies (KZNDAE, undated). A study conducted in KwaZulu-Natal however states that rural areas are not as disease ridden as one would think (Bayer *et al*., 2004:18). The study also indicated that most rural farmers prefer modern medicine over traditional indigenous remedies (Bayer *et al*., 2004:18). Those farmers that did employ traditional medicine are a distance away from major cities and therefore have no access to modern facilities (Bayer *et al*., 2004:18). The use of modern medicine however poses a threat, as farmers purchase drugs on their own accord and therefore may administer incorrect dosages (Bayer *et al*., 2004:18). The use of pesticides moreover has disadvantages such as, prolonged use, without rotation, aids in ticks developing immunity to chemicals (Marufu *et al.,* 2011:172; Moyo and Masika, 2009: 518). So much so, that in parts of the world it is reported that as a result of early use, ticks have become immune to pesticides with extremely high toxicity, such as arsenic and organo-phosphorus based acaricides (de Castro, 1997:80). The use of these pesticides has since been banned in most parts of the world as they have a high toxicity that threatens natural resources (de Castro, 1999:80). In addition, the increased use of these pesticides poses a threat to human health as pesticide residues tend to linger in consumed meat and milk produced by treated livestock (Moyo and Masika, 2009:518). Genetic resistance still remains to be the most effective tool in the fight against ticks and tick-borne diseases (de Castro, 1999: 81). This however varies in livestock and is dependent on breed, location and heritable traits (de Castro, 1999:81). Rural farmers that keep indigenous breeds of livestock rely on livestock traits to determine the characteristics of livestock, for example, Marufu *et al. (*2011:173), states that livestock with shorter hairs, smoother coats and thinner skins have a reduced susceptibility to becoming tick hosts. Therefore South African emerging farmers are encouraged to keep the indigenous breeds of

cattle, Nguni and Bonsmara, as they not only are more resistant to pests but also to harsh local environmental conditions (Marfuru *et al.,* 2011:172).

There are alternatives to the use of pesticides in pest management. Although less effective, these methods may be more effective to households that cannot afford vaccinations and pesticides. For example, the clearing of pastures over vast periods, with the implementation of rotational grazing, reduces the survival of ticks in an area (de Castro, 1999:81). Furthermore, the introduction of a biological agent in the form of a predator or pathogen can also be introduced into the ecosystem to manage pest populations (de Castro, 1999:81). Red-billed Oxpeckers is one such species that has aided farmers in past management. An individual is reported to feed on approximately 98 adult ticks and 12,500 larvae per day (Plantan, 2009:7). These indigenous birds however have decreased in population in South Africa partly as a result of mass poisonings with the increased use of acaricides (Plantan, 2009:3),

2.4.4.4. The reuse of manure and sludge

Livestock excrement, hereafter referred to as manure, is made up of faeces and urine (Imbeah, 1998:197). Manure has been used for centuries as a means of maintaining the soil fertility of agricultural land (Tanner *et al*., 2001:22) as it stabilizes soil aggregates thus preventing soil erosion and improving the structure of soil through the promotion of moisture retention (Martinez *et al.*, 2009:5529) and correction of drainage problems in wet areas (Haines, 2004:293). Soil fertility is one of the imperative threats to South African crop agriculture (Mkhabela, 2002:25), therefore nutrient management, which is defined as the transfer of manure from a site with excess manure to one that is lacking in nutrients to allow for nutrient substitution (Mkhabela, 2004:347), is an integral part of rural agriculture. According to the GDARD (2009:46) manure may occur in two forms: “as sweepings from lairages which are built into heaps” and occasionally used by emerging farmers to improve soil fertility; or as kraal manure. Kraal manure is less desirable, as it is usually mixed with soil, water and straw as a result of livestock plodding within the kraal area, thus making the manure more difficult to handle during the collection and distribution processes (GDARD, 2009:46).

The South African agricultural industry currently relies heavily on the agrochemical industry for the production of fertilisers (Greenberg, 2010:9). This is a market dominated by a few companies such as Dow, Bayer and Syngenta that are able to manipulate prices (Greenberg,

2010:9). According to Greenberg (2010:9), the price of fertilisers rose by 200% between 2006 and 2008. With a rising oil price it therefore stands that South African emerging and commercial farmers should turn to livestock manure as a renewable energy and nutrient source as it would be more cost effective and is readily available (Greenberg, 2010:9). According to the Fertilizer Society of South Africa (1998 cited in Mkhabela, 2002:25), approximately 3 million tons of manure, at an estimated value of 29.7 million, is available in South Africa. This manure has the potential to meet 13.3%, 9.9% and 27.6% of the counties nitrogen, phosphorus and potassium needs respectively (Mkhabela, 2002:25). However, only 25% of the manure available is utilised in the improvement of soil fertility (Fertilizer Society of South Africa cited in Mkhabela, 2002:25). The remaining manure is either treated as waste or used as an energy source (Mkhabela, 2002:25). Over the last few decades, despite the perception of locals, that manure is beneficial to soil fertility "the use of manure by farmers is relatively low" (Mkhabela, 2002:25).

Environmental concerns resulting from excess manure involves odour pollution; biogas emissions; increased risk of diseases like typhoid fever; increased insect populations that transmit disease (Suman *et al.,* 2010:1077); and nitrogen and potassium pollution of soil and waterways (Imbeah, 1998:197;). Despite the benefits that organic fertilizers offers soil, their over application may cause the accumulation of macro-nutrients such as nitrogen, phosphorus, potassium and heavy metals such as Copper and Zinc, (Martinez *et al.*, 2009:5529) which are necessary for the growth of plants, but in excess have detrimental effects on the environment and in turn human health (Tanner *et al*., 2001:22). According to Sabiiti (2011:4) nitrogen and potassium pollution has become a significant concern in areas surrounding livestock farms as a result of the misuse of manure through excessive manure application to fields that has the potential to contaminate ground water and waterways with nitrogen and potassium though surface run-off and leaching (Sabiiti, 2011:5). The presence of excess potassium in surface water stimulates the growth of algae and other aquatic plants, which increases oxygen demand that affects fish and other aquatic life (Sabiiti, 2011:5), through processes such as denitrification (Aubry *et al*., 2006:295).

Chicken manure has a high nitrogen content (Makhabela, 2004:347). This nitrogen however only becomes available to plants over a period of time (Makhabela, 2004:348). Application times are therefore of great significance to ensure maximum benefits to soil and future crops

(Makhabela, 2004:348). Furthermore, fresh animal manure is unsuitable for land application as it contains pathogens and unstable nutrients (Imbeah, 1998:197). A key example of this is the case of Reunion Island which has developed a thriving agricultural industry to provide employment to locals thus creating a self-sufficient system in terms of food production (Aubry *et al*., 2006:295). The intensification of the livestock industry in recent years has resulted in the occurrence of a high concentration of manure (Imbeah, 1998:197). These factors have resulted in large quantities of manure accumulating on Reunion Island stimulating environmental concern and causing ineffective disposal practices with insufficient nearby land for application (Imbeah, 1998:197). It is recommended by the GDARD (2009:46) that manure be stored in enclosed sheds to decay slightly before being applied to crops. If fresh manure is applied to soil, substantial loss of nitrogen may occur (GDARD, 2009:46). Other negative effects of nutrient overload through the over application of manure is the increase of heavy metals in soil and decreased soil aeration (Petersen *et al*., 2007:181).

There are different ways in which to manage livestock waste. Some countries store manure as a dilute slurry that is kept in lagoons until needed for application through irrigation (Petersen *et al*., 2007:181). The quality of manure however decreases when it is exposed to air and water as nitrogen is lost through evaporation and Potassium and Phosphorus through leaching (GDARD, 2009:46). Different waste storage facilities greatly affect the levels of incidence of zoonotic agents, which Salman *et al*. (2008:8) defines as agents that are "transmissible from human to animal or vice versa". For example the degree of aeration and the surface area to volume ratio of the facility influence the temperature of the storage facility and therefore the development of agents (Hutchison *et al*., 2005:1232). Hutchison *et al. (*2005:1231) states that the risk of zoonotic pathogens in stored livestock waste decreases over time. On most farms however waste is managed in batches and constantly added to storage facilities, therefore consistently introducing zoonotic agents (Hutchison *et al*., 2005:1232). According to Hutchison *et al. (*2005:1232), aboveground tanks and slurry lagoons indicated less zoonotic agents compared to other storage types. Manure has also been proven to release significant amount of methane, ammonia and nitrogen in the form of oxides into the atmosphere during decomposition (Sabiiti, 2011:5). The volatilization of ammonia facilitates acid deposition within the atmosphere, which produces the phenomena, acid rain (Suman *et al.,* 2010:1077), whereas the presence of nitrogen oxides facilitates ozone depletion (Sabiiti, 2011:5). An aesthetic consequence also arises in the management of waste in terms of odour which if not

dealt with properly, could result in health problems such as headaches (Suman *et al.,* 2010:1077).

Agricultural sludge is "sediment resulting from treating waste or sewage" that occurs at the bottom of treatment ponds (DARD, 2009:10). According to The Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act (36 of 1947), fertiliser should comprise of less than 20% ash and 40% water to be classified as organic fertiliser. Generally consisting of nutrients; metals; odours; and pathogens (Snyman and Herselman, 2006:4), sludge does not conform to this definition however may still be applied to as a fertiliser given that it meets specific requirements. According to the Snyman and Herselman (2006:4, 5), the benefits of sludge application are:

- To supply major plant nutrients (calcium, magnesium, potassium, phosphorus, nitrogen);
- To supply some essential micronutrient (zinc, copper, molybdenum and manganese) and;
- To improve the physical properties of soil, i.e. better soil structure, increased water retention capacity and improved soil water transmission.

Agricultural sludge does however also contain toxic compounds such as heavy metals and pathogens that pose a risk to environmental and human health (Snyman and Herselman, 2006:6). Consequently it is required that sludge be classified into microbial sludge (A, B or C); stability class (1, 2 or 3) or pollution class (a, b or c) (Snyman and Herselman, 2006:7). The GDARD (2009:34) recommends that once sludge is removed from treatment ponds, it should be dried in order to minimise the odour nuisance and used as manure. In cases where sludge is not suitable for environmental exposure, it should be incinerated (GDARD, 2009:37).

2.5. Waste Management technologies

According to Zander *et al. (*2013:9), technological innovation has the ability to radically increase productivity and income levels in developing countries whilst decreasing pressures on natural resources. Therefore one of the main goals of land reform programmes and other agricultural support programmes is to provide emerging farmers with technologies that would improve their agricultural practices. The use of technologies would help rural farmers make the transition to become sustainable emerging farmers and even to commercial status through

the implementation of sustainable, best practices that would be economically and environmentally beneficial. The two main goals of the World Bank's Agricultural Action Plan, for example is to increase agricultural productivity with the introduction of seed varieties, various livestock breed and water management technologies; and to create easier accessibility of farmers to markets through transport infrastructure, access to finance support and market information (Mobile Agri Skills development and training, 2013). Despite the assumed benefits of the adoption of modern technologies, implementation has proven difficult for emerging farmers as a result of a lack of resources available to emerging farmers credited to social and economic inequalities that exist in KwaZulu-Natal; and multiple barriers that co-exist and are enhanced by each other (Zander *et al.,* 2013:9). Market access and disease control according to Zander *et al*. (2013:15), are significant technology factors that limit emerging farmers. Given a lack of resources, in the form of capital and education (Zander *et al*., 2013:15), emerging farmers are generally not able to mitigate pest control to prevent diseases and produce high quality market quality products.

2.5.1. Methods of waste disposal

According to Gwyther *et al.* (2012:1) the global livestock population consists of approximately 1.9×10^{10} birds and 2.31×10^{6} mammals. Farmers therefore require practical, economical and socially viable carcass and slaughter disposal methods to deal with a significant quantities of mortalities (Imbeah, 1998:197) and husbandry waste. Furthermore, the FAO (2006:16) estimates that farm households in rural communities can generate significant quantities of organic waste in the form of manure, feed and crop residues. The improper management of these wastes will result in degraded water quality with increased level of nitrogen; the release of excess amounts of ammonia, methane and nitrous oxides; the deterioration of soil quality with excess potassium and phosphorus levels, in addition to permitting a breeding ground for pests and disease if it is left stagnant (FAO, 2006:16).

Throughout history the most widely used methods of on-farm waste disposal has been the burial or burning of waste due to its convenience and minimal cost (Yuan *et al*., 2013:246). These practices however have environmental negative impacts (Table 2.2) and no recovery, resulting in its ban, for example, in the European Union (EU) (Gwyther *et al.*, 2012:2). Thus over the last few decades there has been the emergence of more efficient, effective and safe

methods and technologies that have emerged and consequently adopted by the global livestock industry.

Table 2. 2. The advantage and disadvantages of disposal methods used by produces and abattoirs with the livestock industry
(Haines, 2004:293)

Disposal method	Advantages	Disadvantages
Burial	• Inexpensive	• Risk of pollution and disease transmission • May reduce the value of the land • Requires land and earth moving equipment for larger animals
Rendering	• Destroys most pathogens • Significantly reduces the volume of waste • Can recycle the waste	• Does not destroy prions • Expensive • Requires collection and storage of waste
Composting	• Cheaper than rendering and incineration • Makes use of nutrients when used as a fertiliser • May destroy pathogens that cause disease	• Risk of disease transmission and pollution • Requires earth moving equipment and material with a high C content • May reduce the value of the land • The compost must be disposed of properly
Biodigestion	• Reduces landfill volumes • Reduces GHGs through the collection of methane • Produces fertiliser	

2.5.1.1. Burial

Traditionally, the burial method is used by producers, abattoirs and dead stock collectors to dispose of dead stock and other meat production waste (Haines, 2004:293). Frowned upon but not illegal, on-farm burial usually entails the burial of waste in "graves, trenches, or in open-bottom containers otherwise referred to as mortality or disposal pits" (Gwyther *et al.*, 2012:2).

Concerns first emerged in the early twenty first century that the burial of livestock waste may result in the pollution of water and soil (Rahman *et al.,* 2009:1), posing a significant risk to human and environmental health with the discharge of prions that have the potential to enter the human food and animal feed chains (Williams *et al*., 2009:4032). Burial was thus banned by the EU with the implementation of the Animal By-Product Regulations to avoid health problems (Williams *et al*., 2009:4032) and is referred to as a "last resort" by the KZNDAE

(KZNDAE, 2012:11). The exposure of soil and groundwater to significant masses of decomposing organic waste has the potential to harm ecosystems in that it may cause the nutrient levels of soil and water to exceed natural levels and introduce pathogens into the ecosystem which would then enter the food chain or water supply (Gwyther *et al.*, 2012:2). The potential of pathogens to move through soil however is determined by a number of factors such as pH, water flow rate and substrate size (Gwyther *et al.*, 2012:2). Therefore many sources of literature believe that the likelihood that dangerous pathogens causing harm is negligible, especially when precautions, such as an impermeable membranes or hydrated lime at the base of the burial pit are employed to limit exposure to soil and the survival of the pathogens (Gwyther *et al.*, 2012:2).

Yuan *et al*. (2013:246) states that even though there are only a few studies that have looked at the effects that livestock waste burial has had on the environment, increased concentrations of ammonia, nitrate, chloride and faecal pathogens in groundwater near poultry burial sites have been noted. Gwyther *et al. (*2012:2) however argues that these assumptions were made from evidence collected during mass events, which would likely have a more profound effect on the surrounding environment and is therefore inaccurate in terms of the on-site burials of emerging farmers.

The location of the burial site and its features are of extreme importance. According to Dippenaar (2014:4), sandy or gravelly soil or an area with a shallow ground water table should not be used as a burial site. In addition, burial sites should be a safe distance away from residential areas and shallow aquifers (Dippenaar, 2014:7). The DWA has established the following guidelines for non-commercial farmers to minimise the contamination of water sources, minimise air pollution and protect public health (DWAF, 2001:1):

- The disposal site will be situated outside a water source and above the 1: 50 year flood line;
- The disposal site will be fenced;
- The site may not overlay and area with a shallow water table;
- The burning of waste on the site will not be a nuisance to neighbours;
- The waste should not cause a nuisance by attracting vermin or insects; and
- Livestock and animals should not have access to the site.

In Ontario, Canada, The Dead Animal Disposal Act, which only applies to horse, sheep, goats and cattle, requires that the owner of a deceased animal dispose of a carcass within 48 hours of the death either by burial below two feet of earth; having it picked up by a licensed collector or laboratory; or composting the dead stock on- farm by covering the animal in at least 60 centimetres of a biodegradable material with a high carbon content (Haines, 2004:285).

2.5.1.2. Burning

Despite the burning of agricultural waste being frowned upon in South Africa, it is a commonly used practice in poverty stricken rural areas of third world countries (Naidoo, 2009:42). The process, according to Gwyther *et al. (*2012:2), involves the burning of animal waste on pyres in open air. Being used mainly for the mass disposal of carcasses resulting from disease outbreaks, there are many biosecurity concerns that have emerged with the use of this method with the emission of infected particles into the atmosphere triggering out breaks of diseases, such as "foot and mouth" (Gwyther *et al.,* 2012:2). Studies however have not indicated a threat to soil or groundwater resources (Gwyther *et al.,* 2012:2). Concerns lie mainly in that open air combustion (Gwyther *et al.*, 2012:3) is assumed to be incomplete and therefore prions, which Mandal (2013) defines as "a small infectious particle composed of abnormally folded protein that causes progressive neurodegenerative conditions", may still be a risk when dispersed in the form of ash to neighbouring land (Sabiiti, 2011:4). In addition, during the burning process air pollution occurs with the release of various gases during the combustion process (Gwyther *et al.*, 2012:3) contributing to climate change.

Carbon monoxide, carbon dioxide, nitrous oxide, nitrogen dioxide pose a significant risk to the environment in that they allow for the formation of ozone and nitric acid which contributes to acid deposition in the form of acid rain, which in turn creates a further challenge to local farmers by increasing the acidity of soil (Sabiiti, 2011;4). South African air monitoring legislation, the National Environmental Management: Air Quality Act no. 39 of 2004, makes no reference to the burning or incineration of agricultural waste on a household level but rather governs industrial activities on a larger scale (RSA, 2012:1). The DWA standards do however state that no disposal site should create a nuisance in terms of odour emissions. (DWAF, 2001:1). Uncontrollable waste burning has thus become somewhat of an unaddressed problem, particularly in rural areas (Naidoo, 2009:42). Naidoo (2009:42) argues that the backyard burning of waste may seem negligible at first glance however when considering that each

household within a geographic region is using this practice it is likely that the environmental effects such as acid rain, smog and water contamination becomes substantial. Furthermore, emissions from the incomplete combustion in the form of dioxins and furans have the potential to negatively affect human health as they are carcinogenic and can therefore pose risks to the human reproductive and immune system (Gwyther *et al.*, 2012:3). The Cancer Research Initiative of South Africa has found that the informal burning of waste, particularly within a drum releases more dioxins than an incinerator that burns thousands on tons in a day (Naidoo, 2009: 62). However, as a result of high cost it is very unlikely that incinerators are being used by emerging farmers in South African rural areas.

2.5.1.3. Incineration

According to Jagath (2010:17), "mass burn incineration is a form of thermal treatment whereby waste is combusted in incinerators". During the incineration or combustion process waste is burnt in an incinerator at temperatures greater than 850^{o}C (Gwyther *et al*, 2012:3) to produce carbon dioxide; water; residues, that are usually made up of small quantities of hydrochloric acid, sulphur, other volatile inorganic compounds, ash (Chen *et al.,* 2003:661); and vast amounts of steam, that may be used in energy recovery (Jagath, 2010:19). Incineration is a method of waste reduction rather than final disposal, reducing waste volumes by up to 90% (Arvanitoyannis, 2008:48) to produce and inert ash that may be disposed of safely on a landfill site (Jagath, 2010:18). Incineration as a disposal method is very costly as it is energy and labour intensive and is therefore mainly used to dispose of small volumes of waste (Rahman *et al.,* 2009:2). Furthermore, the pollution derived from the incineration process is significant (Jagath, 2010:19). Therefore facilities around South African have recently been closed (Jagath, 2010:19). In the United States, the burial of birds is frowned upon due to the excess release of arsenic and other carcinogens (Nachman *et al.,* 2005:1124). Incineration is therefore performed on-site in small quantities to manage the daily mortality of poultry and avoid additional risk imposed by temporary storage (Rahman *et al.,* 2009:2).

Even though it is thought to be one of the most effective processes in terms of the destruction of protein prions, there are a variety of problems and risks associated with incineration. These include fire and explosive hazards, noise pollution, odour pollution, vegetation damage, ground water pollution, air pollution and health hazards (Arvanitoyannis, 2008:47). Incineration, like burning, produces dioxins and furans which have the potential to enter the food chain once it

settles in areas near the incinerator, thus posing a risk to human health (Gwyther *et al.,* 2012:3) in addition to greenhouse gases. According to Gwyther *et al.* (2012:3), studies have also shown that animal carcass incinerators produce flue gas that has a significantly higher metal concentration. The use of technologies such as afterburners can however be used to alleviate this risk (Gwyther *et al.,* 2012:3).

2.5.1.4. Rendering

Used mainly by the commercial South African livestock industry, rendering is a "crushing and heating process that extracts useable ingredients" (EPA, 1999:11). The GDARD (2009:39) describes the rendering processes as "a series of drying and separating processes by which the material is sterilised and the fats and proteins are extracted to produce tallow, blood and meat-and-bone meal". Like incineration, rendering is an energy intensive process, rendering however provides a return on energy with the production of tallow which can be used to make soap or as an energy source thus lowering its environmental impact (Gwyther *et al.*, 2012:4). During the rendering process water is extracted from waste to produce gas and odours emissions in addition to an effluent with high biological and chemical oxygen demand, consisting of grease, oils and suspended solids (Gwyther *et al.*, 2012:4). Industry generally employs technologies such as afterburners, scrubbers and filters to that these by-products before disposal (Gwyther, 2012:4).

Because rendering occurs under extreme pressures, the by-products produced are pathogen free (Rahman *et al.,* 2009:2). There are however still biosecurity concerns surrounding the use of rendering. These lie within the transportation of carcasses to rendering plants (Rahman *et al.,* 2009:2). Rendering is therefore usually not a feasible method in terms of rural waste disposal due to transportation costs and the associated health risks (Rahman *et al.,* 2009:2). For example additional precautions imposed by the Food and Drug Administration since 2009, recommends that prior to the incineration of cattle older than 30 months, the brain and spinal cord be removed and disposed of alternatively, in order to avoid the transmission of mad cow disease (Bovine spongiform encephalopathy (BSE)) (Rahman *et al.,* 2009:2).

2.5.1.5. Composting

Composting or aerobic composting as per Jagath (2010:39) refers to "the biological degradation of biogenic (organic) waste in the presence of oxygen, producing carbon dioxide,

ammonia, water and compost". The composting process is composed of four phases based on temperature changes (Figure 2.4) (Jagath, 2010:39) during which microorganisms, bacteria and fungi break down the organic waste and reduce its mass and volume to produce a soil amendment (EPA, 1999:11). The heat exhibited during the process inactivates pathogens and also acts as an indicator that biological activity is occurring (Barrena *et al*., 2009:380). The first phase, the latent phase, facilitates the growth of micro-organisms in the waste (Jagath, 2010:39). Thereafter the mesophilic growth phase is defined by the growth of the micro-organisms and an increase in temperature to that of a mesophilic range (Jagath, 2010:39), approximately 30- 40ºC (Gwyther *et al.,* 2011:5). The thermophilic phase occurs when temperatures increase to a thermophilic range, approximately 70ºC (Gwyther *et al.,* 2011:5), allowing for waste stabilisation and the elimination of pathogens (Jagath, 2010:39). Finally, the maturation phase is defined by a decrease in biological activity to the mesophilic temperature range (Jagath, 2010:39).

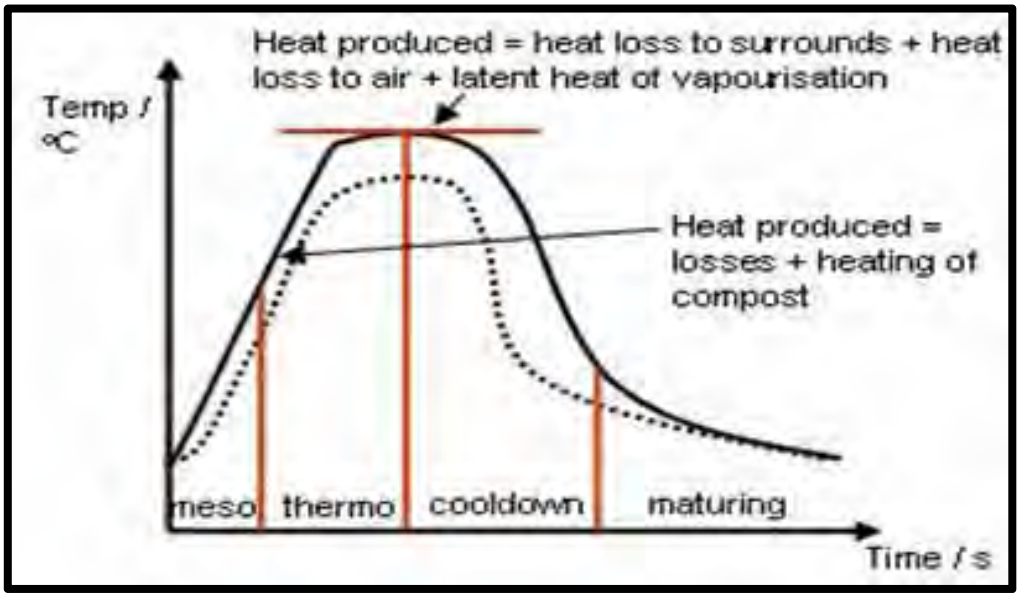


Figure 2. 4. The three phases of composting
(Duc *et al*., 2012).

Composting is usually done in one of three ways: pile or windrow composting; bin composting; or using mini-composters (Rahman *et al.,* 2009:4). The pile or windrow composting method involves the creation of 2-3m high compost piles, arranged in a length of 100m rows, to allow for oxygen and temperature flow through the waste piles (Jagath, 2010:40). Used for the disposal of larger carcass as, this composting system is constructed in open air, to also allow for the easy loading of carcasses, and on a solid floor usually made of concrete to control

leaching (Rahman *et al.,* 2009:5). Initially, the compost pile needs to be managed and maintained at anaerobic and thermophilic conditions to facilitate rapid decomposition therefore avoiding odours during the destruction pathogens (Rahman *et al.,* 2009:5). Thereafter the compost pile is allowed to stand without interference (Rahman *et al.,* 2009:5).

Bin composting requires a three sided container is laid in compacted soil or clay and filled with a suitable bulking agent such as sawdust or tree trimmings to provide structure to the compost pile (Rahman *et al.,* 2009:4). Carcasses and other organic waste is then laid within the bin with a carbon layer in between (Rahman *et al.,* 2009:4). Mini-composters are used in the composting of small volumes of smaller livestock carcasses (Rahman *et al.,* 2009:5). This biotechnological process is widely used around the world to produce fertilizers and soil amendments despite significant knowledge gaps surrounding long term results. (Qian *et al*., 2013:1). To avoid pollution, an impermeable base should be installed prior to composting and a bulking agent such as sawdust to absorb excess liquids (Gwyther *et al*., 2012:5).

The GDARD recommends that the composting of manure be done in either pits or bunkers (GDARD, 2009:46). Both structures are required to have a roofing to avoid seepage (GDARD, 2009:46). According to GDARD (2009:46) a pit is a "hollowing of the earth" whereas a bunker is "a chambered structure constructed with cement blocks above the ground". The filling of both structures should occur with alternative layers of kraal and lairage manure (GDARD, 2009:46). Once filled, the structures are to be covered a layer of organic matter such as leaves followed by roofing to allow for decomposition (GDARD, 2009:46). Every 2-3 weeks the manure should be turned and mixed to ensure that the manure is well rotted after a collective period of 8 weeks (GDARD, 2009:46).

Agricultural compost is made up mostly of organic matter and therefore can be applied to soil without risk to act as a soil amendment that can improve upon crop productivity (Sabiiti, 2011:6). Furthermore the application of compost to soil reduces the occurrence of weeds within crops; decreases the volume of accumulated waste and therefore the pathogens and insects that could harm livestock and crops (Sabiiti, 2011:6). As an additional benefit compost can also be sold contributing to livelihood security through income generation (Sabiiti, 2011:6).

2.5.1.6. Biodigestion

According to Greben and Oelofese (2009:3), anaerobic digestion or biodigestion (Gwyther *et al*., 2012:6), is "the natural process which, in the absence of oxygen, decomposes organic matter", with the use of micro-organisms (Jagath, 2010:23), to produce biogas and digestate. Like composition, biodigestion occurs in phases, namely psychrophilic; mesophilic and thermophilic which occurs at temperatures up to 20 degrees Celsius; 20-40 degrees Celsius and 45-60 degrees Celsius respectively for various periods (Gwyther *et al.,* 2012:6). The various temperatures that occur during the biodigestion process have the potential to destroy various pathogens however, a secondary heat process is usually employed for biosecurity reasons (Gwyther *et al*., 2012:6). During the digestion process, organic matter is broken down by naturally occurring bacteria at each stage (Greben and Oelofese, 2009:3). Therefore the composition and nature of the organic matter influences the products produced (Greben and Oelofese, 2009:3). Jagath (2010:23) defines biodigestion as a series of biochemical reactions:

1. Hydrolysis: insoluble organic waste, such as carbohydrates, is broken down by hydrolytic bacteria to form soluble organics, including fatty acids and amino acids.
2. Acidogenesis: soluble organics are broken down by acidogenic bacteria to form simple organic compounds such as ketones and alcohols.
3. Acetongensis: the simple organic compounds produced during acidogensis are broken down by acetogenic bacteria into organic acids, carbon dioxide and hydrogen
4. Methanogenesis: acetongensis products are reduced to methane and carbon dioxide (biogas).

Co-digestion, according to Greben and Oelofese (2009:3), "is defined as anaerobic digestion treatment of a mixture of at least two different organic waste types". Anaerobic co-digestion of animal and other organic wastes provides a sustainable cycle of natural resources (Figure 2.5) (Chibundo, 2012:15). Manure has proved to be a good substrate as it has a "high buffering capacity originating mainly from the ammonia; a high water content with total solids typically 3-5% for livestock waste from pigs and 6- 9 % for livestock waste from cattle and dairy cows; and is rich in a wide variety of nutrients necessary for optimal bacterial growth". Greben and Oelofese (2009:4) indicate that optimal digestion is achieved with a mixture of equivalent amounts of manure, soil and waste activated sludge, which as defined by the World Bank Group (2014) is a mass of microorganisms cultivated in the treatment process to break down organic matter into carbon dioxide, water and other inorganic compounds", with paper sludge,

sewage sludge and municipal solid waste. In addition, a study compiled by Chibundo (2012:64), in which the co-digestion of manure sourced from various livestock species was evaluated to determine which was the most effective in the production of biogas, indicate that cow dung produced the highest biogas yield, followed by poultry and pig excrement (Chibundo, 2012:64).

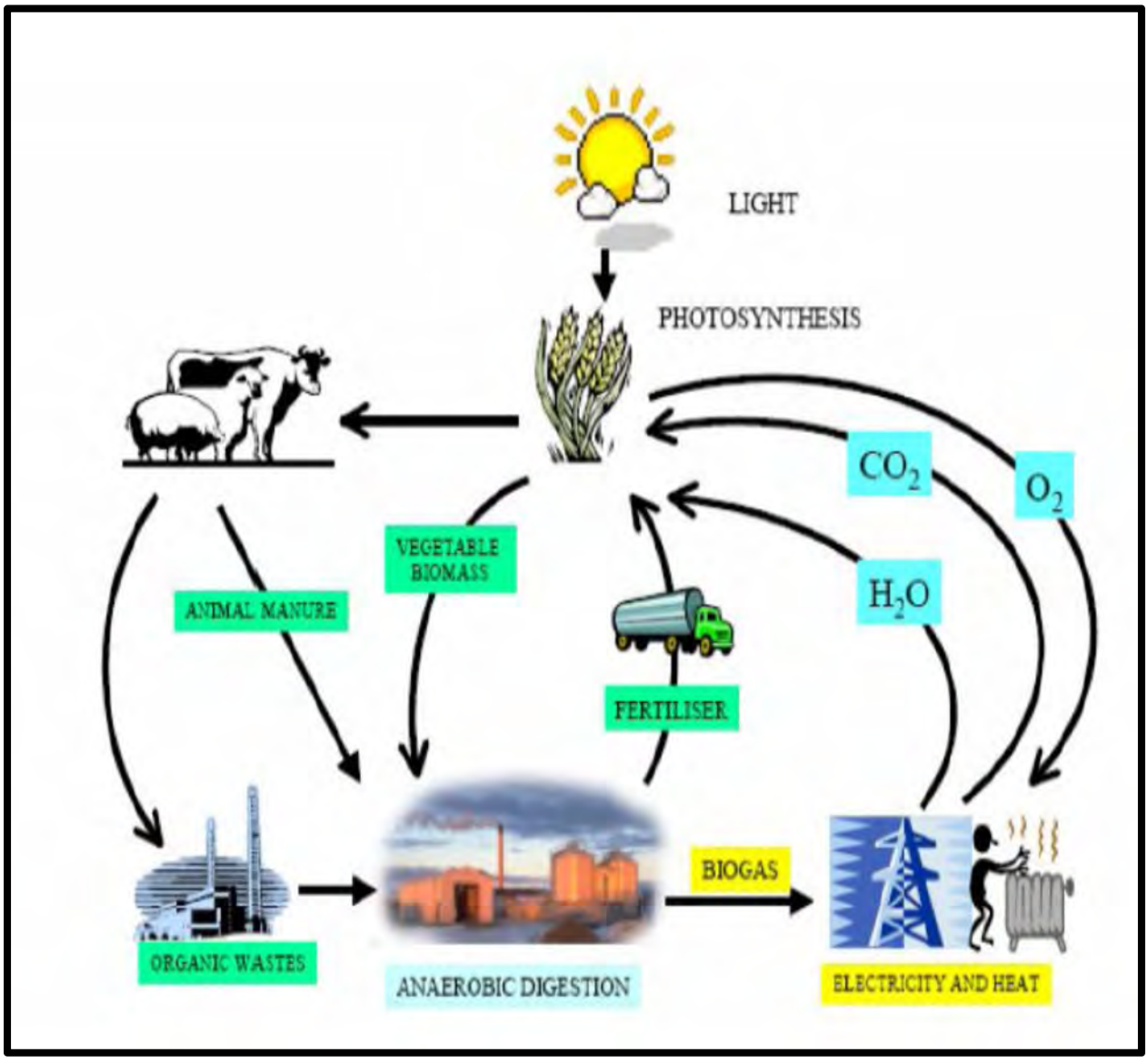


Figure 2. 5. Sustainable cycle of natural resources during the biodigestion process (Chibundo, 2012:15).

Digestate is a reduced amount of bacterial biomass in the form of a nutrient rich liquid (Greben and Oelofse, 2009:3) that results from the biodigestion process and is essentially immature fertiliser (Jagath, 2010:25). Biogas, as a bio-fuel, is a cheap and clean energy source that can

also be used to produce fertilizer for crop production through the decomposition of organic waste (Boyd, 2012:302; Thu *et al*., 2012:64). Supported by the United Nations and the EU as a result of its social and environmental benefits (Boyd, 2012:301), biogas technologies are considered to be a possible solution and mitigation method in manure management and energy production (Thu *et al*., 2012:65). According to Tauseef *et al*. (2013:189), biogas is "generated from the decomposition of organic waste" resulting in a gas made up of 60-65% methane and 35-40% carbon dioxide with traces of ammonia, hydrogen sulphide, other gases and water. In terms of rural livelihoods biogas technologies have the potential to provide a variety of benefits (Boyd, 2012:301). Biogas is an alternative energy source, either being used as a heating source or is converted into electricity (Thu *et al*., 2012:65). By providing warmth and heat for cooking, local vegetation and resources are conserved and deforestation reduced (Thu *et al*., 2012:65). Furthermore biogas technologies have the potential to improve livelihoods through better sanitation with the reduction of odours (Thu *et al.,* 2012:65) and the risk of pathogens and insect infestations; reduced indoor smoke; and through job creation (Boyd, 2012:301). For these reasons biogas capture is commonly done by rural farming households within developing countries (Tauseef *et al*., 2013:189). According to southafrica.info (2013), in order to promote better waste management in rural area six biogas operations have recently been approved for installation within rural areas of the KwaZulu-Natal province by the National Energy Regulator of South Africa as required by national legislation.

Within South Africa biodigestion is a fairly new technology, only being implemented by large industries (Jagath, 2010:32). A few small scale biogas projects exist within the KwaZulu-Natal province working as pilot models for the digestion of sewage and livestock manure (Jagath, 2010:32). In KwaZulu-Natal there still exists many areas without proper sanitation facilities and electricity (Jagath, 2010:32). The implementation of biogas projects therefore serve a dual purpose in this respect.

2.6. South African Policy Surrounding the Livestock Industry

2.6.1. The Agricultural Reform Policy of South Africa

During the last 20 years the South African agricultural sector has undergone significant societal and economic changes. The discovery of diamonds and gold in the late 19th century resulted in

the industrialization and an economic boom within South Africa, and thus an urgent need for unskilled labour (Haringston *et al*., 2004:65). To meet this need, apartheid policy in the form of the Natives Land Act No.27 of 1913 later referred to as the Bantu Trust and Land Act No. 18 of 1936 (Bradstock, 2005:1980), was implemented. During this period agricultural farming technology and practices were rather simple and therefore dependent on labour rather than technologies (Letsoalo, 1987:32). Small-scale family farms, particularly black owned farms, were dependent on family members and neighbours therefore requiring little hired labour (Boonzaaier, 2009:5). The Natives Land Act No.27 of 1913, restricted black farming operations to 8% of the nation's agricultural land, known as African Homelands or Bantustans (Lahiff, 2007:2) and ensured that black people could not purchase farming land from white farmers (Valente, 2009:1540). This meant that the only available livelihood option for black South Africans was within the mining sector. Grand Apartheid practices therefore led to the deterioration of black agricultural subsistence systems (Bradstock, 2005:1980). According to Bradstock (2005:1980), black agricultural systems produced enough to meet their own subsistence needs and obtain a surplus that they could market. Following the implementation of apartheid law, black farmers could not meet up to 45% of their subsistence needs (Bradstock, 2005:1980).

Following the 1994 transition to democracy, traditional farmers re-entered the South African economy. The policy and legislation that were drawn up at a time however, were done so with little knowledge or experience available surrounding resource use, agricultural systems and the socioeconomic state of the nation (Vetter, 2013:1). Nevertheless, the government adopted the principles of the "negotiated land reform" system as recommended by the World Bank and implemented a three-component land reform policy made up of (Obeng-Odoom, 2012:165):

- restitution of land unjustly taken from people and communities;
- land redistribution, and
- land tenure reform

These principles were consolidated in 1996 with the creation of Section 25 of the South African Constitution (Obeng-Odoom, 2012:166). According to the White Paper on South African Land Policy, the Negotiated Land Reform policies enforced that a willing buyer- willing seller system be employed to rectify the "injustices of racially based land dispossession; to establish a more equitable distribution of land ownership; to reduce poverty and contribute to economic growth; to achieve security of tenure for all; and to develop a system of land management that

will support sustainable land use patterns and rapid land release for development" (Bradstock, 2005:1982).

Communal rangelands, according to Vetter (2012:2) make up 13% of South Africa's agricultural land (Figure 2.6). Since this land can be used to facilitate the survival of livelihoods based on livestock husbandry, cropping and that use natural resources, it is important that it be redistributed to be utilized by resource poor rather than commercial farmers (Vetter, 2013:2) to solely benefit the economy. The Governments' 1997 White Paper on South African Land Policy states that "in large parts of the country, in small rural towns and settlements, poor people need to gain access to grazing land and small arable/ garden areas in order to supplement their income and enhance household food security" (Davenport and Gambiza, 2008:513). Therefore with the aim of preserving and improving food security and the economy of South Africa, the focus of the reform program was changed in 2000 to be more market centred (Obeng-Odoom, 2012:166).The Ingomyama trust is of particular importance in the implementation of the land reform project in KwaZulu-Natal as it is authorised by the Communal Land Rights Act (11 of 2004) to act as a medium of distribution of land (RSA, 2004:21). There are approximately 800 recognised traditional communities within South Africa, 286 of which are represented by the Ingonyama Trust Board within KwaZulu-Natal (Figure 2.6) (Olivier, 2006:305). According to the KwaZulu-Natal Ingonyama Trust Act (RSA, 1994:2), the Ingonyama Trust Board is a corporate body "established with perpetual succession and power to sue and be sued" regarding matters involving traditional land use within KwaZulu-Natal.

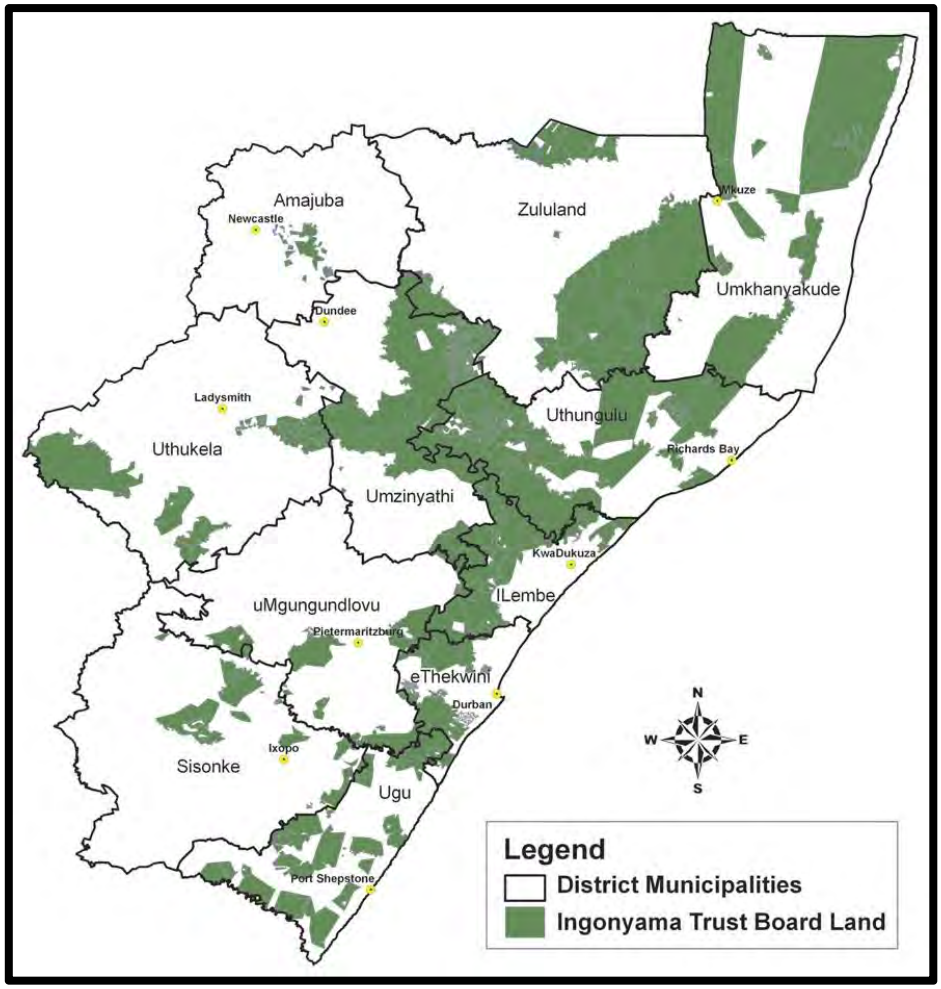


Figure 2. 6. Distribution of Ingonyama Trust Board Land in KwaZulu-Natal (Bridges, 2014).

The implementation of the land reform programme is not as simple as purchasing land from white farmers and transferring it to municipalities that would allocate land to those that are disadvantaged (Davenport and Gambiza, 2008:513). In order to maintain and improve food security within rural and urban areas whilst improving livelihood vulnerability and preserving natural resources, support to the farmers needs to accompany policy (Ulrich *et al*., 2012:242). To achieve this, it is vital that land be allocated to those whom have appropriate farming skills. With the development of many agricultural innovations that dominate the commercial agricultural industry today and the loss of traditional and indigenous farming knowledge as a consequence of apartheid displacement, large-scale commercial farmers have gained a competitive advantage through mass production and specialized farming (Davenport and Gambiza, 2008:513). Large-scale farmers have also, over time, established contracts directly

with big buyers in terms of supplying them with products therefore saturating local agricultural markets (Davenport and Gambiza, 2008:513).

In 2001 the Land Redistribution for Agricultural Land Development (LRALD) subprogram was implemented on a national level (Bradstock, 2005:1982). The updated efficient approach, differs from the initial reform policy. Instead of leaving large concentrations of land in the ownership of a few unskilled individuals, the state now provides subsidies to poor, willing, skilled farm owners, who wish to purchase land from white farmers, therefore encouraging redistribution and the establishment of profiting emerging farmers (Obeng-Odoom, 2012:166). As a result small-scale farming on a hectare basis emerged within the livestock industry giving those households that take part in agricultural activities a better opportunity within markets (Dovie *et al*., 2006:260). As of September 2009, only 6.9% (5.67 million hectares) of agricultural land had been transferred to 1.78 million people, of which 26% is located in arid Northern Cape (Greenberg, 2010:4). This prompted a new target for the land reform programme: 30% land transfer is to be completed by 2025 (Greenberg, 2010:5).

The failure of meeting the target set by Ministry of Land Affairs and Agriculture and the discrepancies in its implementation lie in various factors. Firstly the land reform policy was implemented by separate departments; namely department of Agriculture and the department of Land Affairs (Hall and Cousins, 2013:11). This was exacerbated in 2009 with the creation of two divided ministries from the Ministry of Land Affairs and Agriculture (Hall and Cousins, 2013:11) into the Department of Rural Development and Land Reform (DRDLR), who is responsible for rural development and land reform and rural economic development and the Department of Agriculture, Fisheries and Forestry (DAFF), whom focuses on the activities on the commercial agricultural sector (Vetter, 2013:2). The split of these departments further broadened the gap between commercial and emerging farmers by hindering the support available to land reform beneficiaries and creating a further communication gap between the two sectors as well as between land development and agricultural officials. (Vetter, 2013:2).

In order to rectify the previous failures of the land reform, President Jacob Zuma on the 30 June 2014 re-opened land claims by re-signing the Restitution of Land Rights Bill (Frost Illustrated, 2014). The Land claims period will last five years, ending 30 June 2019, during which time any person or community that had lost land after 19 June 1913 as a result of racial

discrimination under apartheid or the Betterment policies without just compensation, may claim land (RSA, 1996:1253). Even though the intention of this process is to correct historical injustices by re-opening land claims to the South African Land Claims court, it has received vast media scrutiny in South Africa, with local industry professionals and current farmers stating that the project could result in people being "pushed out of their homes" and national food insecurity (Makinana, 2014). Furthermore, the department of rural development and land reform have proposed that commercial farmers give half of their farms to black employees (Makinana, 2014). This proposal was received with similar criticisms from the farming industry and local media with reports that the implementation of this would create instability within the South African commercial farming industry therefore making it difficult for farmers to get loans from banks and other institutions in addition to discouraging foreign investment (Wagner, 2014).

Policies, both local and national, lack the perspective of the resource-poor farmer, concentrating more on economic benefits to South Africa and support to larger farming operations (Greenberg, 2010:1). This is evident in national legislation and similarly in current farming guidelines recommended by the KZNDAE. These guidelines describe recommended systems that may be employed to manage livestock however do not take into account the needs of emerging farmers and the resource availability. Hall and Cousins (2013:12) reasons that policies and guidelines are usually derived by farming industry officials; and therefore take a commercial stance.

2.6.2. Agricultural Policies

2.6.2.1. Local Agenda 21 (LA21): South Africa

The United Nations Conference on Environment and Development (UNCED), also known as the Earth Summit, took place in Rio de Janeiro in 1992 with intentions of addressing global climate change (Owen and Videras, 2008:260). Four treaties were approved during UNCED, one of them being A21 (Owen and Videras, 2008:260). According to Barrutia *et al. (*2007:33), A21 "is a worldwide work plan, proposing a series of policies on a whole range of sustainable development related areas". Aimed at helping those countries that have subscribed to the treaty with creation and implementation of agricultural action plans, A21 proposes that (United Nations, 1992: 118):

- The “Sustainable development” principles be integrated into all agricultural and rural development policies;
- Communities have more influence on the use natural resources through policy and public awareness. This is based on the principle that if a community is dependent on resources they will preserve them;
- Agricultural operations be intensified in such a way that specialisation be avoided as this increases ecosystem vulnerability, environmental stress and market fluctuations;
- Agricultural land be utilised in a manner that acknowledges the potential, carrying capacity and limitations of local resources;
- Land degradation be addressed;
- Indigenous plants and plant biodiversity be conserved to facilitate food security;
- Indigenous animal species be conserved;
- Integrated pest control be implemented to minimise resource pollution and avoid unnecessary livestock and crop losses;
- Soil productivity be maintained so as to maintain plant nutrition levels; and
- Sustainable rural development be a key goal for development.

Section 28 of A21 implements the use of LA21, which according to Owen and Videras, (2008:260), is “a decentralized initiative that focuses on the role of local governments in the implementation of sustainability programs within a country”, to address issues such as water resource management, air quality, energy management and solid waste reduction. The use of LA21 ensures that local government plays a critical role in development programmes with the implementation of specialised programmes. The LA21 set up for South Africa makes reference to the Agricultural Act, stating that the National Department of Land Affairs along with provincial municipalities are responsible for providing support to emerging and commercial farmers to allow for the purchase of agricultural land and infrastructure (United Nations, undated). LA21: South Africa also supports the 1995 white paper for agriculture and its functions stating that (United Nations, undated) “the Government is reforming its agricultural policy with three strategic aims:

- Making the sector more efficient and internationally competitive;
- Supporting production and stimulating an increase in the number of new, small scale and medium scale farmers; and

- Promoting the conservation of agricultural natural resources."

2.6.2.2. South African agricultural policies

South African policies and legislation are unique to other first and third world policies mainly in terms of the cultural and monetary significance that has been placed on livestock. Within South Africa, there are a number of existing policies that have been created to assist livestock farmers (Todd *et al*., 2009:7). These policies however are either too narrow in that they deal with specific areas of the industry or too broad, providing insufficient specialized data on important aspects (Todd *et al*., 2009:7).

According to Jonsson (2011:1), chapter two, section 27 of the South African constitution, the Bill of Rights, protects not only the "civil, political and socioeconomic rights of all people", but also preserves the rights of future generations and their right:

- "to an environment that is not harmful to their health or well-being; and
- to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that
    i. prevent pollution
    ii. and ecological degradation;
    iii. promote conservation; and
    iv. Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

In order address these rights NEM: WA commenced on the 1 July 2009 with the aim of imposing general duties with regard to the handling, storage and disposal of waste. In essence, NEM:WA implements the principles reflected by the waste hierarchy (Figure 2.3), therefore encouraging that waste be minimised, reused and recycled, with landfilling becoming the absolute last resort for waste disposal. Section 4(1) states that "the Act does not apply to the disposal of animal carcasses", therefore NEM:WA deals with specific types of animal waste and byproducts, in other words, animal waste that is not regulated by the Animal Health act or the Animal Diseases Act such as biogas (RSA, 2008:10). NEM: WA considers the agricultural sector a commercial industry making reference to the extender producer responsibility principle, which states that the producer of a product is to a degree responsible for the products

management past the point of sale and thus only making provision for commercial activities. For example, Schedule A (17) states that "the storage, treatment or processing of animal manure at a facility that has a throughput capacity of 10 tonnes per month" and "the processing of waste at biogas installations with a capacity for receiving five tonnes or more per day of animal waste" (RSA, 2008: 90). NEM: WA however does state under Section 4, Subsection 16, which would apply to emerging farmers, that (RSA, 2008:32): "A holder of waste must, with the holder's power,

(a) take all reasonable measures to avoid generation of waste and where such generation cannot be avoided to minimise the toxicity and amounts of waste that are generated;
(b) reduce, re-use, recycle and recover waste;
(c) where waste must be disposed of, ensure that the waste is treated and disposed of in an environmentally sound manner;
(d) manage the waste in such a manner that it does not endanger health or the environment or cause a nuisance through noise odour or visual impacts; ..."

As an implementation tool of the Waste Act, a NWMS of South Africa as required by the Waste Act, was drawn up in 2011. The objective of the NWMS is to reach the objectives set by the waste act. To achieve this, the NWMS addresses existing waste management issues in terms of the waste hierarchy (Figure 2.3). This necessitates taking steps to deal with a growing population and therefore growing waste volumes, particularly in developing and urbanised areas, in addition to providing improved waste management in rural areas (DEA, 2011:15). Agricultural waste is not directly dealt with in the NWMS, however the NWMS has given municipal institutions the responsibility of "diverting organic waste" either through composting or biogas digesters. (DEA, 2011:22). Municipalities are also responsible for the implementation of projects that recover recyclables in addition to organic waste, as prescribed by NMWS. There are 8 goals set by the NWMS. These include (DEA, 2011:22):

- Promote waste minimisation, reuse, recycling and recovery of waste;
- Ensure the effective and efficient delivery of waste services;
- Grow the contribution of the waste sector to the green economy;
- Ensure that people are aware of the impact of waste on their health, well-being and the environment;
- Achieve integrated waste management planning;
- Provide measures to remediate contaminated land; and

- Establish effective compliance with enforcement of the Waste Act.

In terms of rural agricultural systems, the fulfilment of these goals will increase environmental and local livelihoods directly and indirectly. In the current strategy plan proposed by the KZNDEA, much focus has been placed on the growth of rural agricultural systems in terms of natural resource preservation, training and the education of emerging farmers and the assistance of emerging farmers in terms of capital and infrastructure (KwaZulu-Natal Department of Agriculture, Environmental Affairs and rural development - KZNDAERD, 2010:21). In order to cope with waste management the proposal aims to address chemical management; ensure that environmental pollution is dealt with appropriately and in a timeous fashion; address activities that may result in environmental degradation and promote waste minimization and cleaner production practices (KZNDAERD, 2010:18).

The policies of other third world countries such as India and Brazil have the prime focus of developing the economy and the livelihoods of the local poor and therefore these policies pay more attention to factors that benefit rural development. The Brazil Agricultural Policies, for example, are anthropocentric in that, (The Global Methane Initiative, 2010:7) like South Africa, they focus on correcting injustices of past social injustices that have affected livestock farmers (Vetter, 2013:3). To do this the Brazilian Government has introduced a policy that aims to reduce government involvement within agricultural markets and in turn stabilise prices and inflation rates (Ministry of Agriculture, Livestock and Food Supply, 2008:5). These policies aim to do this by introducing rural credit to emerging farmers that would assist them in financing infrastructure and market development (Ministry of Agriculture, Livestock and Food Supply, 2008:6). In terms of livestock waste management, Brazilian policies have looked into the managing of methane as a resource and a possible income stream to emerging farmers. The Global Methane Initiative (2010:7), which is a voluntary organisation that attempts to link all affected bodies in order to monitor methane and reduce methane emissions, considers livestock waste as an important source of methane. Therefore with statistics showing that the Brazilian agricultural sector is responsible for an estimated 22% of the country's total GHG emissions, a number of projects have been initiated to reduce waste within Brazil (Global Methane Initiative, 2012:17).

In India, there are 70 million rural households that own at least one form of livestock species (Government of India, 2013:4). It is these factors and circumstances that have encouraged the

development of a National Livestock Policy that acts as a framework for improving India's livestock sector. Indigenous farmers are faced with a large number of infectious diseases that plague livestock in addition to insufficient livestock health care services therefore negatively affecting local productivity as well as export potential (Government of India, 2013:6). The effects of climate change in addition to a lack of marketing infrastructure and technical know-how with the implementation of traditional farming practices have also limited productivity within rural areas (Government of India, 2013:6). By applying greater focus and funding into the following sectors the Government of India, national co-operatives and private sector partners hope to alleviate these challenges through (Government of India, 2013:6):

- Research and development with regards to health care and livelihood development
- Better co-ordination and convergence between co-operatives to bridge the gap between the public and private livestock sectors and to facilitate the development of marketing channels
- Strengthen infrastructure and services in terms of health care, breeding and fodder production
- Upgrading public facilities and technologies and establishing facilities where they are needed
- The establishment of disaster relief programs

The following pieces of legislation govern the waste management practices of both the formal and informal sectors of the South African livestock:

- The NEMA, No. 107 of 1998 act as the main body of environmental governance, providing guidelines to co-operatives, institutions and organs of state (RSA, 1998:4);
- The NWA, No. 36 of 1998 regulates the use of water nationally as well as regulates activities that could pose a risk to the countries water supply (RSA, 2009:1). According to Greenberg (2010:10), it is compulsory for agricultural producers to register as water users therefore allowing the state to allocate water to human basic needs and ecological processes;
- Conservation of Agricultural Resources Act aims at controlling the use of natural agricultural resources to preserve them and prevent ecological degradation by invasive species (RSA, 1984:1);
- Meat Safety Act, Act No, 40 of 2000 aims to "provide for measures to promote meat safety and the safety of animal products; to establish and maintain essential national

standards in respect of abattoirs; to regulate the importation and exportation of meat; to establish meat safety schemes; and to provide for matters connected therein" (RSA, 2000:1), however it only regulates the activities of abattoirs and excludes activities that are not within this sector;

- Fertilizers, Farm feed, Agricultural Remedies and Stock Remedies Act, Act No. 39 of 1947 regulates the pest control industry in terms of the use of pesticides and fertilizers (DEA, 2011: 19);
- The Animal Health Act, No 7 of 2002, according to NEM:WA, regulates the disposal of animal carcasses (RSA, 2008:18); as does the
- Animal Diseases Act, No. 35 of 1984, which deals with cases when a carcass is contaminated as well as the national movement of livestock to prevent the movement of pathogens (RSA, 1984:3).
- Landfill site disposal standards (Section 2.4.3)

These pieces of legislation however focus on the livestock industry on more of a large scale perspective, making exemptions for small scale, rural farmers. For example, the meat safety act permits the slaughter of animals for traditional purposes and for own consumption (RSA, 2000:1). South African regulations do not provide specific guidelines for the use of small scale livestock production systems therefore the KZNDAE has established provincial nature conservation ordinances. These ordinances are a set of comprehensive recommended farming practices available of the KZNDAE website [http://www.kzndae.gov.za/].

2.7. The role of waste management in food security

"Food security exists when every person has access to sufficient food to sustain a healthy and productive life, where malnutrition is absent, and where food originates from efficient, [equitable] and low-cost food systems that are compatible with sustainable use of natural resources" (IFPRI, 1995:50). Originating in the 1990's at the World food summit, food security is viewed as a combination of: food availability, food access; food utilization (Ruane and Sonnino, 2011:356) and more recently the risks that affect these factors, which need to be fulfilled simultaneously (Kruger, 2007:1). Food insecurity is therefore dependent on four key

factors; availability, stability, accessibility and utilization and is therefore a problem mainly faced by low income households (de Cock *et al.,* 2012:270).

According to Devendra (2012:7), the International Fund for Agricultural Development reported in 2009 that by 2050, 132 million people globally will be at risk of hunger as result of climate change. South Africa is a middle income country that is currently food secure at a national level and has been able to meet the nation's food needs for the past 20 years whilst still exporting and importing food (Kruger, 2007:11). Statistics however indicate that 2.8 million households (11.5 million individuals) within South Africa still face food insecurity (Mohlabi, 2012:7). Seventy two percent of this is largely concentrated in rural areas and households that have been disadvantaged. (Rooyen and Sigwele, 1998:492).

Section 27 of the South African Constitution states that: "everyone has the right to have access to sufficient food and water" (RSA, 1996:15). The South African government has therefore made a commitment to reduce poverty by half between 2004 and 2014 by pledging support and implementing a variety of programmes (de Cock *et al.,* 2012:269). On an international level, South Africa has pledged to be a part of the World Food Summit Plan of Action, which was epitomized in the 1996 Rome Declaration on World Food Security, to facilitate technology development, farm management, trade and growth policies and distribution systems that foster food security (DoA, 2002:11). Recently the South African government has launched two other programmes to assist in creating food security; the Zero Hunger Programme and the Outcome 7 programme (de Cock *et al.*, 2012:269). Much emphasis has also been placed on household food security through the implementation of the Integrated Food Security Strategy in 2002 (IFSS) (de Cock *et al.*, 2012:269). The vision and goals of the IFSS, which are similar to that of those set by FAO and the MDGs, are to "attain universal physical, social and economic access to sufficient, safe and nutritious by all South Africans at all times to meet their dietary and food preferences for an active and healthy life" by : (DoA, 2002:13):

- increasing household food security and market access;
- improving household income and community employment rates;
- improving local and national food security;
- revising and improving local disaster management;
- enforcing capacity building; and
- improving stakeholder engagement.

There are approximately 240,000 black farmers in South Africa (DAFF, 2011:14). These farmers sustain the livelihoods of more than a million family members and employ 500,000 community members in addition to enhancing food security within their own households and community (DAFF, 2011:14). Poverty and food security are partly owed to the several centuries of apartheid (DoA, 2002:17). Poverty does not however just imply a lack of financial income but also implies bad health, illiteracy or a lack in social services, including any situation that would render a household more vulnerable (Krantz, 2001:2). Poverty is therefore a driver of food insecurity especially in terms of rural emerging framers who have to sell food which they have produced for use within their household (Love *et al*., 2006:733). Krantz (2001:2) recognises that there is a distinct relationship between economic growth and poverty reduction. To allow for economic growth the poor need to have the capacity to take advantage of opportunities that would facilitate economic growth (Krantz, 2012:2). Agriculture is the key to the alleviation of poverty and thus food insecurity in poverty stricken rural areas of South Africa (Phiri, 2009:18). This stems from that with the implementation of sustainable agricultural practices agriculture can: reduce food prices; create employment; improve farm income and overall health; and increase employee wages. Given that 20% of South African households and 23% of households that lie in KwaZulu-Natal, do not have adequate access to food, it is therefore not surprising that 3 million people in South Africa produce food for their own needs (du Toit, 2011:11).

2.7.1. Uses of livestock by South African emerging farmers

Livestock, defined by Defoliart (1994:1) includes "domestic animals kept for use on a farm or raised for sale and profit". South African subsistence and emerging farmers however, keep livestock for varied reasons, including, food production; social status; income generation, manure production, a power source and to act as a financial investment as listed in Table 2.3 (Randolph *et al.*, 2007:2789). There are currently no reliable statistics available regarding the livestock present in KwaZulu-Natal (KwaZulu-Natal Department of Community Safety and Liaison, 2008:10) however, many studies have indicated that poor households existing within communal areas are dependent on livestock as a primary livelihood resource therefore emphasising the importance of livestock (Dovie *et al*., 2006:260). It is even assumed that small scale subsistence farmers keep the majority of cattle and goats whereas commercial farmers

account for the majority of sheep. (KwaZulu-Natal Department of Community Safety and Liaison, 2008:10).

Table 2. 3. Summary of benefits and products derived from livestock (Stroebel et al., 2011:187).

Benefit	Products
Food	Meat; milk; eggs; blood; processed products
Clothing	Wool; hides; leather
Work	Tilling; cultivation; transport of good and people; threshing; milling; pumping water
Monetary	Capital; investment; insurance; sale of products and animals
Social	*Lobola* (bride price); ceremonial; companionship; status
Manure	Organic fertiliser (rehabilitation of land); fuel; flooring
Other	Feathers; bone; soap production

A study done in Limpopo Province, South Africa indicates that households in South Africa keep livestock for multiple reasons rather than just for monetary or social purposes (Dovie *et al*., 2006:260). The study shows that the most important function of cattle within this particular community is to plough arable land followed by milk production and cash sales whereas goats are employed mainly for meat and slaughtered for ceremonial purposes (Dovie *et al*., 2006:263). In another study conducted in 2004 on three KwaZulu-Natal rural farming communities, livestock functions differed in that all the livestock being kept were done so with the intension of being sold (Bayer *et al*., 2004:15). It was also found that cattle are rarely slaughtered for the consumption of meat but rather act as an investment which can be sold for cash or traded for traditional reasons such as *lobola* (Bayer *et al*., 2004:15). According to Ngomane *et al*. (2010:33) *lobola* is a wedding tradition followed by most ethnic groups in Africa that involves exchanging money or cows to the bride-grooms' family for the bride. This is done to symbolise the union of two families (Ngomane *et al.,* 2010:33) and has been found to lower the divorce rate by enforcing that if the man is found guilty of infidelity the woman's family do not have to return the *lobola* payment (Bayer *et al*., 2004:15). Another use of livestock for traditional purposes is for the production of traditional attire and as a sacrifice during customary activities. In some ethnic groups it is traditional law that a married woman wear a leather skirt made of either cow or goat skin (Bayer *et al*., 2005:15). It is traditional that a cow would be slaughtered at a wedding or in the event of a family member or community member returning from a long absence whereas a goat would be slaughtered at a funeral (Bayer *et al*., 2004:15).

Livestock are integral to enhancing food security in that their main function is to convert organic wastes such as crop residues and excrement into a source of food and energy (Sabiiti, 2011:5). The use of livestock waste as a soil amendment is the chief way in which proper agricultural waste management can enhance food security (Sabiiti, 2011:5). Animal excrement, feed and carcasses have a high organic content. This waste can therefore be introduced to soil through composting, without any threat of environmental harm (Martinez *et al.*, 2009:5529). In addition, livestock waste is rich in nutrients such as phosphorus and potassium (Martinez *et al.*, 2009:5529), therefore playing an integral role in maintaining soil fertility and the success of future agricultural activities. Most waste management technologies, such as composting and biodigestion (Section 2.5.1) reduce the volume of waste and as a consequence limiting the threat of environmental pollution; diseases; odours and the formation of weeds that threaten crops (Sabiiti, 2011:6) and therefore maintaining a suitable agricultural environment. Furthermore compost can provide an additional source of income to farmers therefore strengthening the asset base.

The diverse livelihood strategies of livestock agriculture have therefore led Van't Hooft *et al*. (2012:51) to believe that livestock play a significant part in the fulfilment of the first MDG, to reduce extreme hunger and poverty. Van't Hooft *et al*. (2012:51) furthermore states that livestock agriculture reduces gender inequality (MDG three), by giving women the opportunity to sustain their own households; the impact of HIV/AIDS (MDG four) through the empowerment of women and therefore increasing the resilience of their livelihoods; and enduring environmental sustainability (MDG seven). Men are more likely to obtain wage earning income leaving women to sustain agricultural activities largely due to that men generally earn more money compared to that of women (FAO, 2011:4). According to FAO (2011:3) women comprise of 43 % of the agricultural labour force in developing countries such as South Africa. Hart and Aliber (2012:2) furthermore agrees stating that "women far exceed men when farming is done to produce household food". Figure 2.7 indicates that within South Africa women have the ability to secure food within their households. The search for higher income leads to males migrating to urbanised areas. The FAO describes this as "male-out migration, and states that this process increases the vulnerability of households as is suscepts women to gender based labour, such the herding of cattle, which is perceived as more difficult for women (FAO, 2011:8).

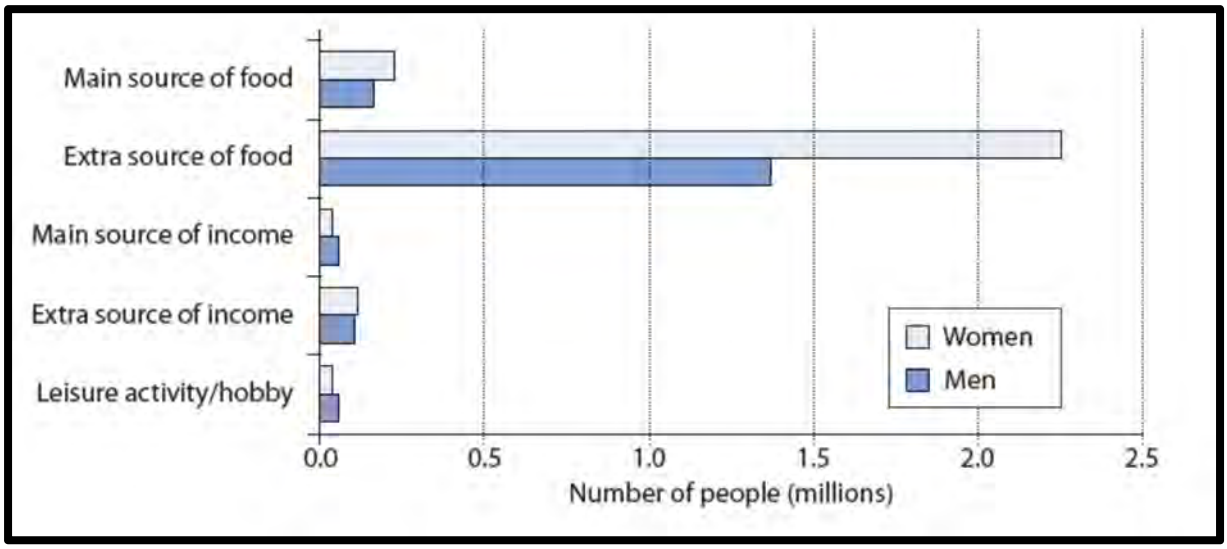


Figure 2. 7. Gender distribution in obtaining food security within rural South Africa (Hart and Aliber, 2012:3).

According to Lin *et al. (*2009:538), waste is generated during all stages of food production in the form of pesticides; GHG emissions and food scraps. This waste however is overlooked and generally disposed of through landfill and incineration (Lin *et al*., 2009:538). Water is a scarce resource in South Africa. Given that agricultural systems utilise 70% of the world's freshwater supply (Lin *et al*., 2009:538), the recycling of waste would decrease the consumption of water. For example the recycling of organic wastes to produce bone meal and animal feed reduces the need for crops to sustain livestock agriculture. In India, the livestock industry faces a significant shortage of feed and fodder within an ever growing industry as a result of a shortage of land; the overgrazing of existing land and the growth of the poultry industry (Government of India, 2013:6). Farmers have therefore abandoned their staple crops such as millets to grow maize to be used as fodder, consequently causing food insecurity in many regions (Government of India, 2013:6). The reuse of waste as fodder therefore preserves water as a resource whilst enhancing food security through decreased fodder production. The use of manure as a replacement further increases food security through the rehabilitation of agricultural land, facilitating the growth of higher crop yield and the preservation of grazing fields (Lin *et al.,* 2009:538). The improper management of manure and fertilisers, which are costly, conversely threatens water sources and sediment, therefore threatening food security (Lin *et al*., 2009:538).

2.7.2. Climate Change

Recent literature acknowledges that a complex relationship between water, energy and food systems exists (Gulati *et al*., 2013:150) and could be one of the greatest threats to food security and the global economy (Lawford *et al*., 2013:607). Figure 2.8 shows the interdependence of resources on each other, how the demand of one resource can affect the others and how the cost of one can influence production systems (Gulati *et al*., 2013:151). Created at Bonn Nexus Conference in 2011 (Gulati *et al*., 2013:150), the water, energy and food nexus was created based on that "pressure on resources could finally result in shortages which may put water, energy and food security for people at risk, hamper economic development, lead to social and geopolitical tensions and cause lasting irreplaceable environmental damage" (Ringler *et al.,* 2013:617). Food production requires energy and water and even land, as they are required in fertilizer production, irrigation, livestock production and in processes further down the value chain such as processing and transportation (Gulati *et al*., 2013:151). Therefore in order to ensure sustainability it is necessary to create a system that uses these resources in such a way that they are not diminished of compromised. Climate variability is a significant concern that creates instability amongst these dimensions threatening food security (Megersa *et al.,* 2013:315). Therein comes in management challenges requiring that all processes within the food industry be understood in order to manage the use of energy and resources (water and land) (Lawford *et al.,* 2013:608). In South Africa, management challenges are further emphasized by the rising cost of resources involved in food production, which make future food security a concern (Gaulati *et al*., 2013:152). In addition, the rural poor are more dependent on their surrounding environment, therefore factors such as natural resources and weather patterns influence livelihood success (Wlokas, 2008:12).

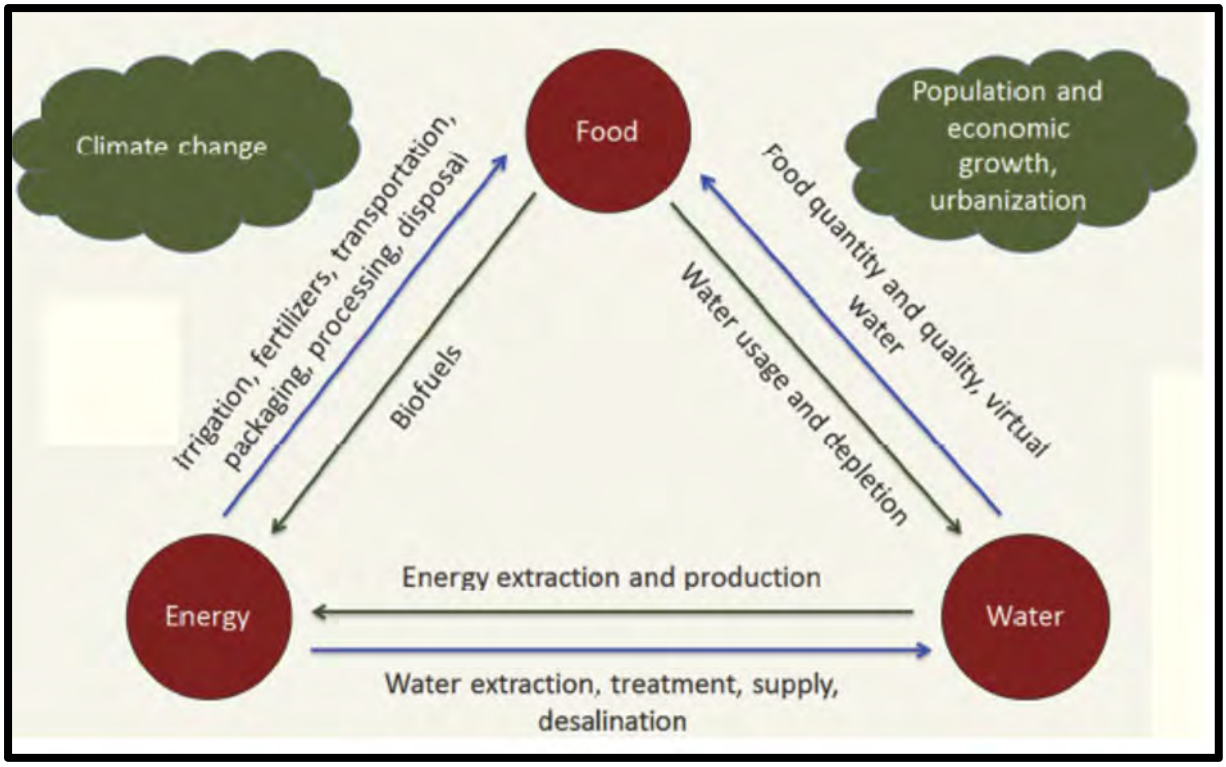


Figure 2. 8. Water, food and food nexus
(Gulati et al., 2013:151)

The Fourth assessment Report of the Intergovernmental Panel on Climate Change predicts that by 2100 the global average surface temperature will rise by 1.8- 4.0 degrees Celsius and sea levels will rise by 30- 60 centimetres (Below *et* al., 2010:3). Furthermore climate variability will increase, with more rainfall in the Northern hemisphere and less in the Southern (Below *et* al., 2010:3). According to Ziervogel *et al.* (2014:605), climate change affects water resources, food security, health, infrastructure, ecosystem services and biodiversity. South Africa is considered a water-stressed region, adaption and mitigation strategies are therefore integral in dealing with the effects of climate change on local agricultural systems (Figure 2.9). Research indicates that with an increase in temperature: the intensity, frequency, and occurrence of weather will change; ecosystems will change to adapt to weather changes; and sea levels will rise (Figure 2.9). These environmental effects result in thermal stress being placed on human populations and agricultural systems; weather anomalies that destroy crops; and creates vector for zoonotic agents (Figure 2.9) therefore intensifying the vulnerability of the rural poor who are directly dependent on their local natural resources

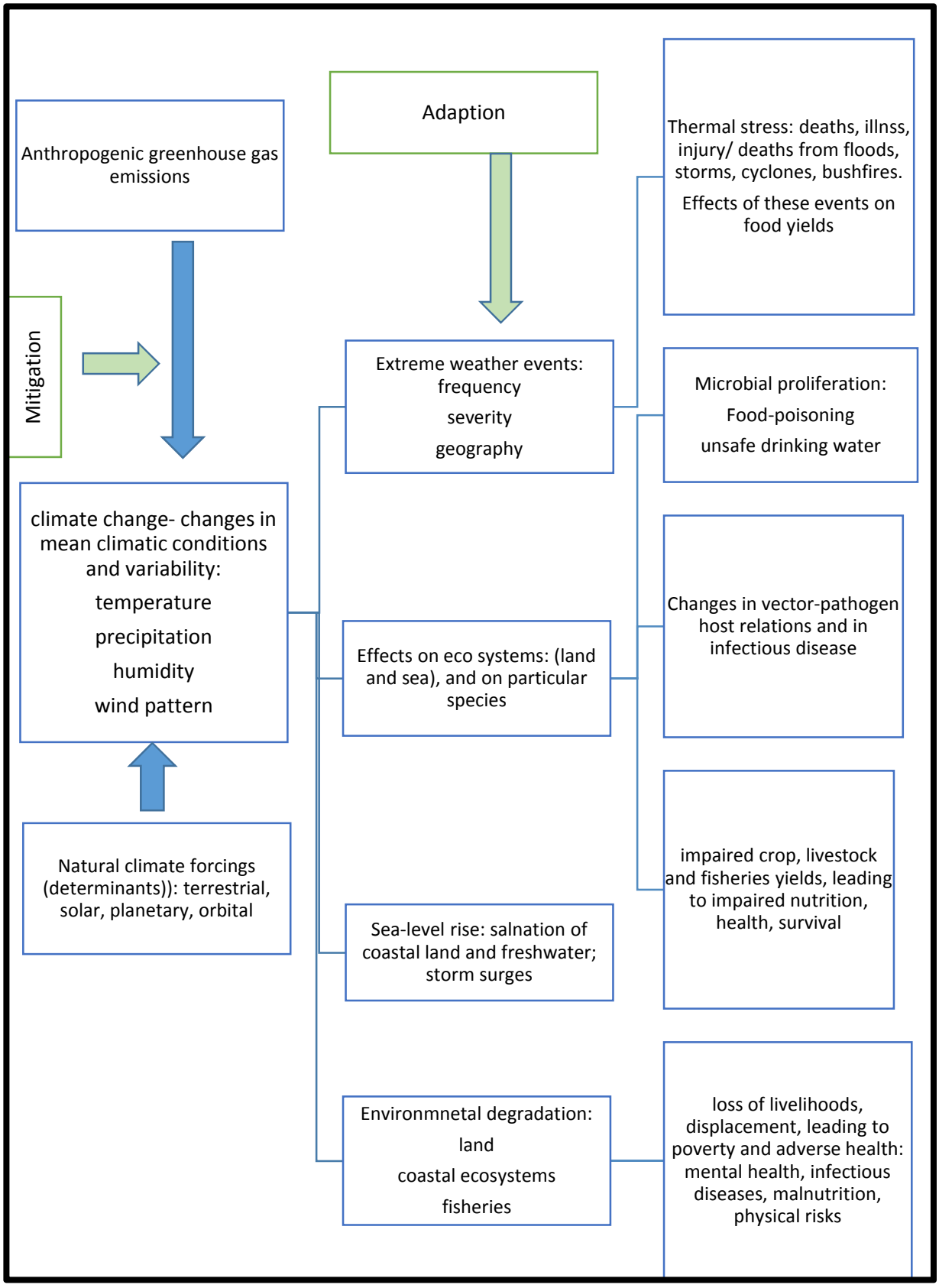


Figure 2. 9. The effects of climate change on agricultural systems (Wlokas, 2008:15).

Extensive studies done in 2006 indicate that livestock farming contribute to 18% of GHG emissions (Herrero *et al.*, 2011:780). The main gases produced are carbon dioxide during land use changes and livestock metabolic processes; methane from the enteric fermentation of manure and; nitrogen dioxide which is released from the use of nitrogenous fertilisers and manure; and ammonia (Mara, 2011:7). Livestock generate a significant quantity of nitrogen dioxide emissions as a result of nitrogen excretion in the form of urine and faeces and are responsible for one third of global anthropogenic emission of methane (Metz *et al.*, 2007:510). In addition nitrogen can be lost to water bodies through surface runoff (Aneja *et al*., 2012:93). Nitrogen lost to the environment undergoes transformation reactions therefore facilitating changes within local ecosystems (Aneja *et al*., 2012:93). Methane emissions can be reduced by manipulating the diet of livestock (Metz *et al.*, 2007). To reduce the concentration of nitrogen present in the urine and faeces of livestock, the protein intake of livestock is increased (Delve *et al.,* 2001:227). The addition of specific oils or oils seeds and probiotics such as yeast suppress methanogenesis (Delve *et al.,* 2001:227). Furthermore, by adding more concentrates to replace forages, the animals daily methane emissions are increased but emissions per kg of feed significantly decreased (Metz *et al.*, 2007:510; Delve *et al.,* 2001:227). Other agents that can be administered include: antibiotics which have been banned in the EU as it may be transitionary (Metz *et al.*, 2007:510).

One of the most significant concerns that surround livestock is the quantities of methane that are produced by ruminants, being released either from manure through anaerobic digestion ; during respiration via microbial fermentation, which occurs in the large fore-stomach (rumen) during the digestive process; and ruminant exhaling (Tauseef *et al*., 2013:187). Increased attention to the impacts of global warming has become a focus within the livestock industry due to the added benefits in the form of a potential income stream to both the commercial and informal sectors. The predicted rise in methane levels over the next two decades can be seen in Figure 2.10.

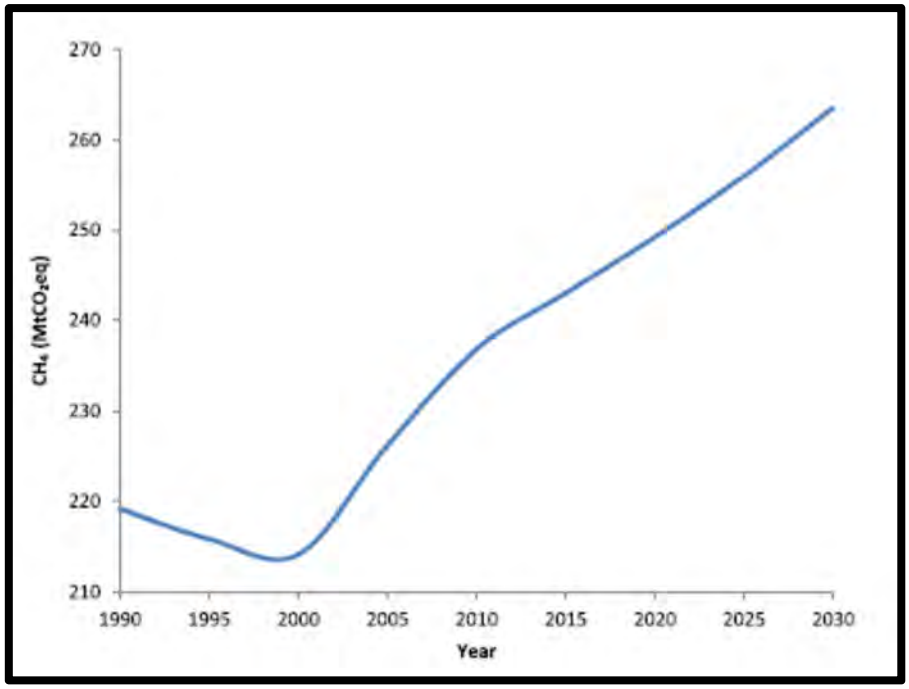


Figure 2. 10. Global trend of methane production in terms of livestock manure management (Tauseef et al., 2013:189).

Every year on average six million hectares of forestland is converted to agricultural land, which is used either as grazing grounds for livestock or croplands (Metz *et al.*, 2007:502). Grazing lands occupy a much larger area than that of croplands and are less intensively managed therefore are more likely to be responsible for majority of GHG emissions produced from the agricultural sector (Metz *et al.*, 2007:508). The presence of livestock further increases GHG emissions as they produce substantial amounts of methane and carbon dioxide **(**Ding *et al.,* 2012: *inpress***).** Furthermore, according to Lin *et al.* (2009:538), the production of animal derived food releases more GHGs than the production of plant sourced foods. Cattle and pig husbandry produces 30 times more carbon dioxide than protein rich cropping, these statistics are largely based on that ruminants contribute to methane emissions through enteric fermentation (Lin *et al*., 2009:538). Mara (2011:2) estimates, using the Intergovernmental Panel on Climate Change inventory system, that livestock contribute 8-10 % of global GHG emissions. Carbon dioxide produced from livestock respiration however is not considered with these estimates because the carbon present in the feed consumed by livestock is broadly equivalent to the carbon dioxide emitted during respiration therefore there is no net increase in atmospheric carbon dioxide (Herrero *et al*., 2011:779).

Grazing lands sequester a substantial quantity of Carbon within grasses and the soil. This is greatly affected by the intensity and timing of grazing, as it influences the removal; growth; carbon allocation; and flora that occupy the grasslands, as well as the region due to variations in species, climate, soils and grazing practices (Metz *et al.*, 2007:508). Carbon sequestration within grasslands can be improved upon by alleviating nutrient deficiencies with the use of fertilizers and manure, as this increases plant litter returns and in turn soil carbon storage (Metz *et al*., 2007:508). The addition of nitrogen through the misuse of fertilisers however often results in the emission of nitrogen oxides (Ding *et al.,* 2012: *inpress*). Practices that can improve upon the nitrogen efficiency include: the estimation of crop needs so that excess fertilizer is not used; the use of slow or controlled-release fertilizer; the use of nitrification inhibitors; and applying nitrogen when it is most needed by crops where it is most accessible to the plant, which is at the roots (Metz *et al.*, 2007:507).

Sustainable development and climate change have a mutual relationship in that climate change has a significant effect on natural resources that forms the basis of social and economic development and in turn the actions of society and industry effect GHG emissions which influence climate change (Metz *et al.*, 2007:121). According to Tauseef *et al.* (2013:187), manure based methane is responsible for four percent of all anthropogenic methane produced. With the increasing global demand for livestock products these estimations are expected to increase to 16.5% (Tauseef *et al*., 2013:187). Since biogas is a secondary energy source, capturing it conserves natural resources, prevents the unnecessary release of GHG into the atmosphere and additionally contributes to South Africa's goal to contribute 10000 GWh of renewable energy to final energy consumption within ten years (Boyd, 2012:302). In South Africa, however biogas technologies are not employed as readily despite the various benefits (Boyd, 2012:302). Looking at countries that do employ these technologies, both developing and developed, biogas programmes are supported by policy frameworks and incentives (Boyd, 2012:302). According to Boyd (2012:303), in South Africa, there are 300,000 households with at least two cows and no electricity, 45% of schools with no electricity, 66% with insufficient sanitation facilities and 12 % with no sanitation whatsoever. The installation of biodigesters and biogas capture is thus a viable potential energy source within South Africa that needs to be addressed in terms of research and policy (Boyd, 2012:305). The implementation of waste management best practices in the form of the sustainable use of manure and collection of biogas

has the potential to limit the effects of climate change which negatively affect local agricultural activities, thus threatening food security.

2.7.3. The Link between Animal-Sourced Products and Human Health

According to Yongabi *et al. (*2013:6), zoonotic diseases are linked to poverty, hunger and livestock husbandry. In developing counties it is estimated that approximately 20% of sicknesses are the result of zoonotic diseases (Yongabi *et al*., 2013:6). Infectious diseases therefore substantially jeopardize the South African economy by undermining the health status of the working class (Yongabi *et al*., 2013:1), in addition to affecting livestock numbers. In the event of a mass contamination, it is not uncommon for livestock to be slaughtered to avoid further risk of human health and the spread of zoonotic pathogens. "The sheer growth in numbers of food animals, use of intensive genetic selection, and enhanced breeding practices to increase production is causing a lack of genetic diversity and increasingly monotypic character of animal herds and flock. These practices may increase the susceptibility of animals to novel disease pathogens and outbreaks" (Rabinowitz and Conti, 2013:191). Kotze and Rose (2015:31) estimates that over the last six decades, 20% of the world's livestock breeds have become vulnerable to extinction.

Even with significant resources being used by organisations, such as World Health Organisation, to combat the spread of infectious diseases, a lack of sanitation facilities and waste management best practices resulted in resource and health degradation (Yongabi *et al*., 2013:1), on and off agricultural sites (Sobsey *et al*., 2001:1). Although the risk of infection is elevated in commercial agricultural settings, research shows evidence that small scale agricultural operations are capable of affecting water sources and therefore local ecosystems (Rabinowitz and Conti, 2013:192). Transmission routes that facilitate the spread infectious diseases between animals and from animals to humans are: the faecal-oral route, which involves the interaction of faecal matter from infected animals to the mouth of susceptible organisms; the nose-to-nose route, which occurs when susceptible organisms inhale aerosols derived from coughing, defecation or urination; and pests (Gay, 2012:7). The World Health Organisation estimates that approximately 300 diseases found in Africa are the result of poor agricultural water and environmental sanitation (Yongabi *et al*., 2013:6). Therefore as livestock agriculture increases in rural regions, the risk of contamination increases (Yongabi, *et al*., 2013:6). Agricultural waste contains high concentrations of human and animal pathogens

(Sobsey *et al*., 2001:609). Agricultural waste water similarly, is derived from sewage, manure management and processing activities, and is a key contributor to the facilitation of zoonotic agents, consisting of various pathogen derived from bodily fluids and excrement (Yongbabi *et al*., 2013:6). Furthermore, when waste, in the form of manure is distributed in agricultural fields, livestock are at risk of reinfection (Yongabi *et al*., 2013:6). Gay (2012:10) views livestock housing, feed and equipment as vectors of pathogens and pests and therefore states that the cleaning and disinfection of facilities are vital in controlling diseases. Personal hygiene is also imperative (Gay, 2012:14) as farm workers are a risk daily to allergic exposure; injuries, that would facilitate transmission; and infection, 2013:193). Farm workers are therefore urged to wash their hands on a regular basis and clean clothes with an appropriate disinfectant to limit exposure to zoonotic pathogens (Gay, 2012:14), that are sometimes inactive and not detectable (Sobsey *et al.,* 2001:610). Safety however, according to Yongabi *et al. (*2013:6), is not considered to be important in South Africa, particularly in rural regions, and little research has been done to determine the full extent of the persistence of zoonotic pathogens outside of the agricultural environment (Sobsey *et al*., 2001:610). Generally emerging farmers do not use protective clothing (Yonabi *et al*., 2013:6).

2.7.3.1. The use of antibiotics and hormones

The importance of breeding and other management practices within livestock production have been emphasized in recent years with the emergence of a number of livestock diseases that not only cause harm to livestock but in most cases, are transmitted to humans**.** The administration of hormones such as testosterone, progesterone and other synthetic equivalents to livestock for example, have been known to increase the weight of livestock by up to 20% with minimum cost (Nierenberg, 2005:50). These antibiotics along with hormones and other toxins remain in the meat and products produced and pose a threat to human health when consumed through the emergence of new sicknesses and diseases amongst humans (Alcorn, 2012:1). For example, breast and intestinal cancer in humans has been linked to hormones in animal sourced products thus leading to the ban of hormone use in 1988 by the EU (Nierenberg, 2005:50). In the 1960's antibiotics entered the international commercial livestock industry to increase the growth rate of livestock thus decreasing the price of meat and livestock products whilst increasing profits (Grace Communications Foundation, 2013). Today antibiotics are also used by commercial husbandry facilities to compensate for unsanitary conditions in which livestock are kept (Grace Communications Foundation, 2013)

In the past, steers lived up to four or five years of age before they were slaughtered (Nierenberg, 2005:23). Due to increased consumption and demand for beef, commercial farmers now grow calves based on weight, growing them from 36 kilograms to 544 kilograms in a mere 14 months with a diet of corn, soybeans, antibiotics and hormones (Oishio *et al.,* 2011:38). Cattle are however ruminants and therefore are not adapted to digest corn but rather grasses and crop residues (Patil *et al*., 1995:87). The high protein nature of this diet is harsh on the stomachs of livestock and increases their weight drastically (Patil *et al*., 1995:87). To cope with the weight change and changes in their digestive system, calves are administered medication and antimicrobial drugs, which may cause them to suffer from bloating, acidosis or liver abscesses (Nierenberg, 2005:23).

Dr Margret Chan, the Director of the World Health Organisation stated in 2011 that "in the absence of urgent corrective and protective actions, the world is heading toward a post-antibiotic resistant era, in which many common infections no longer have a cure and, once again, kill unabated" (Grace Communications Foundation, 2013). The consumption of products that contain antibiotics are making it increasing difficult to fight against food-borne and other diseases as a result of humans developing a resistance to these antibiotics and therefore an immunity to them (Nierenberg, 2005, 46). In 2010, the United States Food and Food and Drug Administration reported that livestock in the United States of America consumed 13 million kilograms of antibiotics, four times more than that of people (Alcorn, 2012:1). The role of antibiotics is to kill susceptible bacteria within the human system therefore when these chemicals are ingested in small amounts with livestock products the human gut acts as a breeding ground for bacteria, exerting evolutionary pressure on microbes without killing them and accelerating their resistance to antibiotics resulting in "resistant bacteria" (Alcorn, 2012:2). Antibiotic-resistant bacteria poses an increasing problem to human health as it is expensive and increasingly difficult to treat; posing the greatest risk to children, the elderly and people with weakened immune systems such as those undergoing chemotherapy, HIV or with compromised health (Grace Communications Foundation, 2013).

For thousands of years endogenous hormones have been introduced into the environment through the excretions of humans and animals. However the rate at which this occurs and its effects on wildlife and humans has become more significant over the past five decades as a

result of an exponential increase in the human population and thus more intensive industrial farming; and with the production and increased use of synthetic hormones (Bartelt-Hunt *et al*., 2011:94). Synthetic hormones were created as a result of that orally taken natural hormones become deactivated through biotransformation (Preston, 1999:123). The disadvantage of using synthetic hormones however is that they manifest within organisms and are persistent within the environment once released therefore having the potential to disrupt natural systems (Lange *et al*., 2002:28). In vertebrates, sex hormones are responsible for the regulation of behaviour, morophologies and functional differentiation of the reproductive system at all stages of life (Lange *et al.,* 2002:28). After being used by the system hormones are excreted via bile, faeces or urine (Bartelt-Hunt *et al*., 2011:94). For example, ruminants excrete oestrogens through their faeces whereas monogastic pigs do so through urine, the rate at which this occurs is dependent on the age, sex and reproductive state of the invertebrate (Lange *et al.,* 2002:28). The greatest impact of hormone excretion occurs within the aquatic environments (Chen *et al.,* 2003: 3233). In these environments hormones have the ability to activate the intracellular oestrogen receptor in developing and adult fish that could result in abnormalities such as external genitalia (Matthiessen *et al.*, 2006:617). Other toxins administered to livestock include arsenic, dioxin, polychlorinated biphenyls, and other organic pollutants. These pollutants can sometimes be found within animal fat and are hazardous to humans even in low concentrations (Nierenberg, 2005:50).

2.7.3.2. Livestock diseases

According to the FAO, the spread of Avian flu or bird flu (H5N1) from birds and pigs to humans can be attributed to the drastic scaling up of farming operation (Nierenberg, 2005:35). The H5N1 is a disease that farmers have struggled with for centuries as it is able to spread from farm to farm with a 100% mortality rate (Nierenberg, 2005:35). Over the last ten years however the H5N1 virus has mutated and now poses a risk to human health (Nierenberg, 2005:35). According to Elder (2007:2), H5N1 is a sub type of the influenza virus of which there are 27 types. H5N1 however is of particular importance as it has the potential to be transmitted to other species. Influenza viruses are of concern within South Africa, currently there is concern that there may be an outbreak influenza with 100 cases of swine flu being reported within KwaZulu-Natal and the death of a woman whom had contracted H1NI (Legent, 2013).

BSE is suspected to have originated in feed-processing plants in the United Kingdom when contaminated sheep meat infected with Scapie, which is a similar disease to that of BSE, was fed to cattle (Nierenberg, 2005:40; Taylor, 1996:504). This amplified the disease within cattle in addition to spreading it (Nierenberg, 2005:40). BSE, also known as "mad cow disease" was first detected in 1986 in the United Kingdom as Creutzfeldt-Jacob disease, the human form (Nierenberg, 2005:41). BSE is caused by prions, which are rogue proteins that deteriorate the brain of cattle, destroying cells therefore causing cattle to show symptoms of aggression and nervous symptoms that later lead to death (Nierenberg, 2005:41). The disease however does not perish with the animal and may therefore spread if the infected material is consumed (Taylor, 1996:503). A strain of BSE, known as bovine amyloidotic spongiform encephalopathy (BASE) has been found in Italy in cattle that do not show the same symptoms as BSE therefore making it difficult for slaughterhouses to determine which cows are infected (Nierenberg, 2005:42). Thus in September 1990, the use of meat and bone derived from waste is not permitted by South African law (GDARD, 2009:12).

Foot-and-Mouth disease (FMD) is a highly contagious virus that affects only cloven-hoofed animals (Rémond *et al*., 2002:309). In 2001, 600,000 cattle, 3.2 million sheep and thousands of pigs, goats and other animals were slaughtered in the United Kingdom to avoid further spread of this virus (Nierenberg, 2005:43). South Africa is considered to be a FMD free zone despite the Kruger National Park being an endemic area as a result of the African buffalo which dwells within the park is a permanent carrier of the disease (Thomson, 1995:503). The virus has the potential to spread to other clover-hoofed animals within the park such as impala and neighbouring livestock therefore redline areas have been set up and vaccines administered to control the virus (Mangera, 2004:1). Another source of threat to human health from red meat comes in the form of food-borne infections. The most common infections are caused by listeria, cryptosporidium and pathogenic *E.coli* (Nierenberg, 2005:44). In February 2011, during routine sampling, FMD was detected in the northern part of KwaZulu-Natal forcing the slaughter of cattle found near the infected sites (DAFF, 2011:1). To date the disease has been contained within a restricted red zone as shown in figure 2.7 with more sampling points being established at dip tanks nationally every year (DAFF, 2011:6)

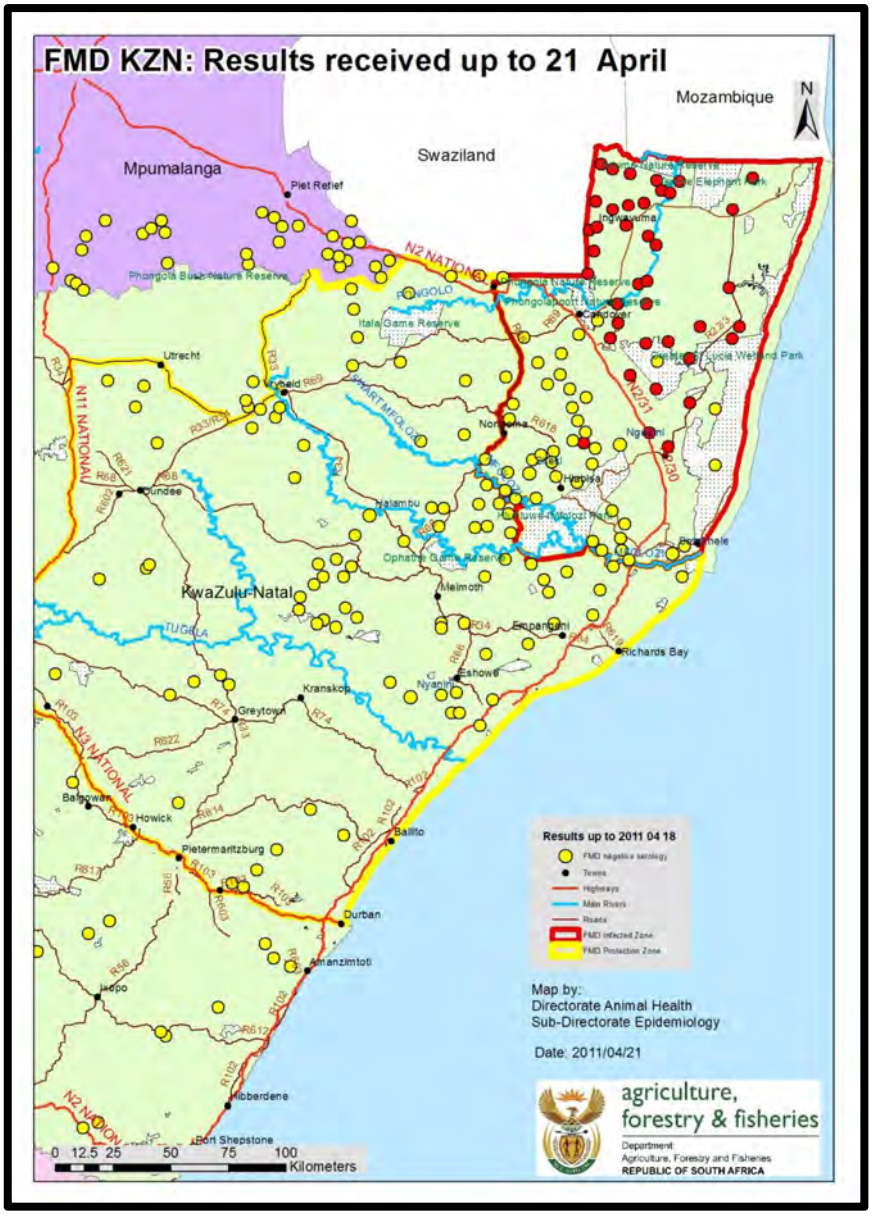


Figure 2. 11. Locations within KwaZulu-Natal that tested positive and negative for foot-and-mouth disease in April 2011
(DAFF, 2011:3).

2.7.4. Market access

According to Mthembu (2008:15), "in the past, South African agricultural policies were developed to suite white commercial farmers who were given access to substantial support services". Chikazunga (2012) argues that this can be transformed with the acknowledgement of emerging farmers in an already saturated agricultural industry. South African emerging farmers face limited access to basic financial markets such as banks; weak agricultural

investment (Stroebel *et al.*, 2011:188), weak governance and weak support and infrastructure (Mthembu, 2008:14). This is attributed to the market liberisation of 1992 (Chikazunga, 2012).

According to Mthembu (2008:6), smallholder farmers deal with a variety of obstacles that limit market access and participation. Even farmers that are in closer proximity to potential markets need support in the sale of products (Mthembu, 2008:6). A crucial barrier to market access is cost. Emerging farmers are faced with a variety of costs in the form of direct and indirect costs (Table 2.4) and costs that occur as a result of farmers being located distances from markets; poor infrastructure; and a lack of information (Mthembu, 2008:7). Market information is therefore imperative to the success of farmers. Valid pricing information and the location of markets and customers greatly reduces costs incurred. Mthembu (2008:7) states however that market information is costly to gather as a result of low literacy levels and incompetent communication structures, and therefore insufficient in developing countries.

Table 2. 4. Direct and Indirect costs
(Mtembu, 2008:7)

Direct costs	Indirect costs
Hiring labour	Searching for trading partners
Hiring vehicles	Screening of trading partners
Hiring tractor to prepare land	Bargaining
Transporting products from farms to markets	Monitoring of markets
Trading partners' commission	Cost of search of information

2.7.4.1. Supporting Emerging Livestock Farmers

Smallholder agricultural growth is inhibited by a lack of access to farmers support services (Mthembu, 2008:18). Farmers are generally excluded from commercial markets as a result of inconsistent production rates and product quality; and a lack of infrastructure compared to commercial farmers and therefore a lack of efficiency (Chikazunga, 2012). In addition most agricultural markets are resistant to emerging farmers as a result of procedure policies required by retailers, which include contractual agreements and labelling (Chaikazunga, 2012). Support services are therefore required by emerging farmers, support services that provide: roads; credit institutions; suppliers; subsidies; brokers; market information services; extensions services and research (Mthembu, 2008:18). According to the FAO, a cooperative is "an autonomous association of women and men, who unite voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly owned and democratically controlled

enterprise, that aims to create a profit while meeting the needs of society by providing members with economic opportunities and various services" (FAO, 2012:2).

Cooperatives play a significant role in improving food security, reducing poverty and creating employment opportunities (FAO, 2012:2). According to South African legislation, chapter one, schedule 1, part 4 of the Cooperatives Act (Act no. 14 of 2005) states that the objectives of agricultural cooperatives are (RSA, 2005:51):

- To undertake the marketing of any agricultural product or anything that is derived from an agricultural product;
- To acquire, or to acquire control over, any agricultural product or anything derived from an agricultural product;
- To process an agricultural product or anything derived from it, manufacture it and dispose of the end product or of the agricultural product and anything derived from it;
- To hire, buy, produce, manufacture, let, sell or supply services or things required for purposes of farming;
- To hire, buy, acquire, produce, manufacture, let, sell or supply any article for consumption;
- To hire, establish, erect, use or make facilities available for use in connection with farming;
- To render services which are necessary and useful in farming;
- To render any other services, including services which relate to buying, selling and hiring of fixed agricultural property; to farm and dispose of farming products, process products or manufacture articles and dispose of them; and
- To undertake insurance business, this relates to farming risks for farmers.

In terms of smallholder producers', cooperatives often facilitate access to natural resources such as water; access to markets, and knowledge; provide seeds, fodder and tools at reduced prices as well as provide support when securing land-use rights and contract farming opportunities (FAO, 2012:1). Chikzunda (2012) however argues that co-operatives may not be the best facilitation vehicle for emerging farmers, given that many fail as a result factors such as power dynamics and in-house fighting. The Broadening Access to Agriculture Trust (BATAT) was the first support co-operative created by the South African government, with

the intention of providing financial, technological and marketing support for the purpose of creating a profit (Greenberg, 2010:7). BATAT however had difficulty in its implementation owing to the lack of consideration given to the needs of emerging farmers (Greenberg, 2010:7). In terms of land reform, the South African government has implemented two separate organisations; namely the LRALD programme and the Comprehensive Agricultural Support Programme (CASP) (Greenberg, 2010:11). These programmes were created in 2003 as a core support system to newly based farmers (Greenberg, 2010:11). A lack of progress over the first few years of implementation led to the integration of the two organisations in 2008 (Greenberg, 2010:11). Implemented by the DRDLR, whom is responsible for planning of projects, along with the DAFF, whom are responsible for programme implementation, and provincial departments, the following objectives were proposed (Greenberg, 2010:11):

- redistribution of five million hectares of land to 10,000 beneficiaries;
- increase new agricultural entrepreneurs by 10-15%;
- provide core support to farmers;
- increase market access of rural farmers by 10-15%; and
- Increase agricultural production by 10-15%.

However, by 2009, 29% of the LRAD programme projects had failed resulting from a lack of support (Greenberg, 2010:11).

There are also a number of co-operatives that have been implemented on a local scale. The KZNDAE have implemented a Famer Support and Development Programme that falls in line with the objectives of a cooperative as stated in the Cooperatives Act. The purposes of these programmes as per the KZNDAE (Undated) are:

- "to provide extension, input support and training to farmers , with special emphasis on developing emerging farmers in communal areas and supporting those from the Land Reform Programme;
- to co-ordinate and implement various food security projects in partnership with sister departments, municipalities and dinner agencies;
- to facilitate institutional building and creation of micro-enterprises, prioritising vulnerable groups, especially: youth, women and disable groups; and
- to be a catalyst in the promotion of investments, partnerships, cooperatives, marketing and agribusiness development and intergovernmental cooperation in the agriculture and environment sectors to champion and support agrarian development".

Other programmes that have been implemented by the KZNDAE include; a livestock training programme which educates subsistence and emerging farmers on animal identification, breeding, animal nutrition, grazing management, maintenance of infrastructure and marketing methods; the installation of dip tanks which are used as a form of pest control; and the installation of boreholes and watering points and watering dams to give locals easier access to sanitary water (KZNDAE, undated).

2.8. Agricultural Indigenous Knowledge

In South Africa, indigenous knowledge has become negligible. Largely attributed to the historical adoption of colonial and apartheid regimes, African indigenous knowledge was assumed backward and inappropriate (Mtshali, 2002:26). According to Jaya (undated: 2), indigenous knowledge or traditional ecological knowledge (Codjoe *et al*., 2013:1) "is knowledge generated, developed and used by people in certain areas. It forms the basis for the art of identifying combining and unfolding and protecting local resources". Codjoe *et al.* (2013:2) explain that indigenous knowledge is reliant on place, time and the ethos of people and their relationship with their local environment. With increased urbanisation and the promotion of the use of modern technologies particularly in the agricultural industry, indigenous knowledge has become a diminishing aspect of South African culture. The need to preserve indigenous knowledge in recent literature has thus emerged not only from a historical standpoint but also in terms of facilitating the success of rural agricultural systems, which in developing countries such as South Africa, are necessary (Masango, 2010:76). Traditional agricultural practices are informed by indigenous knowledge that has been developed over centuries through experience and passed down from generation to generation and are therefore are suited to local ecosystems (Dlamini, 2010:1). In this way farmers have over the centuries developed various means of preserving their local environment through agricultural activities (Mugwisi *et al.*, 2012:105). For example in Swaziland, livestock farmers use manure collected from kraals, blue-green algae and legumes as a source of nutrients (Dlamini, 2007:28). Farmers have also developed agricultural methods that combat soil erosion and natural methods of pest control to name a few (Dlamini, 2007:27).

2.8.1. Importance of indigenous knowledge to emerging farmers?

Throughout history agricultural systems have evolved from traditional farming to merchandised agriculture (Mugwisi *et al.*, 2012:105). Historically, within the Zulu culture meat was consumed on special occasions, therefore livestock such as cattle, goat and chicken were commonly kept by Zulu farmers (Modi, 2009:13). With the establishment of white- owned stores and the introduction of taxes and levies imposed by chiefs for the ownership of livestock, indigenous people were forced to seek employment to sustain their families (Modi, 2009:9). With the evolution of humans and the commercial agricultural industry, crop variety has decreased as a result of the development of techniques of sowing, weeding, irrigation and fertilisation that are only suitable for a minority of crops (Modi, 2009:7). Presently, the human diet is based on 30 commercial food crops, decreasing the value of traditional crops typically produced by indigenous farmers (Modi, 2009:7). According to Dlamini (2007:1), modern food production involves the application of modern technologies such as increased chemical use; specialisation and the maximization of production that has benefited modern society in terms of food security but has also increased the cost of food and caused significant risk to the environment and human health. The part of traditional foods in decreasing poverty and malnutrition in South Africa however is not well documented (Modi, 2009:ii).

A thousand five hundred years ago indigenous African people travelled south from the Limpopo River to the Drakensburg Mountains, bringing with them cattle and cultivation techniques. Traditional crops included cereals (bulrush millet and sorghum); legumes (cowpeas and groundnuts); and cucurbits (gourd and African melon) (Modi, 2009:10). However with the introduction of European food, such as processed fats and spices, the diets of indigenous people evolved to incorporate conventional food (Modi, 2009:9). The results of a study conducted in in the Northern KwaZulu-Natal, indicates that cattle and goats had similar cultural functions (Kunene and Fossey, 2006:6). Furthermore during the same study traditional knowledge within the Zulu culture was documented (Table 2.5). The results revealed that Zulu cultures use various plants as supplements to obtain a desired product from livestock. For example, ground peanuts are used to increase the reproductive rates of livestock (Kunene and Fossey, 2006:6). In addition, indigenous farmers use the characteristics of livestock to determine the quality of products produced that will be produced and to determine how husbandry practices should be manipulated to obtain desired outcomes. For example, according to Kunene and Fossey (2006:9), having a hump and a big neck indicates high fertility rates in bulls whereas the low

or soft vocal range of a bull indicates bad fertility. South African agricultural indigenous knowledge has not been recorded and therefore is threatened with extinction (Dlamini, 2007:21). As a result of apartheid many black farmers were barred from their farms to encourage cheap labour for the mining industry. This meant not only a loss of land but also a loss of indigenous agricultural knowledge.

Table 2. 5. Indigenous knowledge employed with the Zulu community with regard to livestock husbandry
(Kunene and Fossey, 2006:5).

Sarcostemma viminale (igotsha), *Crinum macowani* (umdaze) and *Tetradenia riparia* (ibozane) are used to **increase milk production**
Rhocissus tredentata (isiwazi), potassium permanganate and ground peanuts are used to **improve reproductive rates in livestock**
Castration of cattle increases **weight gain**
A high milk yield is denoted by the following characteristics: a small head and slender neck; a big udder; large hollow body cavity; thin skin; a fine tail; and A friendly look and temperament
High fertility is observed in cattle that: have a hump and a big neck and a large voice
A cow with a flat backbone and straight legs will produce **good meat**
A big udder and good reproductive rate **increase the quality of milk**

There is an increased recognition of the importance of indigenous knowledge in terms of sustainable development. Indigenous knowledge provides opportunities for environmental conservation and the improvement of rural livelihoods whilst benefiting national economies (Dlamini, 2007:2). The importance of indigenous knowledge lies in that skills and knowledge is unique to local areas and therefore suited to stressors (Mugwisi *et al.*, 2012:105). The key to obtaining such success as India's emerging farmers, whom are largely responsible for India becoming the Worlds' largest producer of milk, lies in productivity growth whilst utilising resources in a sustainable manner (Moyo and Swanepoel, 2010:7). Furthermore, Warren and Rajesekaran (1993:10), state that in order for Third world countries to progress, technological development should be approached with indigenous knowledge in mind as this results in more efficient and cost effective systems.

Research done in West Africa shows that the informal farming sector, which does not employ the use of modern technologies or chemicals in their farming practices, has produced a higher output of products than modern agricultural practices as a result of effective farming processes that were precisely adapted to the characteristics of the region (Dlamini, 2007:32). Sixty percent of the worlds cultivated land is still farmed using traditional systems (Mugwisi *et al.*, 2012:105). Within South Africa, traditional subsistence societies are prominent within rural areas. Within these areas residents generally do not have access to modern technologies and in some cases, do not even have access to water and electricity and therefore are forced to employ traditional agricultural practices and indigenous knowledge (Dlamini, 2007:1). Emerging famers diverge from the commercial manner of production in that they have a low input or no-input system which entails livestock usually foraging on plants or food waste, which would otherwise be disposed of (Randolph *et al.*, 20007:2789). In the rural areas of KwaZulu-Natal the communal pastoral grazing method is the most common feeding method implemented as it is low-input and cost effective (Kunene, 2010:8; Vatta *et al.,* 2011:27). This farming strategy involves the implementation of a 'free-range system" that allows livestock throughout the year to graze freely during the day and be herded into a homestead in the afternoon for the night (Bayer *et al*., 2004; 16; Kunene, 2010:8). During winter however, the forage value of the pasture vegetation decreases forcing farmers to feed livestock crop residues in the form of maize stubbles (Kunene, 2010:8). Other feed resources have been noted to range from banana peels, sweet potato vines and brewers waste (Lumu *et al.,* 2013:1578). Pasture grazing practices have a significant role in food production systems in that it ensures the health of the livestock and therefore influences the quality of animal sourced products produced, soil fertility of the area and food costs (Di Grigoli *et al*., 2012:S29). For example during the wet season many South African indigenous farmers release their cattle into the pastures to graze during the late morning, once the dew has dried, in order to avoid worm infestation of their livestock (Bayer *et al*., 2004:16).

The use for which livestock are kept is partly based on the resources that are available to the farmer (Mapiye *et al*., 2009:196). In the rural areas of KwaZulu-Natal poultry are usually free range. These chickens are able to fend for themselves by scavenging however, most farmers feed them mealie-meal or poultry mix (Bayer *et al*., 2004:27). Despite its popularity within rural southern Africa there are limitations to free range pasture feeding. For example, there is irregular availability of forage with the variation of seasons therefore improper management of

pastures can lead to decreased herbage availability, increased parasite infestation and the degradation of the pasture soil (Di Grigoli *et al*., 2012: S30).

In commercial farming genetic livestock breeding is just as important as husbandry management methods. This applies to emerging farmers in that it can affect their livelihood vulnerability. In terms of cattle, Nguni Cattle have a small frame and a low performance, which has resulted in the introduction of large framed, fast growing foreign breeds of cattle into the South African commercial livestock industry and subsequently into communal areas (Mapiye *et al*., 2009:197). With regards to emerging rural farmers these more productive and marketable cattle leave farmers at a disadvantage due that they are high feed maintenance and have a lower resistance to the South African climate and local bacteria and diseases (Mapiye *et al*., 2009:197). Rural farmers are resource poor and they therefore require multipurpose, disease resistant livestock that thrive with low input to produce the highest possible output (Mapiye *et al*., 2009:197). Local breeds of livestock have therefore proven to be more suitable in terms of emerging farmers.

"For centuries farmers have planned agricultural production and conserved natural resources with the instruments of indigenous knowledge" (Mugwisi *et al*., 2012:105). Indigenous knowledge therefore integrates waste management with husbandry practices. This is evident with the use of feed waste such as banana peels and other household waste as fodder. In addition farmers employ livestock waste, in addition to mixed cropping and mulching, in preserving soil fertility and water conservation (Mugwisi *et al.,* 2012:10). The management of agricultural waste also limits the risk of disease and pests. Farmers are known to burn waste and spray livestock urine on crops as a substitute for agrochemicals (Mugwisi *et al.,* 2012:10)

2.9. Conclusion

Like all ecological systems, livestock management systems are interdependent. Furthermore all livestock management practices, whether it is husbandry or waste management practices, are directly linked to the development of sustainable situation in terms of emerging farmers as explained by the SLA. This chapter has elaborated on the livelihoods of emerging livestock farmers by looking at the challenges they face in terms of land; climate; lack of resources and historical social injustices as a result of apartheid that have crippled the ability of indigenous

farmers from making the transition from the emerging farming sector to the commercial sector. In addition the importance that livestock plays as a food source and in ecological conservation was looked at along with the various livestock husbandry and waste management methods of emerging farmers in order to determine how these methods integrate with the traditional and social lives of indigenous farmers. These methods were compared to that of international policies giving insight into potential husbandry methods that could improve upon the current situation within the KwaZulu-Natal Midlands and bringing to light the existing gaps in current South African agricultural policies and guidelines.

CHAPTER THREE: STUDY AREA

3.1 Introduction

This chapter provides insight into the study area, the KwaZulu-Natal Midlands. The chapter starts off by looking at the geographical and ecological features of the KwaZulu-Natal Midlands. This chapter thereafter explores the current waste management state of the study area; the political site history, the demographic nature of the study area and how these attributes impact upon present day emerging farmers.

3.2. Location

The Kwazulu-Natal Midlands, or otherwise referred to as the Midlands Meander Corridor, is defined by the three towns, Pietermaritzburg, Howick and Mooi River (Mathfield, 2000:6) (Figure 3.1). The majority of Midlands Meander consists of uMgungundlovu District Municipality (Figure 3.1). Known as the Indlovu Regional Council up until 1999 (Mlotshwa, 2007:52), uMgungundlovu District Municipality is one of 11 district municipalities in KwaZulu-Natal (Jagath, 2010:64). uMgungundlovu District Municipality is made up of seven local municipalities that lie on either side of the N3: Msunduzi; uMshwathi; uMngeni; Richmond; Mkhambathini; Mooi Mpofana and Impendle.

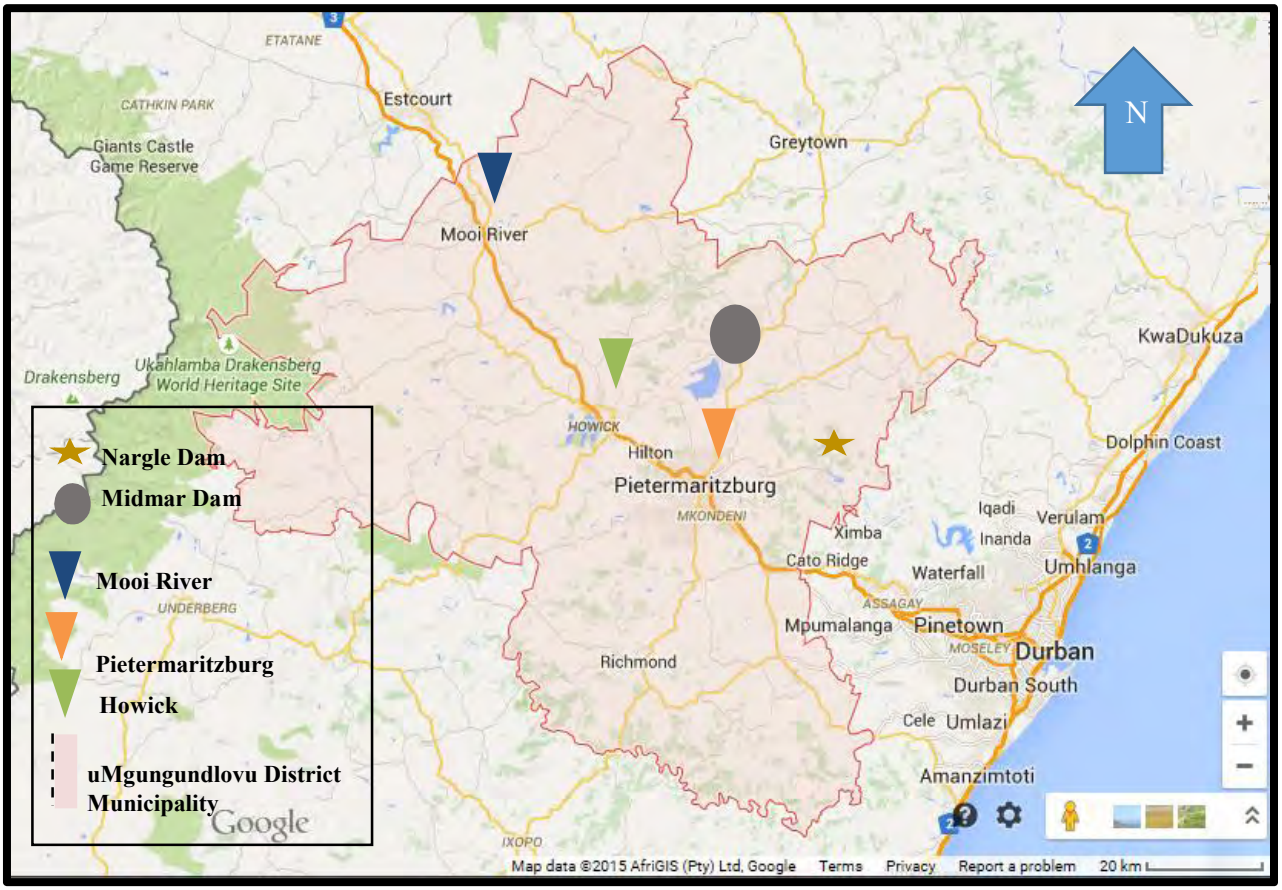


Figure 3. 1. uMgungundlovu District Municipality.

3.2.1. Geographical and Ecological Features

The Midlands is a local term used in South Africa designated to a mid-altitude area of KwaZulu-Natal (Mucina and Rutherford, 2006:796). Made up of the Moist Midlands Mistbelt and the Dry Midlands Mistbelt, the Midlands Mistbelt of KwaZulu-Natal, the Midlands is considered a centre of endemism as a result of its unique characteristics (Mucina and Rutherford, 2006:423). The Moist Midland and Dry Midland Mistbelts differ in that the Moist Midland Mistbelt receives more precipitation (800 millimetres) than the Dry Midland Mistbelt (738- 825 millimetres) (Mucina and Rutherford, 2006:423). This occurs mainly in summer months, from October to March (Mkhabela and Materechera, 2003:152). Mist occurs on a regular basis, along with hailstorms in the summer months (Mkhabela and Materechera, 2003:152).

3.3. Economic profile

Good rainfall and rich soils coupled with its location have made the Midlands Meander a popular settlement destination for dairy farming, maize cultivation, wattle growing and stock feed farming (Olivier and Olivier, 2005:95). The Midlands Meander exists along the national route, N3, located between two South African major cities (Durban and Johannesburg) (Mathfield, 2000:6) and is therefore exposed to a high density of travellers on a daily basis. The district has a diverse character in that there exists developments ranging from urban to rural informal settlements and a vibrant industrial sector, which has made it the fastest growing economic area in KwaZulu-Natal (Jagath, 2010:64). In recent years there has been much focus placed on urban development and industrialization within Pietermaritzburg and the surrounding areas to support the economic boom within the KwaZulu-Natal province and the development of the local tourism industry (uMgungundlovu District Municipality, 2009:9). Being located on a national route between two of South Africa's major cities, in addition to having a rich historical background and offering a scenic rural environment and arts and crafts, the Midlands Meander has become a popular tourist route (Lourens, 2007:480). With the intention of creating an urban getaway the idea was first initiated by art enthusiasts in the 1980's (Lourens, 2007:481). Despite being confronted by numerous social and economic challenges in the initial stages of development, the Midlands Meander has grown into an entity that is able to provide support to emerging art and agriculture markets by integrating these characteristics into tourism attractions of the area.

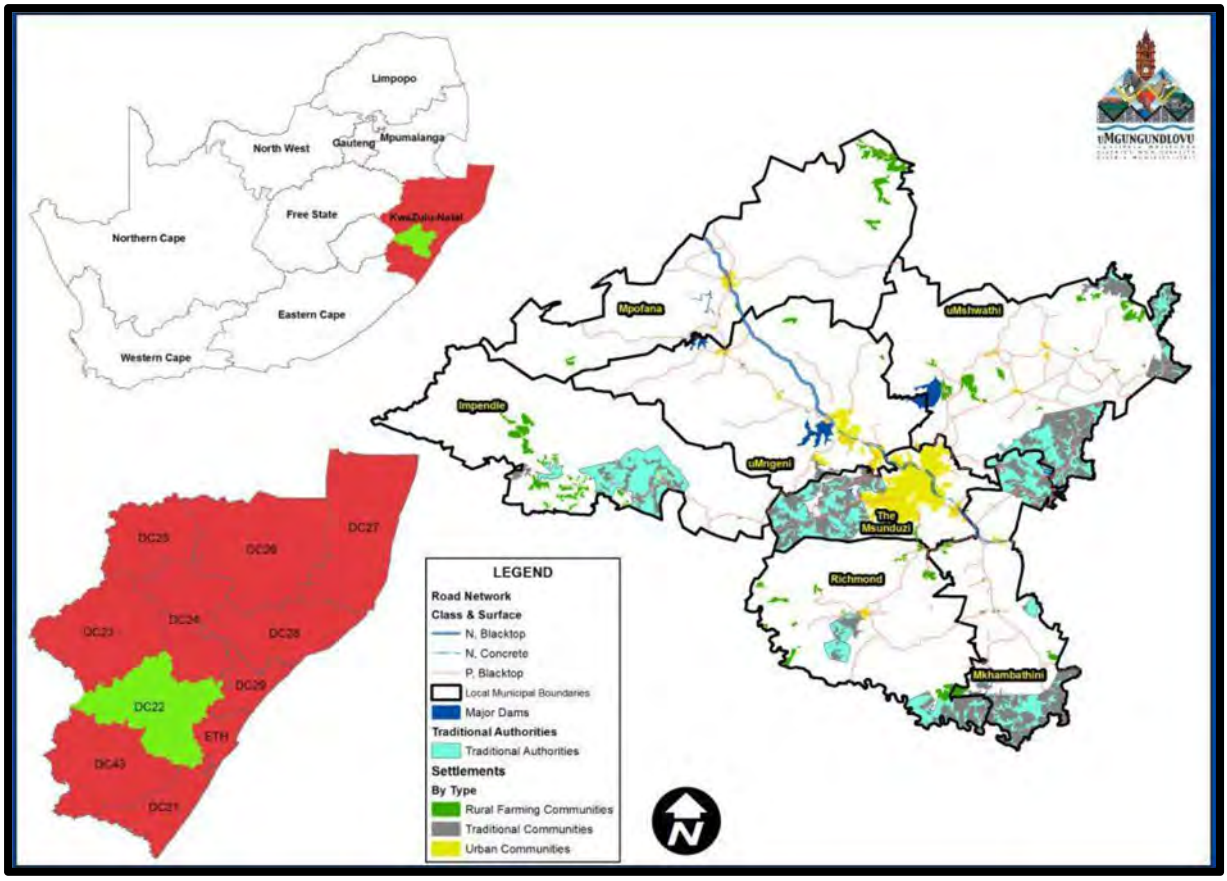


Figure 3. 2. Traditional Land ownership within the uMgungundlovu District Municipality (uMgungundlovu District Municipality, 2014: 4).

Historically, due to the enforcement of 1913 the Natives Land Act and the 1936 Trust and Land Act the Midlands Meander was centred around white-owned commercial agriculture, forestry and agro-industrial manufacturing (Marcus, 2000:20), today however various types and sizes of farming activities can be found within this area including commercial, informal small-scale farming settlements and traditional farmland communities (Jogiat, 2010:2). Despite the increased popularity of agricultural activities in the Midlands, farming activity and agricultural employment has decreased over the last few decades, largely due to pressures from climatic variability; global market forces; an increase in the tourist industry in the area and the effects of diseases such as HIV/AIDS and Tuberculosis (Marcus, 2000:20). Mkhabela and Materechera (2003:152), state that approximately 75% of the 1.6 million people that dwell in the Midlands Meander still part take in smallholder agricultural activities. Dwellings in the form of traditional huts and squatter townships define the rural sector of the district and are the most common form of housing within these areas (uMgungundlovu District Municipality, 2009: 39). The 2011 census indicated that within the uMgungundlovu District Municipality, 9.9% of households are informal and 25.3% traditional in nature (Lehohla, 2011:28). Figure

3.2 depicts land within the study area (uMgungundlovu District Municipality) classified as traditional land and therefore under the jurisdiction of the Ingonyama Trust Board.

3.4. Population characteristics

According to a 2011 census, the uMgungundlovu District Municipality has a population of 1,017,763, 52.26% of which are female and 47.74% Male (Lehohla, 2011:53). The Integrated Development Plan (IDP) of uMgungundlovu District Municipality states that there are three main factors that define the population of the uMgungundlovu Municipal District (uMgungundlovu District Municipality, 2013:88):

- The youth (15-24) within uMgungundlovu District Municipality accounts for 21.3% of the entire population. This implies that half of the municipality's population is dependent on state subsidies for health care, education and their general welfare. The IDP of uMgungundlovu District Municipality credits these figures to not only a high population growth rate but also to a low life expectancy rate as the population declines by 40% by the age of 55. This may be due to the effects of extra ordinary factors such as HIV/ AIDS and a lack of access to health care services.
- Of the population, 36.3% is recognised as part of the working population.
- The gender structure indicates that the majority of households are female headed. In most cases female headed households are reliant on a single income which is generally lower than that of what would be obtained by a male employee (Bob, 2002:28). There are however more males below the age of forty. The male population decreases by 18% between the ages of 30 and 40 due to the high mortality rate associated with HIV/AIDS and the movement of men out of the district in search of employment opportunities.

Challenging circumstances coupled with other vulnerabilities add to the poverty and insecurity within the uMgungundlovu area. Barnabus *et al*. (2005:19) found that the vulnerabilities that small-scale rural farmers faced were dependent on each other in that the increased intensity of one of these vulnerabilities could lead to the intensification of the others. In the rural parts of the midlands there is a lack of employment opportunities and thus income. A socio-economic survey done by the Agricultural Development Agency, showed that in the Middelrus area the level of unemployment is over 40% and average income levels were below ZAR2,000 ($165 US) per month (Agricultural Development Agency, 2011:3). The lack of income inhibits farmers from being able to plan for their future even on a short term basis and from being able

to grow as they are reliant on state funding such as social grants to provide food security to their household (Barnabus *et al.,* 2005:19). Food insecurity can result in poor nutrition which in turn can result in sickness or even disease due to a lack of access to water, sanitation and social services, particularly health care and education services which intensifies the vulnerability of locals (Barnabus *et al.,* 2005:19). Within the district, the Msunduzi local municipality has the highest percentage of electricity and water service connections whereas all rural areas have no formal refuse service. (uMgungundlovu District Municipality, 2009:40). A lack of access to educational facilities cripples the ability of future generations from improving this situation and results in most cases in individuals indulging in crime and alcohol.

Adding to food insecurity and the vulnerability of uMgungundlovu District Municipality households is the threat of theft of livestock. KwaZulu-Natal police estimate that within the year to end March 2007, ZAR 554m ($46,000,000 US) worth of livestock in the form of cattle, sheep and goats were stolen from South African farmers (KwaZulu-Natal Department of Community Safety and Liaison, 2008:10). Within the Midlands 5889 cattle and 2765 goats were stolen (KwaZulu-Natal Department of Community Safety and Liaison: 2008:11).These figures however are not reliable as most theft incidences in rural areas are not reported and in some cases reported unofficially to the *Amakhosi* (traditional leader) (KwaZulu-Natal Department of Community Safety and Liaison: 2008:11). The uMgungundlovu District Municipality sector has experienced a decline in investments over the last few years due to the slow pace of land claims in the land transformation process initiated by post-apartheid policies therefore creating an unstable and vulnerable investment environment (uMgungundlovu District Municipality, 2009:30).

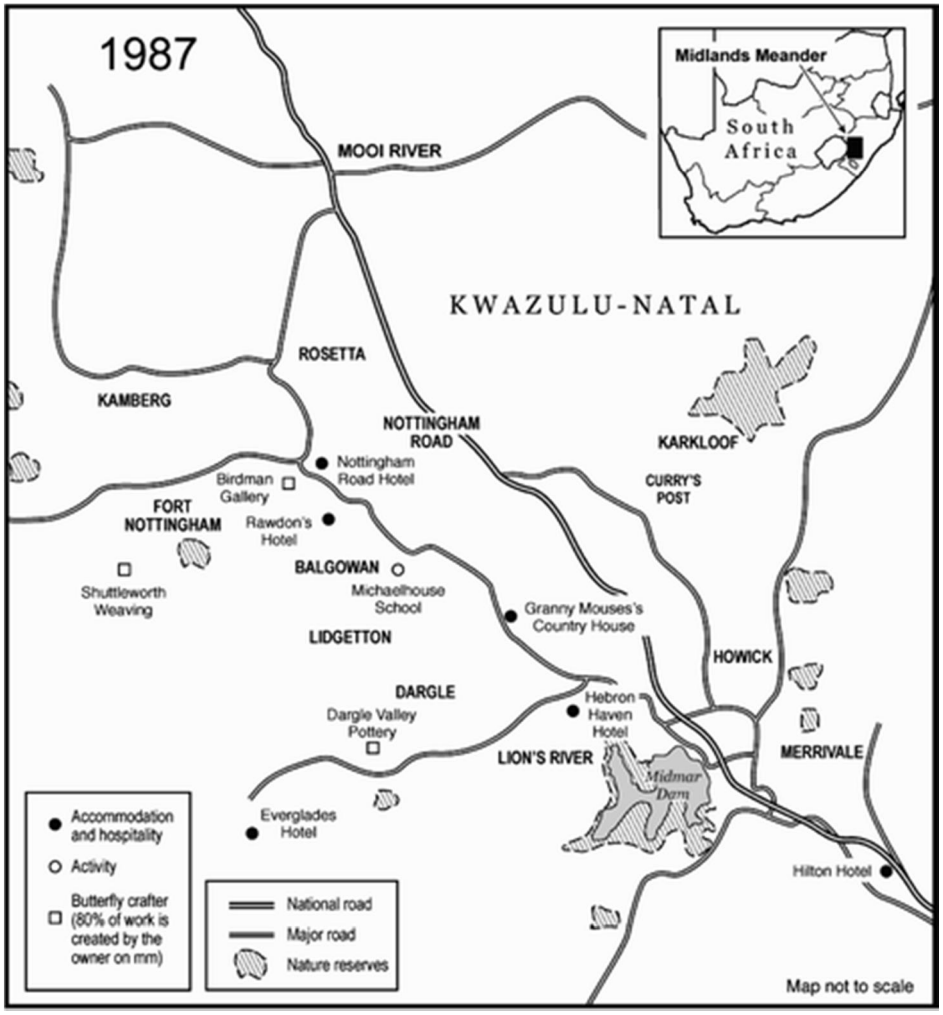


Figure 3. 3. KwaZulu-Natal Midlands
(Lorens, 2007: 481).

Thirty four percent of the Midlands Meander is considered to be arable, with 20% having high potential agricultural soil (Mkhabela and Materechera, 2003:152). One of the most threatened vegetation types in KwaZulu-Natal is the Midlands Mistbelt Grassland (Ferraz, 2000:42). The Midlands Mistbelt Grassland is a hilly grassland dominated by forb rich, tall, sour *Themeda triandra* (redgrass) grassland in its pristine state (Ferraz, 2000:42). However as a result of intensive agricultural practices, native *Aristida junctiformis* (Ngongoni grass) has transformed the area (Ferraz, 2000:42). The invasion of Ngongoni grass reduces agricultural productivity drastically in that livestock need to search in between ngongoni tuffs for suitable forage species (Tainton and Camp, 1999). Natural occurring forestry is sparse within the Midlands regions largely due to the success of the commercial forestry industry (Figure 3.4). The areas of forestry are currently found on cool damp southern slopes and fire refuge sites (Tainton and Camp, 1999). These sites are made up of the mainly exotic species such as *Acacia* species (spp).,

Eucalyptus spp and the American bramble (Ferraz, 2000:42). Most of the Midlands have the potential to develop into evergreen forest due to the moist climate however due to defoliation of fires, grasslands have continued to thrive over the years (Tainton and Camp, 1999).

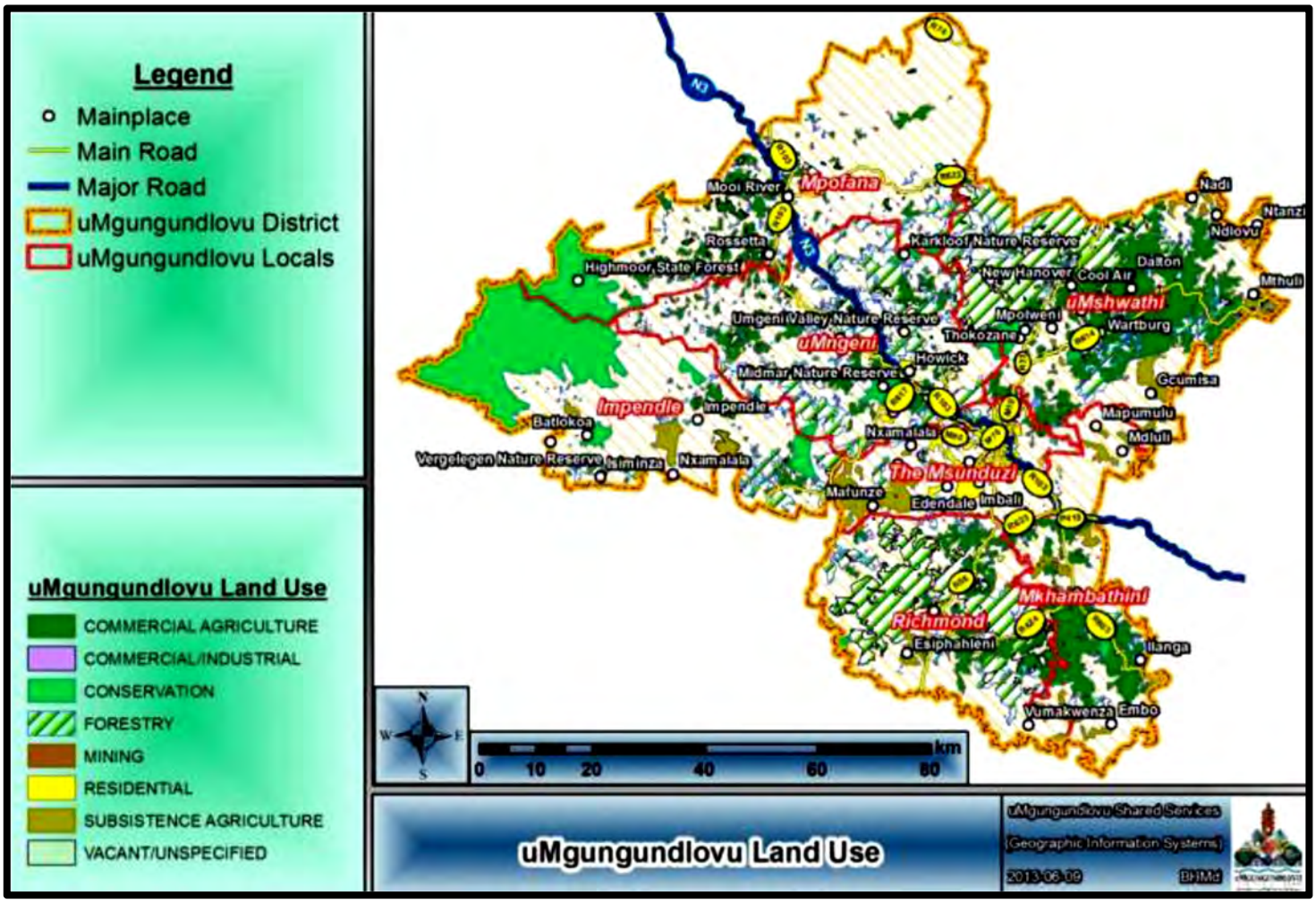


Figure 3. 4. Land use activities within uMgungundlovu District Municipality (uMgungundlovu District Municipality, 2013: 121).

3.5. Waste Management institutional arrangements in the study area

Within uMgungundlovu District Municipality exists key water resources (Midmar dam and Nagle Dam) (Figure 3.1) that are vital at a provincial and national level (Jogiat *et al.*, 2010:2).These water sources sustain local agricultural systems that facilitate national food security. According to Sikwela (2013:111), the resources found in the uMgungundlovu District Municipality accounts for 13.5% of KwaZulu-Natals' gross domestic profit. Given that South Africa is defined by the United Nations as a water "stressed" country (van Deventer, 2012:6),

proper waste management in the District is thus emphasised to avoid degradation of an already depleted and vulnerable water resource base.

3.5.1. Existing Waste Management

Agriculture is a primary source of pollution through irrigation return flow, fertilizers, pesticides and the run-off from feed lots (van Deventer, 2012:27). Within uMgungundlovu District Municipality exists immense regions of farmland and therefore large capacities of waste that is produced and underutilised (Nothling, 2013). A pre-feasibility study conducted by the Dutch Ministry of Economic Affairs; the Trade and Industry KwaZulu-Natal Department and uMgungundlovu District Municipality, estimated that excess agricultural waste has the potential to produce 14.6MVe of energy through anaerobic processes (Nothling, 2013).

Within uMgungundlovu District Municipality 200,000 tons of waste is generated annually (Jagath, 2010:80), the character of which is illustrated in figure 3.5. However only 53% of households within the District have access to refuse collection, majority of which exist in urban settlements (Jogiat, 2010:2). Waste generation rates vary between 0.35- 076. kg/capita/day for urban settlements and 0.1- 0.61kg/capita/day in rural regions (Jagath, 2010:80). There are six existing landfill sites present within the district (Table 3.1) (Jagath, 2010:81) that will be exhausted within the next 5 to 10 years (Jogiat, 2010:3). According to Jagath (2010:81), the majority of landfill sites in the uMgungundlovu District Municipality (Table 3.1) do not have permits or infrastructure in the form of weigh bridges and recording machinery. In a study conducted by Jagath in 2010, two landfill sites were analysed over a period of two weeks to determine the composition of waste received from rural and urban households (Jagath, 2010:83). Results indicated that organic waste was consistently high throughout all profiles analysed (Figure 3.5) (Jagath, 2010:147).

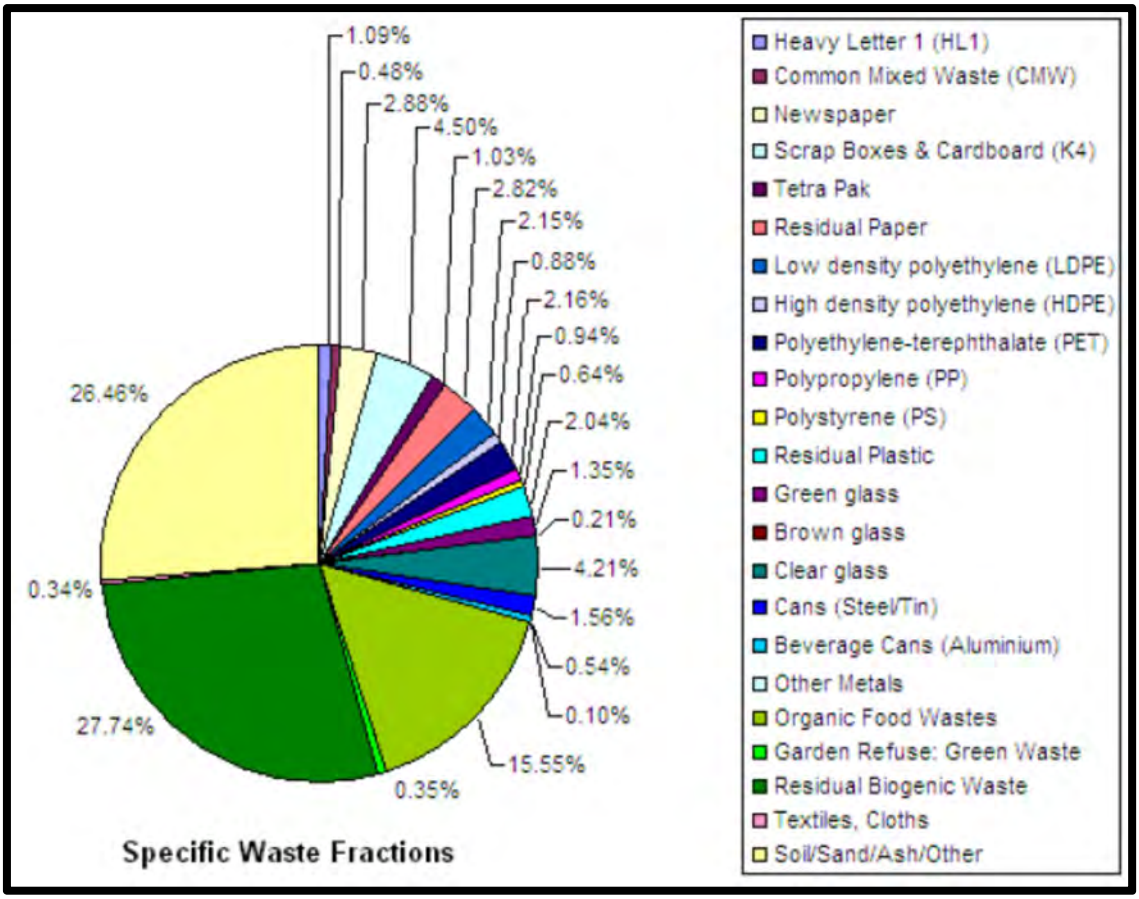


Figure 3. 5. Character of waste received from rural regions at uMgungundlovu District Municipality landfill sites
(Jagath, 2010:113).

Table 3. 1. uMgungundlovu Landfill Sites

uMgungundlovu Landfill Sites	Local Municipality Served
New England Road Landfill	uMsunduzi, uMshwathi and Mkhambathini
Richmond Landfill	Richmond
Impendle Landfill	Impendle
Mooi River Landfill	Mooi River
Curry's Post Landfill	uMngeni

3.5.2. Institutional Support

According the NWMS, the monitoring of waste management activities and the implementation of projects at a local level is the responsibility of municipalities (DEA, 2011:22). An Integrated Waste Management Plan (IWMP) was created in 2002 as per the Waste Act for uMgungundlovu District Municipality and was later reviewed in 2004 (Jogiat *et al.*, 2010:2). According to Jogiat *et al.* (2010:2), both versions of the IWMP concentrate on the 'disposal

function with very limited planning on refuse collection services, waste minimisation and the development of local IWMP's'. Jogiat *et al.* (2010:2) also stated that the outcome was that integrated waste management planning was not practiced at local levels thus impeding waste management services. uMgungundlovu district Municipality thus internally created an organisational structure that would allow for departments to function effectively (Mlotshwa, 2007:62). The structure is made up of four departments: The technical services department; the financial services department; the community services department and; the corporate services department (Mlotshwa, 2007:63). Figure 3.6 explores those municipal officials that play a role in agricultural waste management.

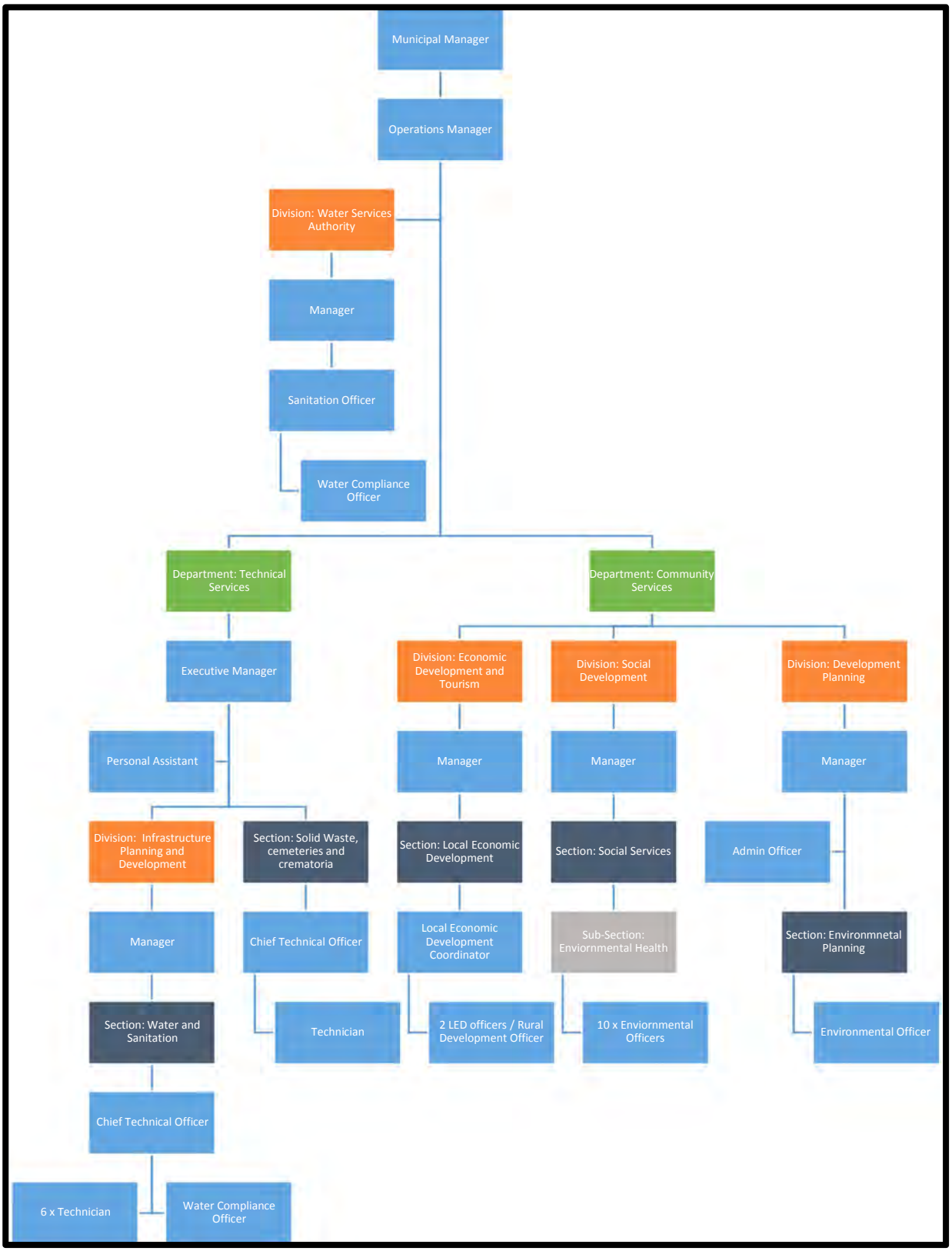


Figure 3. 6. uMgungundlovu District Municipality's organisational structure with reference to Waste Management
(Mlotshwa, 2007:64).

Throughout South Africa, cooperatives and NGOs have been set up to support the livestock agricultural sector. South African agricultural cooperatives have increased from 256 in 2001 to 459 in 2004 (Chibanda *et al*., 2010:295). How many of these are thriving and still operating however is unknown. KZNDAE states that the failure of cooperatives lies in a lack of communication and co-ordination between cooperatives; a lack of financial and institutional support; a deficiency of markets; no mentorship or monitoring of farmers and an absence of skills (Chibanda *et al*., 2010:295). Many NGOs are also founded by private institutions with the aim of offering assistance to rural emerging and subsistence farmers all over the country in attempt to give back to the community. The Farmer Support Group (FSG) for example, is a local cooperative in KwaZulu-Natal. Established in 1985 by the University of KwaZulu-Natal, School of Agricultural Earth and Environmental Sciences, the FSG addresses the needs of emerging farmers in KwaZulu-Natal in implementing sustainable agricultural practices in terms of food security, natural resource management and entrepreneurship (FSG, Undated).

3.6. Political History

Lying on the main route from South Africa's busiest port, Durban, to the industrial and financial capital, Gauteng, the Midlands Meander became a popular settlement for white commercial farmers in the early 1900's (Mathfield, 2000:6). Being used mainly for the production of wattle, dairy products, sheep and cattle, most of the Midlands Meander were reserved for white ownership (McClendon, 1997:44). In terms of livestock agriculture, grazing pastures in the Midlands provided summer free range pasture grazing for livestock whereas in winter livestock grazed at a lower altitude therefore most farm owners owned two farming properties that either boarded on each other or were bridged (Bizley and McKenzie, 2007:142).

In the 1900's white farmers relied on local labour either in the form of casual labour; migrant labour and labour residents (McClendon, 1997:45). Under the 1913 Natives Land Act and the 1936 Trust and Land Act labour residents, who were black families who would trade labour for access to land for crop agriculture or livestock husbandry, were required to provide a minimum of 90 days per year of service (Obeng-doom, 2012:165 and McClendon, 1997:46). With the discovery of gold and diamonds in the nineteenth century, the apartheid government passed Ordinance 2 of 1855, which stated that white landowners were allowed to keep a maximum of three labourer families on their property and gave local magistrates the power to

remove black squatters and labourers from public and private land (Letsoalo, 1987:32). The enforcement of the Ordinance put further limitations on black ownership and access of agricultural land giving poor white farmers more opportunity to thrive (Letsoalo, 1987:32; McClendon, 1997:46). This left many labour workers frustrated as they were forced to farm on white landowners' sites before being able to tend their own livestock and crops and were prevented from finding other work or new landowners due to the implementation of a Pass Law (Letsoalo, 1987: 31).

With the outbreak of tick-borne East Coast Fever and the loss of thousands of cattle between 1906 and 1909, regulations were established that required the regular dipping of livestock and permits for the movement of livestock (McClendon, 1997:48). These limitations put pressure on many traditional social relationships within KwaZulu-Natal. For example, in terms of *lobola*, transactions were usually made without actually moving cattle to the bridegroom's house (McClendon, 1997:48). This was known as *ukusisa* or cattle loaning and had benefits in that individuals could avoid displaying their cattle wealth, preventing overgrazing and giving the "cattle poor" access to milk and the opportunity to breed cattle and thus increase their social wealth (McClendon, 1997:49).

Within the uMgungundlovu District Municipality there is land belonging to the Ingonyama Trust (Figure 3.4). It is rather small compared to that of other district municipalities however this is due to the vast commercial farming sector that currently exists within this area. Over the next decade the range of communal land is expected to increase with the re-opening of land claims in June 2014.

Municipal service delivery within the uMgungundlovu District Municipality has been in the spotlight for the better part of 2014 as a result of violent protests that have taken place on the N3 in the Mpofana Local Municipality by local residents (de Klerk, 2014). These drastic actions have resulted in the Mooi Mpofana municipality being disbanded and seven municipal members dismissed (Matshediso, 2014). In an official statement released by the Co-operative Governance and Traditional Affairs (Cogta), the department had discovered that the IDP of the local municipality "was not credible in that it omitted critical aspects such as Human Resource strategy, workplace skills plan, an integrated waste management plan, status of road networks,

human settlements, associated levels of services and backlogs, consumer debt, borrowing and a spatial development network" (Matshediso, 2014).

3.7. Conclusion

This chapter described the study area as well as gave insight into the history of the site in order to explain the current circumstances of rural emerging farmers and the establishment of post-apartheid policies and the inefficiencies that have occurred with its implementation within the KwaZulu-Natal Midlands. This chapter also gives insight into the agricultural value in the area both in terms of economy and livestock husbandry and therefore its suitability to support emerging livestock farmers.

CHAPTER FOUR: METHODOLOGY

4.1. Introduction

This chapter discusses the methodologies and techniques used in the data collection and analysis process employed in the study. A combination of quantitative and qualitative data analysis methods were used to obtain a well-rounded view and simultaneously address the multiple objectives that need to be met. Data collection was done in a stepwise manner that was initiated with preliminary research being done into the issues surrounding the livelihoods of emerging livestock farmers within the KwaZulu-Natal Midlands. This was then followed by the convenience sampling of a population of emerging livestock farmers and livestock industry informants within the Midlands using questionnaires and key informant interviews respectively as research tools. Once the necessary data was obtained, Stastical Package for Social Sciences (SPSS) in the evaluation process.

4.2 Research Methodology Design

Ndlela (2008:128) states that in order to develop a feasible methodology it is important to address the following questions:

- Will the methodology collect the essential data?
- How precise will the data collected be?
- Can one achieve the task, given the people, time and resources involved?

These questions largely informed the methodology of this study. To reiterate, the objectives of the study are:

- To investigate the waste management practices and environmental impacts of the emerging livestock industry in KwaZulu-Natal Midlands;
- To determine the waste management technology needs of the emerging livestock industry;
- To determine the knowledge network that is used in waste management practices of the emerging livestock industry;
- To evaluate the contribution of the emerging livestock industry to local food security;

- To determine the impact of policy on emerging livestock farmers and whether it supports or hinders their sustainability.

Ndlela (2008:127) states that research design is "a plan, blueprint or guide for data collection and interpretation-sets of rules that enable the investigator to conceptualise and observe the problem under study". Mugabe (2011:58) states research design is "a strategic framework for action that the researcher can use as a bridge between the research question and the implementation of the research". Jalil (2013:7) goes on further to state that research design is used to articulate "what data is required, from whom, and how it is going to answer the research question". Bearing this in mind, to adequately address each of the objectives mentioned above, the research design initially focused on a theoretical framework that surrounds the livelihoods of emerging livestock farmers within the KwaZulu-Natal Midlands (Section 2.2). Investigating emerging farmers using the SLA thus involved analysing the various income streams within which emerging farmers indulge; their husbandry and management practices to evaluate their vulnerability. The role that co-operatives, NGOs and government play with regards to this study was also analysed to recognise the type of support the target population receives in terms of becoming sustainable and comparing this with the potential and current progress of other countries and their particular waste management practices.

Both qualitative and quantitative data analysis methods were employed in the research design to obtain triangulation, which according to Salomon (2011:51) and Jick (1978: 602) is the exploration of an issue from multiple perspectives using a combination of methodologies. The use of both methods takes into account both statistical information collected as well as various perspectives of all stakeholders involved and thus approaches the objectives of the study in a holistic manner. Sumner (2006:249) defines qualitative research as "research that investigates aspects of social life which are not amenable to quantitative measurement. Associated with a variety of theoretical perspectives, qualitative research uses a range of methods to focus on the meanings and interpretation of social phenomena and social processes in the particular contexts in which they occur". In contrast, Garwood (2006:251) states that quantitative research is "research involving the collection of data in numerical form. The defining factor of quantitative analysis is that numbers result from the process, whether the initial data collection produced numerical values, or whether non-numerical values were subsequently converted to numbers as part of the analysis process, as in content analysis." In this study the qualitative methods

employed were conducted through a secondary data source analysis that included a policy analysis and an emerging livestock industry review; and primary structured key informant interviews as well as a written questionnaire conducted with emerging farmers. Quantitative data was obtained from data gathered from the structured questionnaire as well as key informant sources.

4.3. Secondary Data Collection

To obtain an extensive preliminary knowledge of the South African emerging livestock sector and thus fulfil the objectives, a content analysis was initially done using secondary sources. Information from journal articles, research papers and the websites of livestock industry associations, local and district municipalities and local and international polices were collected and recorded. All the data gathered related to the livelihoods of the local emerging livestock farmers both locally and internationally. Focusing on the products emerging farmers obtain from livestock husbandry practices; the local and international emerging livestock industry in relation to waste management practices, policies that has been developed; and environmental and social issues associated with the emerging livestock industry, chapter 2 was compiled to facilitate the understanding of the current state of the South African emerging agricultural industry and thus assist in the preparation of primary data collection sources.

4.4. Primary Data Collection

4.4.1. Key Informant Interviews

Key informant Interviews are a qualitative research collective tool that involves the performance of in-depth interviews with individuals whom have first-hand knowledge and experience into a community; the activities that occur therein; and are articulate enough to share this knowledge (Kumar, 1989:1). Key informant interviews can be performed using either telephone or face-to-face techniques depending on the type of information that is required. The face-to-face technique, as employed in the research methodology of the study, is considered more valuable when observing a subject's reaction to questions when opinions are required. The purpose of conducting key informant interviews within this study was to obtain further insight from industry professionals as to the local emerging livestock industry, their

livestock husbandry practices, waste management practices and the vulnerability of rural farmers. This method of data collection was used so that in-depth responses could be elicited. One stakeholder within 7 different sectors of the livestock industry was interviewed (Table 4.1).

Table 4. 1. Key Informants utilized in the study.

Category	Pseudonym	Reason for inclusion	Appendices
Manager of a commercial farm in Richmond Municipality	Commercial farm manager	The interview provided insight into commercial waste management. This particular farm provides agricultural training to prospective farmers for a fee.	II
Academic	Agricultural academic	Described the livelihoods of emerging farmers in the KwaZulu-Natal Midlands	III
Director of a local farmers association in uMngeni Municipality	uMngeni-Farm association director	Informant is involved in support initiatives for emerging farmers in uMngeni as well as co-ordinates a farming association for commercial dairy farmers in the area.	IV
Manager of municipal functions within uMgungundlovu District Municipality	UDM-municipal manager	Informant oversees waste management activities within the district; plays and integral part in potential anaerobic ventures with local livestock farmers; and enforces local policy.	V
Representative of the uMgungundlovu District Municipality State Veterinarian	UDM- state veterinarian	Informant advised on the use and disposal of pesticides and how the proper management of livestock and their health can facilitate resilient livelihoods and decreased waste volumes.	VI
Waste Manager of DAE	DAE- waste manager	Informant approves waste licences for farmers in KwaZulu-Natal and therefore provided insight into waste management best practices; the current practice of commercial and emerging farmers; and how pollution is dealt with	VII
Deputy Director at DWA (KwaZulu-Natal)	DWA-Deputy director	Informant described how pollution to water sources is dealt with and policy that is in place in terms of farmers, water pollution and water use.	VIII

These stakeholders were purposefully chosen as participants based on the assumption that the interviewees would be able to provide current information into local livestock farmers that was not yet available from literature sources. In the search for a well-rounded in-depth view of the emerging livestock industry, it was deemed appropriate that the expertise of various specialised individuals be tapped into.

Respondents were informed prior to the interview that their responses would be used only for the purpose of the study and that their identities would be kept confidential. The responses for each interviewee were then noted during the session using a recording device as well as with hand written notes. The respondents were also encouraged to give additional information following the interview through email or telephonically. In keeping with the confidentiality agreement made with key informants, pseudonyms have been generated, as listed in Table 4.1, for each informant. These pseudonyms will be used throughout this study as a means of describing opinions expressed by the key informants and observations made during the interviewing process. The questions that each corresponding key informant was presented with is available within Appendices II- VIII (Table 4.1).

4.4.2. Emerging Farmer Questionnaire Design

Questionnaires in general are used to obtain both quantitative and qualitative data and to explain a predefined opinion (Ndlela, 2008:145). In order to obtain a personal perspective from emerging livestock farmers, a questionnaire was drawn up based on the relevant literature found during the analysis of the secondary data sources as well as the information gathered from the key informant interviews. The purpose of presenting a questionnaire to the emerging farmers of the KwaZulu-Natal Midlands, was to collect personal data from farmers to attain a holistic and in-depth perspective of the current state of the emerging livestock sector. Holyk (2008:657) states that "questionnaire design is the process of designing the format and questions in the survey instrument that will be used to collect data about a particular phenomenon". Therefore to draw up a well-designed questionnaire the problem at hand needs to be conceptualised and potential explanations established (Waltermauer, 2008:880). Failure to understand all possible explanations could result in the exclusion of important information that may become apparent once the study has been concluded (Waltermauer, 2008:880). There are a number of steps in the designing of an appropriate questionnaire. They are as follows (Holyk, 2008:657; Williams, 200-3:116):

(1) Determination of goals, objectives and research questions;
(2) Establishment of the target population;
(3) Definition of key concepts;
(4) Generation of hypotheses and proposed relationships;
(5) Choice of survey mode and;
(6) Question construction.

Once this is achieved, the method of measurement or operationalization, needs to be determined. In the study, short, simple questions were asked in order to ensure that the respondent would understand the questionnaire and provide the required information. The questionnaire (Appendix 1) consisted of both open and closed ended questions in order gather data on the study that was unclear following the secondary source analysis and key informant interviews. Open-ended questions allowed the respondent to answer with whichever data he/she feels is relevant and to obtain personal information and opinions (Holyk, 2008:657). Closed-ended questions on the other hand are those that have predetermined answers that make it easier from the respondent to answer, avoiding confusion (Williams, 2003:116). These questions also create more opportunity for the comparison of answers and are therefore are used in the quantification of data (Holyk, 2008:657).

From statistics obtained from the uMgungundlovu District Municipality survey it was noted that the literacy rate in 2003 was significantly low (19.41%) (uMgungundlovu District Municipality, 2009:32). Assuming that this percentage prevails in rural areas, most of the questions within the survey were closed ended in order to ensure that the respondent interpreted the questions in the correct manner; that the required data was obtained and to ensure that the subject understood that the survey would only be used for research purposes.

The questionnaire was sectioned thematically based on the objectives of the study, grouping similar questions and following a logical sequence (Holyk, 2008:657; Waltermauer, 2008:880). The sections thus focused on waste management practices of rural emerging livestock farmers, the technology and infrastructure that are available to these communities, their traditional practices and uses for livestock and the potential of emerging livestock farming to improve upon the livelihoods of rural communities and national food security (Annexure 1). Surveying measurement errors can result from two sources: variance and bias. To avoid these errors it is important to format questions appropriately so as to not influence the respondent's answers (Holyk, 2008:657). Influence may also arise from the interviewer, the wording of questions and the mode of data collection.

4.4.3. Sampling Procedure

Data collection is integral in the quality of results and information that is obtained, so much so that the manner in which the subjects are approached and the quality of a population or a representation of the population determines the success of the project (Ndlela, 2008:127). With this in mind, it is important to note that surveying the entire population of uMgungundlovu emerging livestock farmers would be too costly and time consuming due to the vastness of the landscape they occupy within the Midlands, therefore a sample on the target population was looked at as an alternative with the use of the purposive convenience sampling.

Dolores and Tongo (2007:147), defines purposive sampling or judgement sampling as "a deliberate choice of an informant due to qualities the informant possesses". The use of this sampling method requires the researcher to be aware of the type of information he/she that is needed and include informants based on specific characteristics (Doloes and Tongo, 2007:147). According to Battaglia (2008:149) convenience sampling is "a type of nonprobability sampling in which people are sampled simply because they are convenient sources of data for researchers". Also known as accidental sampling, with the use of convenience sampling, each subject within a population has an equal probability of being analysed (Phua, 2004:200). Employed in both the collection of qualitative and quantitative data collection, what makes this type of sampling appropriate for this study is the difficulty in defining emerging farmers within the Midlands. Emerging livestock farmers face a variety of hurdles and are not exposed to the same opportunities and resources and therefore cannot be defined by a single factor such as income, for example. The advantages of convenience sampling is self-explanatory in that this method is based on convenience and being cost effective (Salkind, 2010:256). There are however disadvantages of using this method. For instance the focus technique of this method is rather narrow therefore results cannot be used to generalise outside the study area (Phua, 2004:200; Salkind, 2010:256)

The Midlands lies within the uMgungundlovu District Municipality, KwaZulu-Natal. In order to obtain a fair representation of the emerging farmer population living within this area and their capability to be sustainable as farmers, the survey was distributed within three local municipalities as shown in figure 4.2**.** The study area chosen is indicated within figure 4.1 and includes the local municipalities: uMngeni; Msunduzi and Richmond. These municipalities where chosen based on the criteria that they are in close proximity to the N3 which runs directly

from Durban to Johannesburg and to Pietermaritzburg, which is located within the Msunduzi municipality. Farmers within the sample group therefore range from those that are in a better situation in that they exist in close proximity to markets, developed areas and other commercial farms, to those whom dwell in rural areas and have no access to municipal services and limited access to local markets. These statistics, overall, show three very different situations in which emerging farmers dwell.

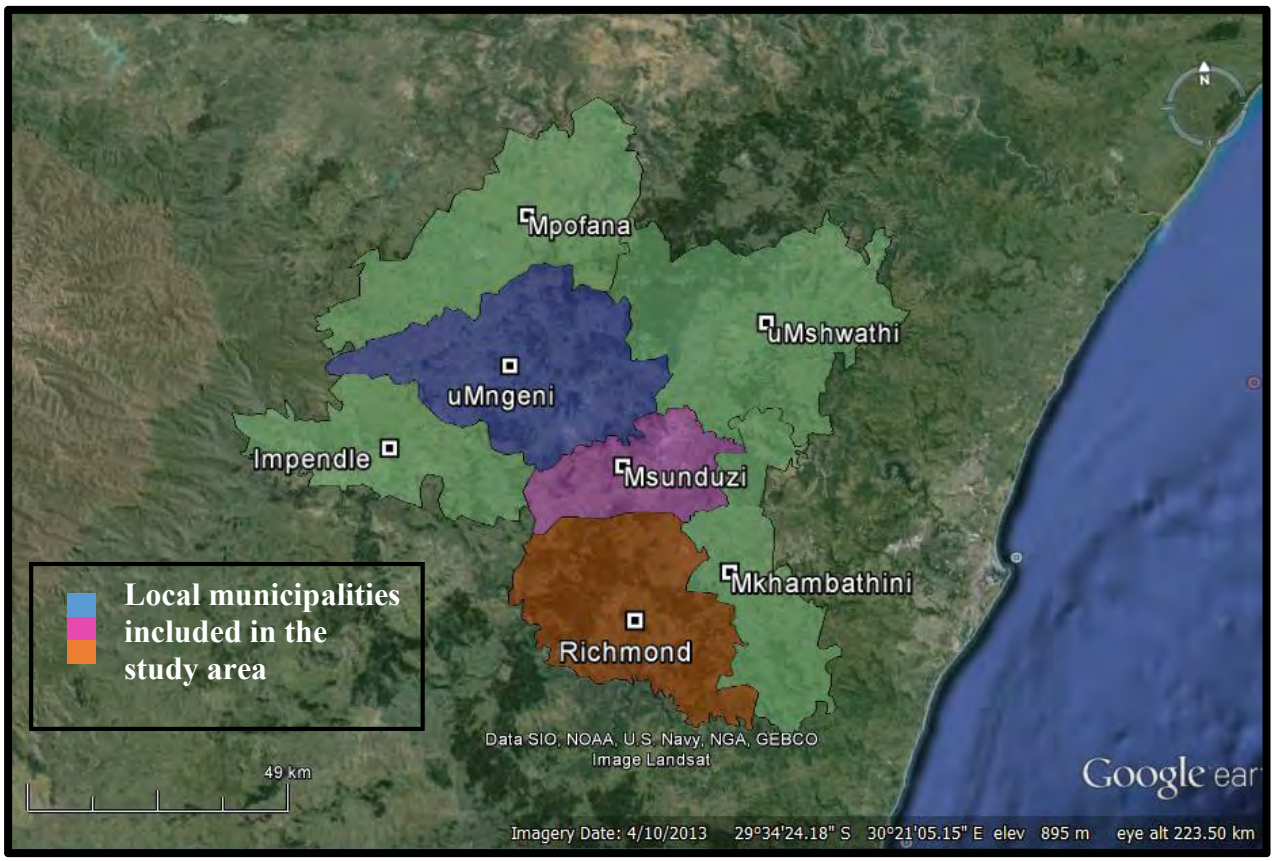


Figure 4. 1. Local municipalities in which questionnaires were distributed (Google Earth).

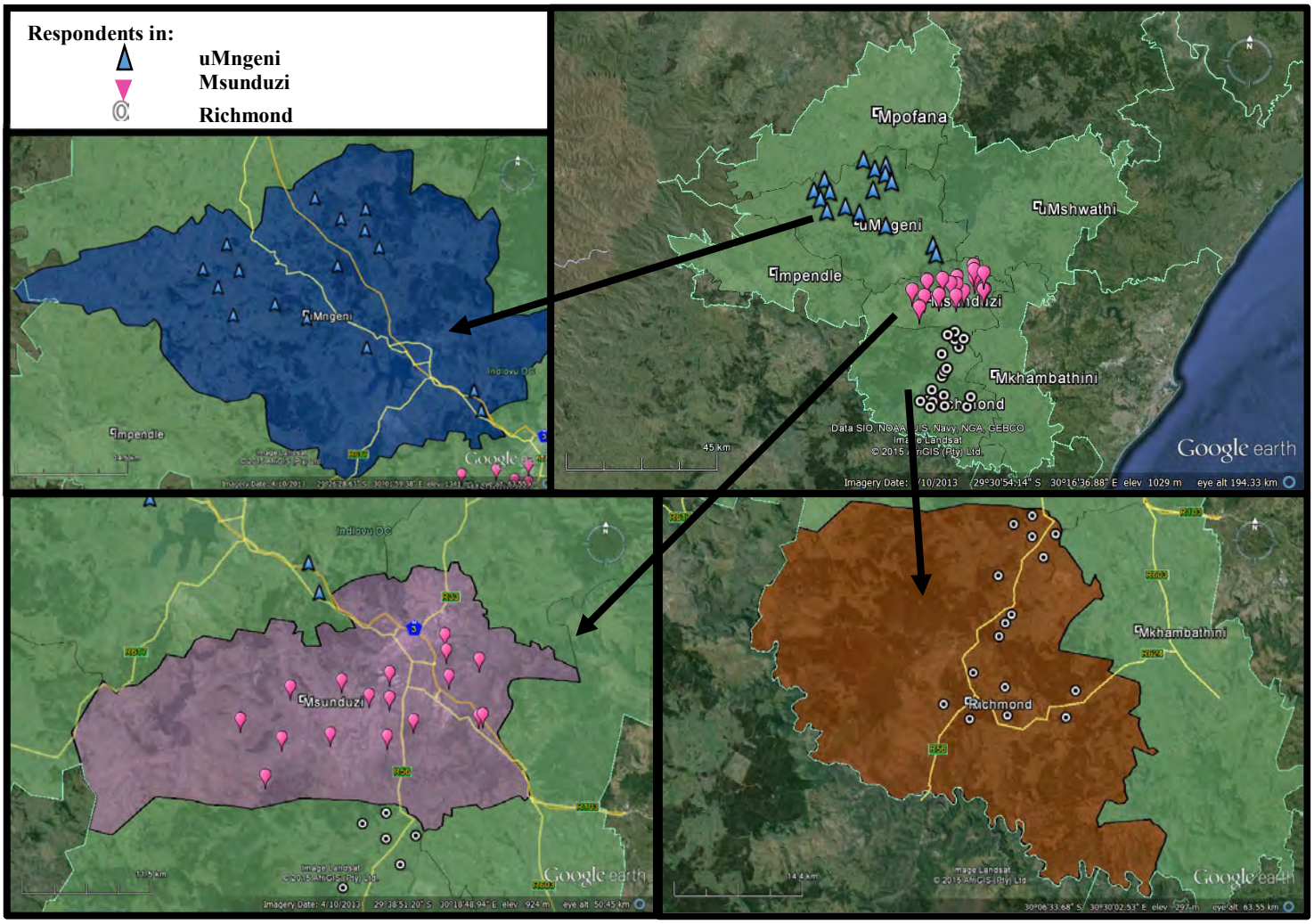


Figure 4. 2. Distribution of questionnaires within the Msunduzi, uMngeni and Richmond municipalities
(Google maps).

With the use of purposive and convenience sampling methods, famers that had livestock within their property where chosen in order to avoid the inclusion of subsistence farmers in the sample population. In total 53 households that partake in livestock husbandry were identified. Of these 50 households were considered as the remaining were regarded as subsistence farming households based on the definition of emerging adopted in section 1.2. Of the 50 emerging farmers surveyed, 16 were located in uMngeni local municipality, 17 from the Msunduzi municipality and 17 from the Richmond local municipality, as shown in figure 4.2. Majority of the population in uMgungundlovu District Municipality speak isiZulu therefore in order to bridge the language barrier and ensure that the farmers that were surveyed understood the questionnaire, it was translated into isiZulu. Help from a translator was engaged to ensure that

questions were perceived in the correct manner and that the required information was obtained. Data Collection was done between September 2013 and March 2014. The head of each household was approached with the survey. In cases where the head was not available or unable to provide information, the family member or employee responsible for farming operations responded.

4.5 Data Analysis

The collected data was analysed using SPSS, a "computer based data management and inferential statistical analysis program" (Bronstad and Hemmesch, 2010:1419) that provides enormous data processing power (Foster, 2006:288). The factors that make SPSS so popular, include that data from other sources such as excel can easily be imported (Paura and Arhipova, 2012:11). The disadvantage of using SPSS however, lies in that it requires updated computer software before being used and has been updated a number of times however old procedures still remain, making the use of SPSS complicated (Bronstad and Hemmesch, 2010:1419). The complex print out of the results that is obtained following the analysis of data can also not be avoided therefore the researcher needs to be able to distinguish between relevant and unnecessary data (Foster, 2006:289).

4.6. Limitations and Data Accuracy

Secondary data collection was limited due to the lack of literature specifically relating to waste management practices within the South African livestock Industry both, commercial and informal. Nor are there any guidelines, policy or legislation in place that encourages informal livestock farmers to manage their livestock waste as currently agricultural waste is not established as a hazard to the environment or human health. Hence, key informant interviews supplemented these details in chapter three. Since waste disposal services are minimal in the rural areas of uMgungundlovu District Municipality, local farmers employ alternative methods of waste disposal despite them not being approved by authorities. This gap in the South African emerging livestock industry however provides an opportunity to gather information that could be used to benefit the livelihoods of rural communities in KwaZulu-Natal. In terms of the

surveys there was a significant language barrier that was resolved with the use of a translator during interviews and the translation of the survey into isiZulu.

4.7. Conclusion

This study investigated the waste management practices of emerging livestock farmers within the KwaZulu-Natal Midlands through an analysis of their livelihood sustainability. By looking at the livelihood systems of emerging farmers, a complete approach is adopted that investigates the inputs, outputs, processes and feedbacks that contribute to the poverty alleviation. (Mtshali, 2002:25). This chapter gave an account of the research design behind the methodology used to conduct the study. With the use of primary and secondary data sources (the former comprising of key informant interviews and an emerging farmer survey) resulted in a holistic view of the environmental and social issues in terms of waste management and the sustainability of the livelihoods of emerging livestock farmers in three local municipalities of the uMgungundlovu District Municipality, which for the purpose of this study is representative of the rural emerging farming population of the Midlands.

CHAPTER FIVE: ANALYSIS AND INTERPRETATION OF DATA

5.1 Introduction

This chapter presents and analyses data obtained from the questionnaire survey conducted with 50 emerging farmers within the KwaZulu-Natal Midlands. Results are primarily presented quantitatively, except where the questionnaire allowed for in-depth responses. The analyses and discussion are further supplemented with data obtained from key informant interviews and literature sources. Using thematic analysis the results are presented in five sections that make reference to the objectives of the study. These sections relate to: the current waste management practices of emerging farmers; the implementation of waste management technologies; the impact of policy on emerging farmers; the role that emerging farmers play within local food security; and finally the knowledge network of farmers.

The target population of the study comprises of emerging livestock farmers located within the KwaZulu-Natal Midlands. Fifty livestock farmers (household heads) were selected, through convenience sampling, within three local municipalities of the Midlands Meander: uMngeni; Msunduzi; and Richmond municipalities, and presented with a questionnaire. The intention of the questions posed to the emerging farmers was to fulfil and find linkages between the study objectives. Eight industry professionals linked to or involved in the KwaZulu-Natal livestock industry were interviewed as key informants. Questions posed to key informants, which will in this chapter be referred to with the use of pseudonyms (Table 4.1), were based around their involvement with emerging farmers and their opinion of the emerging livestock industry, the husbandry practices implemented by emerging farmers and current policy that affects the sample population.

5.1.1. Population statistics

Agricultural academic defined emerging farmers as “resource poor farmers that have the potential to contribute to national food security however generally lack resources and infrastructure”. The emerging farmers included in the study ranged from indigenous people that have gained from land reform projects to those that have been forced to downsize their farming operation to cope with current economic changes in the agricultural industry (Agricultural academic). Fifty six percent of the respondents included in the survey population

were found to be female, 30 % of which lies in the age range of 36- 55 (Figure 5.1). The age of male respondents in contrast varied on a broader scale, occurring mostly between the ages of 26 and 55 (Figure 5.1). Results concurred with statistics reported in the 2011 South African national census that 52% of the uMgungundlovu District Municipality population is made up of females (Lehohla, 2011:53). Similarly, results indicated that the population of uMgungundlovu District Municipality was proportionally split.

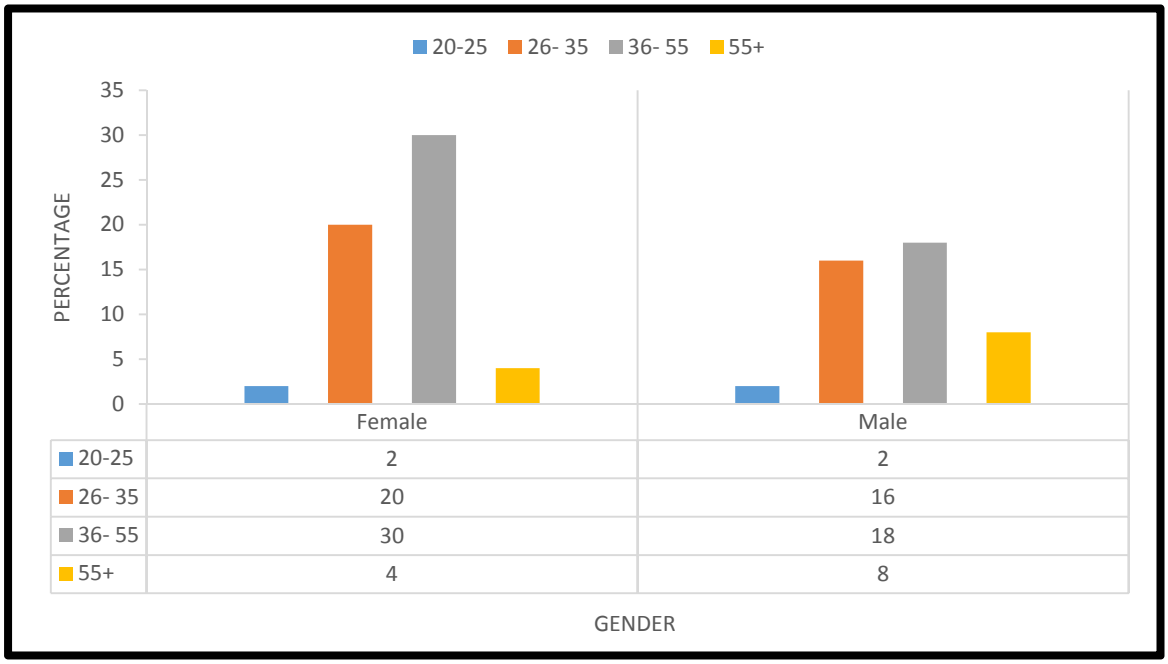


Figure 5. 1. Ages of male and female respondents (n=50, 100%).

The 2011 national census found that 8.5 percent of the uMgungundlovu population aged twenty and over had not received an education; whereas eleven percent had a higher education and 30% had received a matric or a grade ten qualification (Lehohla, 2011:23). Likewise, the study results point out that six percent of females in the sample group had not received an education (Figure 5.2) and 36% of the population had received a secondary education.

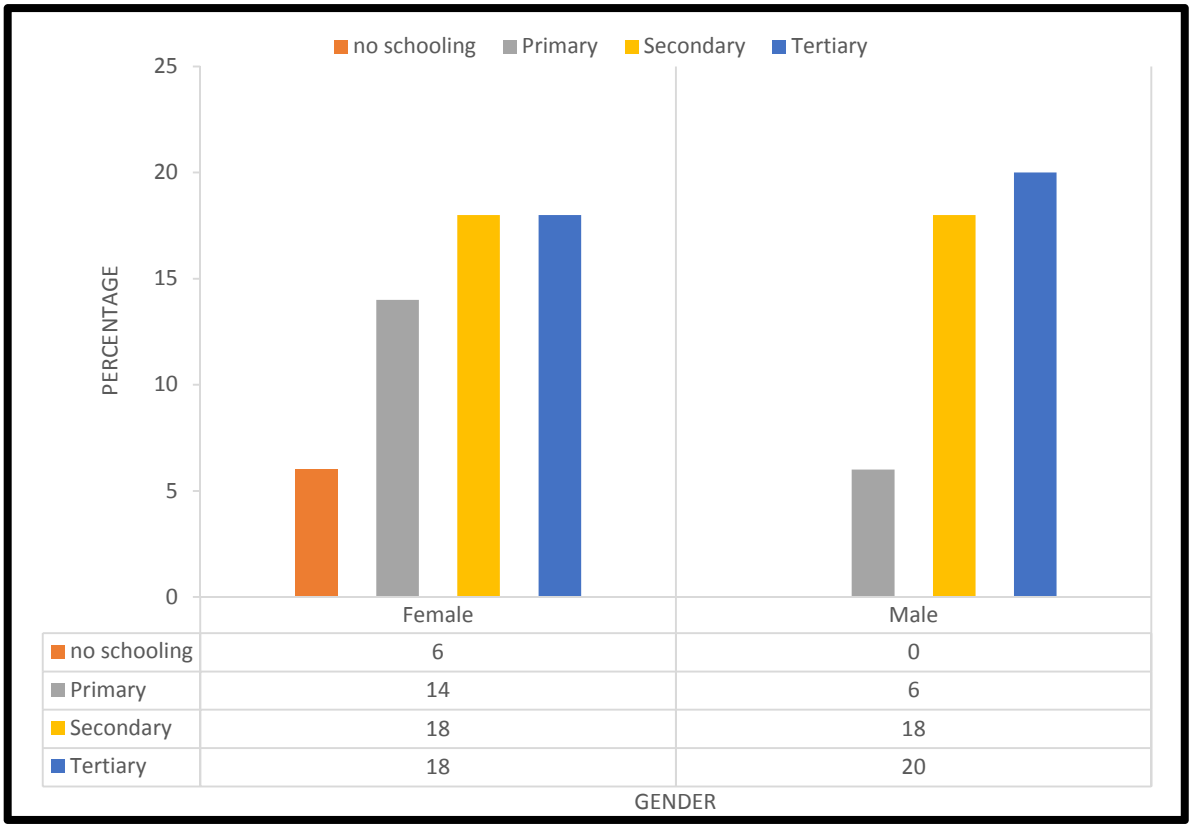


Figure 5. 2. The level of education received by male and female household heads (n=50, 100%).

Only 38% of those surveyed had received agricultural training (Figure 5.3). Given the number of farmers struggling to cope with agricultural challenges, this supports the reasoning behind the lack of success of land reform policies proposed by Ulrich *et al.* (2012:242), to be a lack of skills and agricultural know how. Skills training varied amongst respondents. One third of the 38% that had received training did so at agricultural schools and colleges whereas the remaining respondents had attended training provided by co-operatives, municipal support or NGOs. Twenty four percent of the female respondents received agricultural training (Figure 5.2 and Figure 5.3). In contrast, the number of female respondents (six percent) that did not receive any education, was higher (Figure 5.2). The higher number of females that did not attend school or did not continue their schooling career past the primary stage indicates that within rural environments, the male population generally obtains a higher level of education during their schooling careers. According to literature, this is largely attributed to women and female children generally leaving school as a result of having to help with household, child care and agricultural activities (Ewing, 2007:25). In addition, the effects of HIV and other diseases have increased the number of child headed households. This forces children, females

in particular, to leave school to look after siblings and support their household (Admassie, 2003:169). However 60% female respondents that had not received a formal education took part in agricultural training provided by co-operatives and other supportive institutions, indicating that these individuals were interested in excelling at their trade.

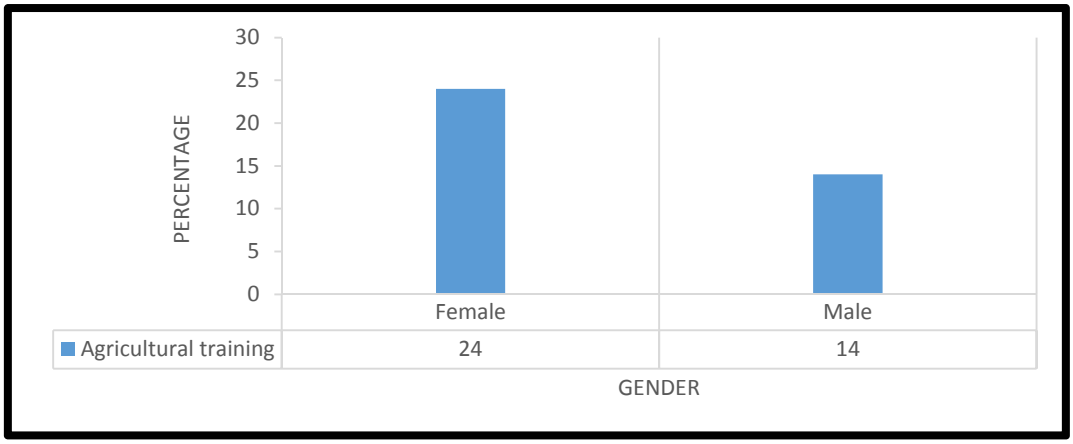


Figure 5. 3. Percentage of males and females emerging farmers that have received agricultural training (n=19, 38%).

The European Agricultural Strategy views emerging farmers as ecosystem custodians (EC, 2012:6). It was evident however that emerging farmers within the Midlands did not have knowledge of their role in preserving local ecosystems, as can be seen in Plate 5.1, in which cattle from a neighbouring farm can be seen grazing in a rehabilitating wetland during winter months, during which there is a shortage of palatable vegetation available for grazing. that the wetland in currently within a transition phase, the presence of cattle could inhibit ecological processes through the compaction of soil, the trampling of indigenous species, pollution of water and overgrazing.

Plate 5. 1. Cattle grazing in a rehabilitating wetland that was previously used as Mondi forestry.

The majority of emerging farmers within the study area have either bought or inherited their land, 76% collectively, whereas 24% use communal land with the permission from the local *Inkhosi* (Table 5.1). Furthermore, 68% of the male respondents had intentions of growing their farming operations by obtaining additional land ('other') (Table 5.1). These numbers reveal that male farmers are more willing to invest capital in land than woman household heads. Only 29% of the women included in the survey had purchased land compared to the 50% of male interviewees (Table 5.1). In contrast, Mkhabela (2002:29), in a study conducted in the Midlands Meander noted that nine percent of the sample population had title deeds to agricultural land, whereas 87% dwelled on communal land and three percent used land under another owner or a tribal authority.

Table 5. 1. Percentage of male and female farmers that bought land, inherited land or farm on communal land.

	Total %	**Female % (n=28)**	**Male % (n=22)**
Bought land	38	29	50
Permission from *Inkhosi*	24	32	14
Inherited land	38	39	36
	100	100	100
Other	58	50	68

Cattle proved to be the most popular livestock breed amongst local uMgungundlovu livestock farmers with 66% of the sample population owning cattle, followed by goat and chicken, 50% and 40% respectively (Figure 5.4). As can be seen in Figure 5.4, female respondents indulged in dairy farming and egg production significantly more than the male respondents. In addition the female household heads were more open to keeping more than one species of livestock (Figure 5.4). These characteristics indicate that women household heads in a rural setting are more open to adaptive strategies that would improve their livelihood resilience. By keeping more than one livestock species, food security and security against diseases, through improved nutrition, and climate variability are heightened. Likewise, women were more indulgent in dairy and egg production therefore keeping livestock species for more than one reason.

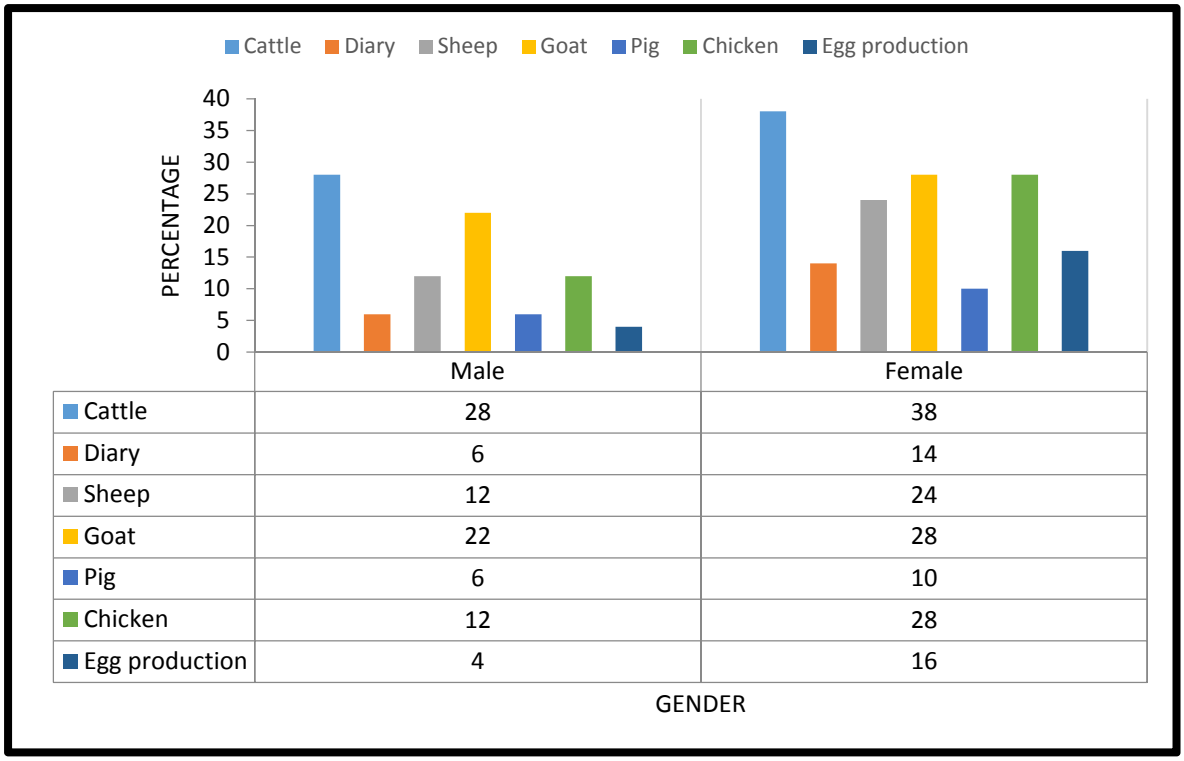


Figure 5. 4. Percentage of male and females with the sample group that keep livestock (multiple responses) (n=50, 100%).

5.1.2. Municipal service delivery

This section deals with a range of service delivery issues pertaining to emerging livestock farmers and includes access to basic resources such as water and electricity; and waste disposal services. Seventy two percent of households included in the study had electricity on their farming site whilst 88% had access to a clean drinkable water source either from the municipality or from a borehole (50% and 38% respectively) (Figure 5.5). Other water sources included were dams (six percent) and rivers (six percent); these water sources however are in most cases polluted and not suitable for human consumption (Agriculture academic). These results correspond with the uMgungundlovu District Municipality IDP 2014/2015 which claims that 80.4% of the population has access to water sourced by the municipality of alternative service providers (uMgungundlovu District Municipality, 2013:80). The IDP also states that the remaining 19.6% of the population has access to water sourced from boreholes; water tanks; rivers; springs and water vendors (uMgungundlovu District Municipality, 2013:80)

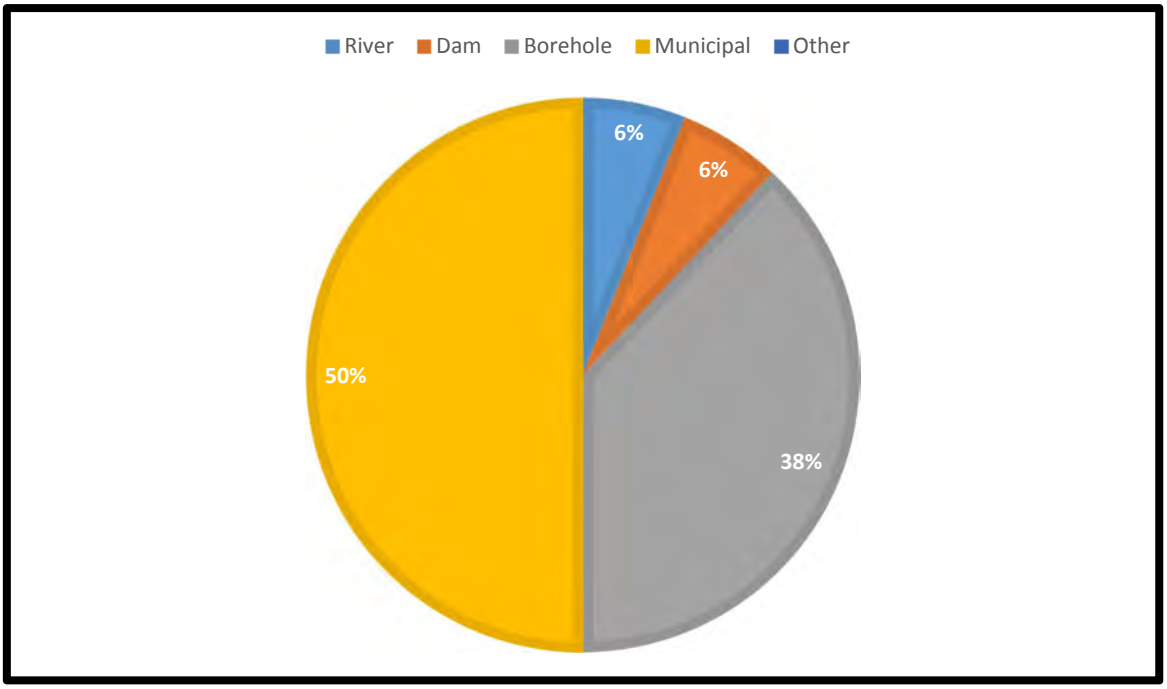


Figure 5. 5. Water sources used by emerging livestock farmers in KwaZulu-Natal (n=50, 100%).

There are landfill sites available in each of the local municipalities surveyed, namely, the New England landfill (Msunduzi Municipality); Currys Post landfill (uMngeni Municipality), which are the two biggest landfills in the Midlands; the Richmond municipality Landfill (Richmond Municipality) and the Hilton landfill site (Msunduzi Municipality) (UDM- municipal manager). These sites are located long distances away from most emerging farmers present in rural areas therefore without the necessary collection services most farmers turn to alternate waste disposal methods. This was evident from litter encountered near homesteads, and the burning of agricultural and domestic waste during the primary data collection process.

5.2. Current Waste Management practices of emerging farmers

This section describes the current waste management practices employed by emerging livestock farmers located within the KwaZulu-Natal Midlands through the exploration of the types of wastes that farmers are faced with and comparing their disposal methods with that of best practice policy, both local and international.

Apart from household waste, waste mentioned by emerging farmers during the questionnaire process included: manure; blood; entrails; carcasses; feathers; feed; and perishables such as eggs or milk (Table 5.2). Manure was collected on every farm included in the study (Table 5.2) and was also considered the most useful waste, being recycled by 70% of the respondents to fertilise crops and grazing fields. These results correspond with Mkhabela (2002:30), who performed a study in the Midlands Meander with the purpose of discerning manure utilisation. Mkhabela (2002:30) found that 73% of respondents had manure readily available on their farm site. All farmers included in the study used rotational grazing as a method of distribution of manure. At night, farmers confined livestock to kraals to prevent them straying and being stolen. During this time manure accumulated within the kraals. Mkhabela (2002:30) states that this manure is generally used for application during winter months. In cases where there was excess manure present on site, respondents of this study composted manure in addition to other organic waste in compost heaps or burial pits that included other biodegradable wastes. One of the respondents was noted to use excess manure to fertilise a small crop of various vegetables that were to sustain his household and employees. Twelve percent of the respondents sold manure. Study results indicate that amongst emerging farmers, those that keep chicken are likely to sell manure as chicken farmers generally do not have large fields which need to be fertilised.

Table 5. 2. Waste found on farm sites (multiple responses).

	Percent (%)	Source of waste
Manure	100	All livestock
Blood	10	On site slaughter of livestock
Entrails	10	On site slaughter of livestock
Feed	36	Chicken, pig, duck
Feathers	26	Chicken, ducks
Carcasses	6	All livestock
Expired products	20	Animal sourced products

The most common feeding method used by emerging farmer respondents in the KwaZulu-Natal Midlands is free range grazing (Figure 5.6). This however is not sufficient during winter

months when succulents are not readily available. To cope, sixty two percent of the respondents stated that they substitute hay during the winter months to compensate for the nutritional needs of livestock. The remaining households stated that in some years they could not afford to purchase additional food and therefore moved their livestock to more acceptable grazing pastures or allowed them to roam free in the surrounding areas (Plate 5.1 and 5.2). Famers may even employ herders to lead livestock to better pastures and watch over them while they graze (Plate 5.2).

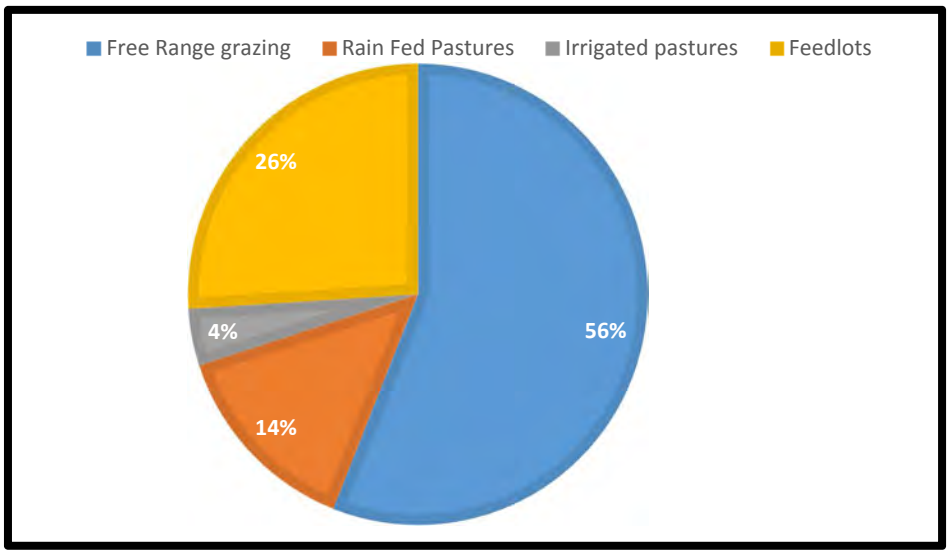


Figure 5. 6. Feeding methods used (n= 50, 100%).

Plate 5. 2. Free range grazing of cattle within Msunduzi Municipality with a herder.

The use of free range grazing (Plate 5.2) means that there is minimal feed waste in terms of the forage species. Thirty six percent of respondents stated that they obtained feed waste (Table 5.2). These farmers where noted to partake in pig and chicken husbandry, which generally requires purchasing feed in the form of maize. Feed is generally considered as waste when it is contaminated by animal excrement or has become "old" or infested by pests and is therefore not suitable for consumption (Commercial farm manager). The proper disposal of such waste is therefore imperative as it has the potential to act as a vector in the manifestation of diseases that can affect both livestock and human populations (D'Mello, 2004:107). All respondents that obtained feed waste, including those that utilised feedlots (26%) (Figure 5.6) used composting as a means of disposal of organic waste. According to Commercial farm manager, this is the most environmentally viable and cost effective method of disposal. Feed waste is organic and biodegradable and is therefore acceptable to be reused as fertilizer (Richmond manager).

Forty two percent of respondents implemented rotational grazing. Rotational grazing (Plate 5.3) according to Agricultural academic, acts as a conservation tool through the distribution of manure with minimal effort and the conservation of grazing land. During rotational grazing, manure is distributed by the livestock themselves within fenced areas allowing farmers to control land use and land rehabilitation. According to Agricultural academic, an added benefit of rotational grazing is that the fencing of livestock in specific areas limits erosion and conserves plant species.

Plate 5. 3. Rotational grazing being practiced in uMngeni municipality by an emerging dairy farmer that manufactures cheese in winter (July 2013).

Key informants (Richmond- farm manager and Agricultural academic) mentioned pesticides; paper and plastic packaging; piggery waste and hide as other wastes encountered in livestock agriculture. Pesticides, such as dipping solutions used to kill ticks, are the most problematic wastes in terms of pollution (UDM- municipal manager). None of the respondents however mentioned pesticides as a waste during the survey procedure or had a disposal plan in place for chemical waste. Furthermore none of the participants mentioned that they returned unused pesticides to their suppliers. Since the release of such chemicals has the potential to degrade water resources and soil, ultimately damaging local ecosystems and affecting future agricultural activities, UDM- state veterinarian recommended that excess pesticides should be

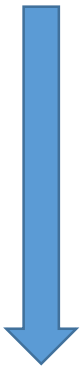
collected in containers and disposed of to the appropriate waste collector. This was the method of disposal used by Richmond farm manager. Emerging farmers however use minimum volumes of pesticides on their livestock, their waste volumes are therefore considered negligible (UDM- state veterinarian). Emerging farmers are therefore according to policy not required to have disposal and a spill plan in place to deal with the entry of such chemicals into the environment.

5.2.1. The contamination of water bodies

Thirty six percent of the sample group indicated access to water as a challenge (Table 5.3). A select few respondents (8%) within all local municipalities expressed disappointment in municipal service delivery stating that water cuts were frequent. Those that did not have access to a borehole or municipal treated water relied on dams and rivers to supply their crops, livestock and households with water. The contamination of water bodies is of particular interest in terms of waste disposal in rural areas, given that communities and industries are directly reliant on these water sources.

Table 5. 3. Challenges faced by emerging farmers based on popularity (multiple responses).

	Frequency (n=50)	Percentage (100%)
Finances	46	92
Theft of livestock	41	82
Access to water	18	36
Lack of Technology	13	26
Food availability	10	20
Waste management	9	18
Climate Change	9	18
Other	4	8



The Midmar dam and Umgeni River supplies, on a yearly basis, 4.8 million people with water within the uMgungundlovu District and eThekwini municipalities (Umgeni water, 2012: 8). Therefore, according to UDM- municipal manager, the pollution sources that are currently threatening water sources are of concern. The establishment of emerging and subsistence farms near water bodies has become a common occurrence in rural regions, particularly in indigenous rangelands (UDM- municipal manager). Control over the exploration of general waste management practices near water sources however is limited due to a lack of funding, staff and public interest (UDM- municipal and DAE- waste manager). In addition, municipalities cannot

remove people from these sites as a result of "political red tape" that limits their authority to enforce polices (UDM- municipal manager). UDM- municipal manager stated that "government organisations do not attempt to intervene on indigenous land in terms of NEMA and bylaws as a result of a lack of willingness to comply with authority". The KwaZulu-Natal traditional leadership and governance bill, 2013 however states under section 29 that in addition to other duties the "*iNkosi* must participate in municipal councils as contemplated in section 81 of the Local Government: Municipal Structures Act, 1998 (Act No. 117 of 1998)" (KwaZulu-Natal, 2013:28).

Being near a water source means easy access to water for crops, livestock and household needs. Farmers therefore see this as a suitable location to establish themselves. This however increases the risk of pollution of water sources. Signs of resource degradation are beginning to show in the uMgungundlovu District municipality. Midmar dam is located within the study area, near the town of Howick. Also a popular tourist attraction, the dam is a source of water for half the population of KwaZulu-Natal (Jogiat, 2014:1). As of August 2014, a warning from the National Department of Water and Sanitation was published in local newspapers, informing the public of KwaZulu-Natal that the level of nutrients, bacteria, detergents and fertilisers within the dam has grown exponentially as a result of residential and agricultural activities taking place on the banks of the dam and the rivers leading into it (Carnie, 2013). Plate 5.4 shows the current state of Midmar dam. With increased nutrient levels, undesirable vegetation has begun to grow within the dam. Although it cannot be seen on the surface, this vegetation is clearly visible with a closer view. The presence of this is an indication of ecological transition and the degradation of water quality. UDM- municipal manager predicts that within the next 18 years the water quality of the entire dam will be such that it will be considered undrinkable and unsanitary to swim in. According to Jogiat (2014:1), pollution within the dam originates from communities and farming institutions, formal and informal, situated in close proximity to the banks of the three rivers flowing into the dam, the Lions, uMngeni and Mooi Rivers. In addition, the dam is situated in close proximity to the Khayalisha and Mpophomeni communities and commercial agricultural operations (Jogiat, 2014:1). Continued haphazard use of these water sources will result in eutrophication of the water source that will ultimately degrade ecological systems that affects downstream systems and the cost of water purification for municipal use.

Plate 5. 4. Panoramic view of Midmar Dam, in addition to a closer view of vegetation growth caused by nutrient overload.

The FAO, (2006:xxii), states that "water used by the livestock sector exceeds eight percent of the global human water use". Water consumption during livestock husbandry is therefore significant particularly in developing countries. Livestock husbandry involves the direct consumption of water through drinking and cleaning practices, in addition to the consumption of water in the production of feed (Chen and Li, 2013:92). However when determining the water footprint of livestock husbandry practices, the degradation of water as a result of these practices needs to be considered (DWA- deputy director). It is required under the DWA policy on the registration of small private non-commercial farm waste disposal sites that farmers complete a DWAF DW 808 registration form in order to gain access to water (DWAF, 2001:1). The aim of this registration is to assist DWA in monitoring disposal sites and water usage (DWA- deputy director). Farmers that produce less than one ton of general waste per day are exempt from registration with the DWA, provided all other environmental health requirements

are met (DWAF, 2001). Registration gives departments some control over emerging farmers compared to subsistence farmers however knowledge obtained from the registration is limited to willingness to comply (DWA- deputy director). Up to 90% of water users within the informal sector, emerging and subsistence farmers, are not registered with regard to any water use (DWA- deputy director). Department and municipal officials therefore face great challenges in terms of the monitoring the sites.

Both waste and municipal key informants have acknowledged that significant portions of pollution originates from subsistence and emerging farmers that use inappropriate waste disposal methods, and are looking into informal waste management practices. It is however nearly impossible to prove in most cases the origin of pollution as generally pollution is found downstream from the point source and could pass multiple potential sources before being detected. In addition, given that most farmers are not registered with DWA, the "polluter pays" principle implemented by NEM: WA cannot be applied effectively. Results obtained from this study indicated that 20% of farmers used water for the cleaning and disposal of animal waste. This being said, results also showed that 94% of emerging farmers had no disposal system in place to collect water that had been used for cleaning or waste disposal purposes. Those that did, opted to keep waste in a tank or drum to be properly disposed of by an appropriate authority.

5.3. Waste Management Technology Needs of Emerging Farmers

This section focuses on the technological needs of emerging livestock farmers with reference to factors that would enhance their livelihoods whilst benefitting the local environment. This is a vast topic as many farmers lack basic resources such as water and electricity, whilst others have established themselves as livestock breeders and are finding it difficult to break into the commercial market. This section therefore looks at current technology needs of emerging livestock farmers and how the improvement thereof would have a positive effect on their ability to progress in terms of the livestock industry and their waste management practices.

Waste management technologies are limited by the resources available to farmers (Agricultural academic). Twenty six percent of the sample group indicated a lack of technology as a challenge faced during livestock husbandry (Table 5.3). None of the farmers however indicated

the use of modern technologies such as incinerators or digesters. During an interview with UDM- municipal manager, future projects that would benefit both the commercial and informal sectors of the South African livestock industry were described. These projects included rendering assistance from other countries such as the Netherlands and Germany to implement projects that have been successful in these respective countries. One of the projects mentioned involves the installation of digesters with the purpose of converting food and livestock waste into renewable energy. Given that some on the largest food and agricultural industries in South Africa, such as Rainbow chicken, are situated in the KwaZulu-Natal Midlands, the province is regarded as feasible for the implementation of the project (UDM- municipal manager). When asked how these projects would affect emerging farmers, UDM- municipal manager stated that initially the project would be implemented in the commercial sector to increase investment and ensure its' success. Thereafter the project would be rolled out to areas closer to emerging farmers to facilitate waste management best practices (UDM- municipal manager). Incentives, in the form of cheaper energy resources and monetary incentives however may be need to be given to encourage rural emerging and subsistence farmers to be more involved in the recycling of agricultural waste.

5.3.1. Waste disposal options

Seventy two percent of respondents stated that they did not have access to a landfill site. This provides some insight as to why respondents generally employed alternative methods of waste disposal. However, the DAE- waste manager argues that the proximity of landfill sites to emerging farmers is irrelevant. The disposal methods employed by emerging farmers are based on cost, convenience and ease of implementation (DAE- municipal manager). The goal of local departments is to reduce waste that is being sent to landfill by 30% within the next three years (UDM- municipal manager). To do this however sustainable alternatives are required. To achieve this building material recovery facilities, in the form of waste sorting facilities and biodigestors, are to be constructed around the district (UDM- municipal manager). Ninety two percent of the farmers that do have access to a landfill site have disposed of animal waste to a landfill site at some point. Questionnaire results revealed that these wastes included feed waste; spoilt animal products or food waste, such as meat and milk; and feathers. The construction of alternative facilities will not only reduce waste being sent to landfill but also would reduce illegal dumping of waste if programmes are implemented in the correct manner (UDM- municipal manager).

In local municipal IWMPs the following alternative disposal methods are recommended (Jogiat, 2010:11)

- Composting;
- Incineration, provided air emission standards are met;
- Biological treatment;
- Clean development mechanisms, such and bio gas collection; and
- Compaction

Of these processes only one (composting) was employed by emerging farmers. These IWMPs however, focus on domestic waste as this poses a bigger threat to the environment (UDM-municipal manager). Domestic waste is generated in large volumes over a relatively small area within the uMgungundlovu District Municipality as a result of existing vast commercial industries and a large residential areas (uMngeni- farm association director). The main focus of local waste management governance in the district therefore focuses on relieving landfill sites without encouraging the use of inappropriate waste disposal systems.

Farmers choose to utilise the most effective disposal optional (DAE- municipal manager). In most cases this means disposing of waste in places where the potential of environmental harm is heightened. The UDM-Municipal manager mentioned that there have been cases of livestock dying in open fields whilst grazing. In order to avoid transportation costs or taking responsibility for the death of the animal, the carcasses are abandoned leaving behind the risk of contamination and affecting the aesthetics of the countryside. Composting was employed by 54% of the respondents (Figure 5.7). Composting however has many pitfalls in that if it is not performed in the correct manner, water and soil contamination could threatens local ecosystems. Composting was however recommended as an alternative waste disposal method by both UDM- municipal manager and DAE- waste manager with local policy providing the following guidelines are adhered to. Burial pits should (DAE- waste manager):

- be no less than 100 metres (m) from the site;
- be done immediately;
- be covered to a depth of at least 6m;
- be at least 90m away from wells or domestic water intakes and 30m away from any other surface water;

- be constructed so that the bottom of the pit is 1.2m above the high water table to facilitate the decomposition of a maximum of 700 kilograms;
- treated with hydrated lime in order to speed up the decomposition process therefore avoiding the infestation of insects and other scavengers; and
- be closed with soil to offer protection from scavengers and the overflow of waste and backfilled each time waste is added in.

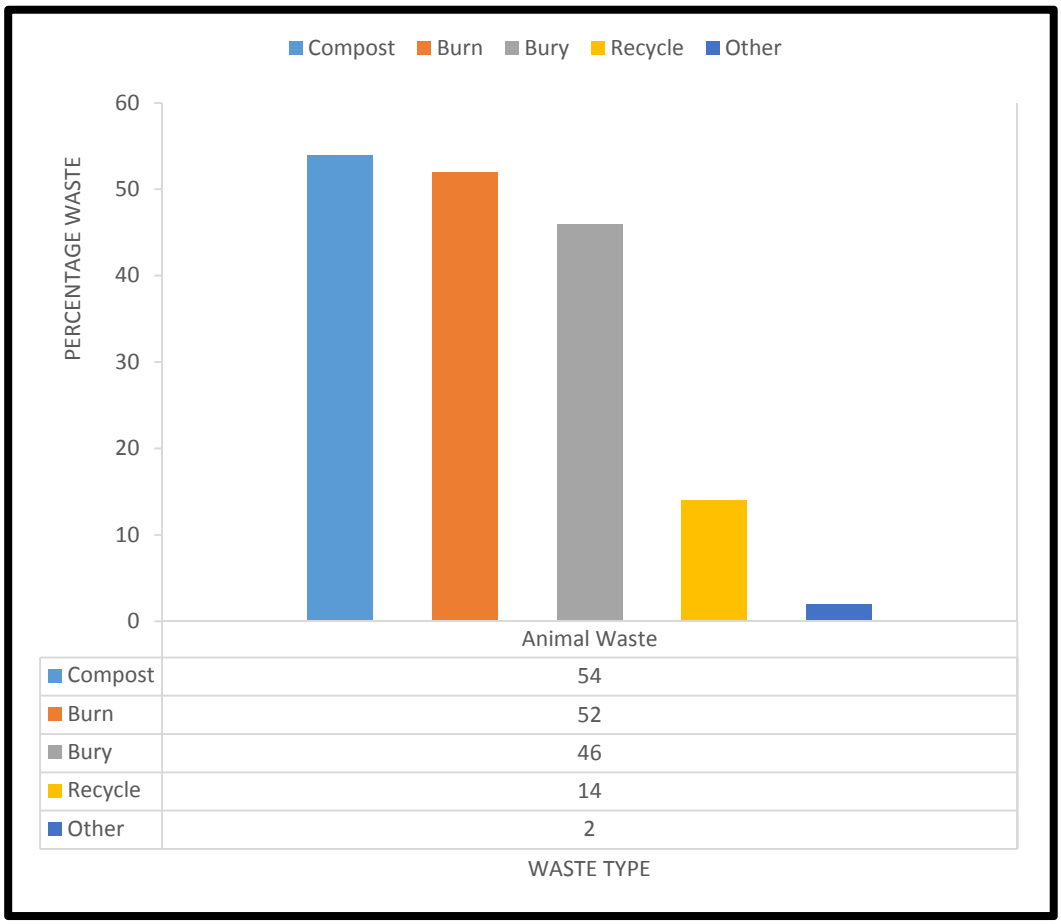


Figure 5. 7. Percent of emerging farmers that implement alternative waste disposal methods (multiple responses) (n=50, 100%).

More than half (52%) of the sample group disposed of their waste by burning it (Figure 5.7). These results confirmed the statement by the UDM- municipal manager that 50% of farmers dispose of waste through burning. The UDM- municipal manager moreover stated that the haphazard burial and the dumping of livestock waste, even though not recommended by policy, is common in the rural areas of the Midlands Meander. Dumping occurs mainly on vacant sites, neighbouring properties, and on river banks. The disposal methods of emerging farmers is

almost impossible to regulate or control. Farmers are distributed across a vast landscapes within which there is little or no regulatory authority present (DAE- waste manager) therefore keeping records are difficult (UDM- municipal manager). UDM- municipal manager also stated that officials find it difficult to rectify problems when there is no evidence thereof. For example, local landfills mostly do not keep a record of waste that comes on site. Those that have been equipped with the necessary equipment have been robbed, losing equipment and the stored information. The constant replacement of such equipment is not budgeted for and it therefore not done when required.

Forty six percent of the respondents (Figure 5.7) buried their livestock waste. The burial of livestock carcasses is widely used amongst emerging farmers. Since animal waste occurs in relatively low volumes on emerging farmer sites and is bio degradable, this method is perceived as acceptable, provided that it is done under specific conditions, and is not likely to cause a nuisance in terms of odour; the acceleration of pest influxes or a health hazard (DAE- waste manager). The burning of waste was not recommended by any of the key informants, largely due to the fact that it creates unnecessary emissions, and is also a nuisance factor in terms of odour and aesthetics (uMngeni- farm association director). Incineration provides an alternative to haphazard burning, being used to destroy infected animal waste to prevent the spread of infectious diseases (Rahman *et al.,* 2009:2). However due to that incinerators require an air emissions licence, further complications for department officials are created with regards to compliance.

Whether the implementation of these alternative methods is acceptable for agricultural waste is not specified by policy or municipal documents (Jogiat, 2010:18). Currently sites located outside of urban areas use their own bags and waste containers to store waste (Jogiat, 2010:18). Furthermore, the municipality only accepts on-site disposal methods given that the process is supervised by an authority on a regular basis (Jogiat, 2010:18). When asked who carries out these functions within the study area key informants that were interviewed stated they did not know whom had been appointed.

5.3.2. Waste management as a challenge to emerging farmers

Waste management practices implemented in terms of livestock management is deemed modest by both emerging farmers and key informants. So much so that most farmers were not

concerned with the implementation of waste management best practices. Respondents were presented with a list of challenges based on the objectives of the study and asked to indicate those that were significant to their livelihoods. Eighteen percent indicated waste management as a challenge (Table 5.3). The justification of the lack of interest in waste management can be seen in Table 5.3, which indicates that farmers have prioritised their challenges, choosing to deal with the problem that currently affects their livelihood resilience the most. According to the DAE- waste manager, all agricultural waste (Table 5.1) produced by emerging farmers is organic and thus biodegradable. Agricultural waste is therefore considered low risk in terms of emerging farmers. Furthermore, the waste volumes produced are significantly low, making emerging farmers less of a priority with regards to the regulation of waste in the agricultural industry (DAE- waste manager). Literature disagrees with this general view, discerning the potential ecosystem degradation that results from poor waste management (Gwyther *et al.,* 2012:2 and Aneja *et al*., 2012:93), as is the case of Midmar Dam which is the main source of water within KwaZulu-Natal.

Ninety two percent of the sample group indicated finances as a challenge (Table 5.3). Finances are largely responsible for the husbandry practices implemented by emerging farmers and therefore the quality of product. For example, a lack of capital may mean a farmer is forced to choose between delivering farm waste to the nearest landfill situated a fair distance away and investing in vaccinations for livestock. Agricultural academic supported this, stating that most emerging farmers cannot afford to purchase excess feed or vaccinate livestock. Farmers therefore do not invest finances or time in the implementation of appropriate waste management practices given that they cannot afford the basic needs of their business (UDM-state veterinarian). Local municipalities have in this case begun to roll out vaccination through national drives to assist farmers however did not keep a record of those farmers that took part in the drive (UDM- state veterinarian). It is this support that local farmers require not only to alleviate financial strain but to also educate farmers about the need of such husbandry techniques (Agricultural academic).

The “other” category mentioned in Table 5.3 referred to recent veldfires and were indicated by two respondents. Both farmers lost livestock and infrastructure on their farm sites as a result of runaway veldfires. In 2014, media sources reported that six people had died and ZAR3million ($ 250,000 US) worth of livestock were lost to runaway veldfires (eNCA, 2014).

In addition vast ranges of grazing land was destroyed which affects the local farming community. Veldfires pose a significant risk to farmers, particularly those that are resource poor. In these cases the loss of livestock would mean the loss of capital. When asked if they could cope with the various challenges experienced in livestock husbandry 28% of the respondents felt that they were not able to whilst 24% stated that they were doing well, 48% stayed neutral on the subject (Figure 5.10).

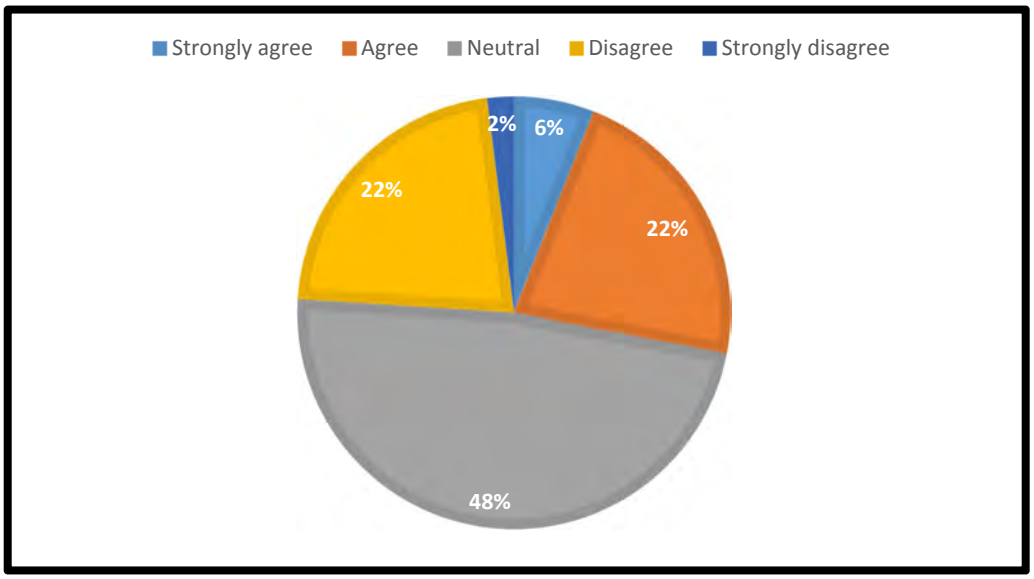


Figure 5. 8. Can emerging farmers cope with challenges they currently face (n=50, 100%).

5.3.3. The slaughter of livestock

Eight six percent of the respondents kept livestock for the purposes of slaughtering. Table 5.4 indicates that farmers are most likely to keep pigs for the purpose of slaughter. The use of an abattoir to slaughter livestock was more popular than on-site slaughter (40% and 36% respectively) (Figure 5.9). Ten percent of respondents used both methods. This is however largely based on the number of livestock being slaughtered and for what purpose. uMngeni-farm association manager indicated that on-site slaughter is generally implemented for traditional purposes. This was confirmed by two respondents, one that was in the midst of preparation for a ceremonial event whilst being surveyed and the other that slaughtered livestock for sale using traditional methods.

Table 5. 4. Number of farmers that keep livestock for slaughter purposes per species.

Livestock	Number of farmers that keep livestock species		Number of farmers that slaughter livestock species	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Cattle	33	66	14	28
Goat	25	50	17	34
Chicken	20	40	13	26
Pig	8	16	5	10
Sheep	18	27	13	26

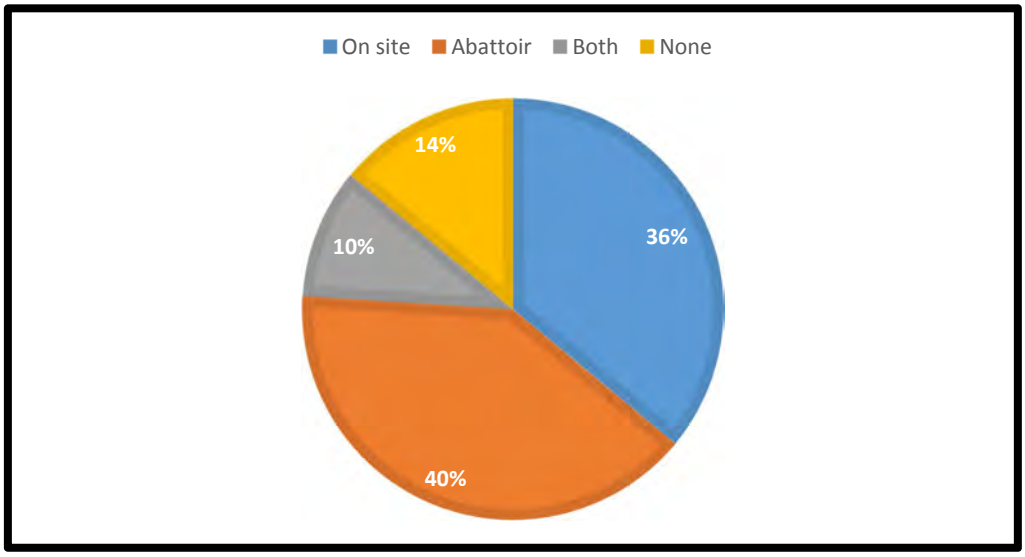


Figure 5. 9. Slaughter of livestock (n=50).

Figure 5.10 shows the percentage of households that slaughter various numbers of livestock. Results indicate that all respondents that partake in cattle, goat, chicken and pig agriculture, slaughter livestock monthly (Figure 5.10). Furthermore, emerging livestock farmers slaughter between 1 and 10 livestock within a species per month. This is however dependent on the market that the respondent deals with, in addition to the number of livestock that is available on site.

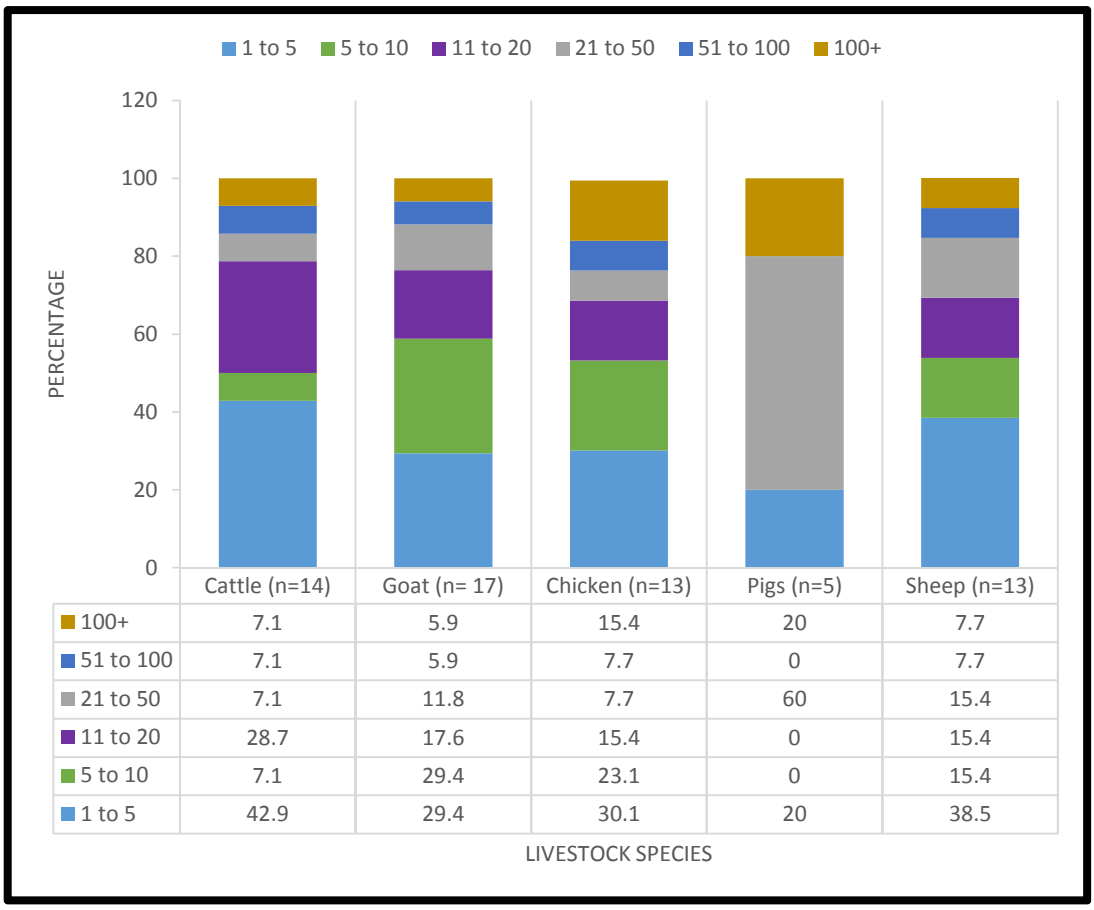


Figure 5. 10. Number of livestock slaughtered by respondents within a month.

The generalised acceptable slaughter age and weight as proposed by the commercial livestock sector, according Commercial farm manager, differs from that of emerging farmers as a result of farmers keeping livestock for multiple reasons. Many emerging famers in South Africa keep livestock for insurance and traditional reasons (Agricultural academic). These farmers slaughter or sell livestock when the need arises. For example, for a cultural ceremony or when money is needed (Agricultural academic). Livestock kept by traditional or emerging farmers are therefore expected to live to an older age. Results varies significantly between farmers shedding some light on that they face various challenges and have different coping strategies. It is likely that those respondents that slaughter livestock at a lower weight and young age do so to provide for a more commercialised market (Table 5.5). Livestock slaughtered at a younger age, according to SAFA (2013), is more tender and therefore in high demand in terms of commercial markets. The age at which respondents slaughtered their livestock did not differ by a large degree to prescribed guidelines as provided the UDM- state veterinarian. This gives

further evidence that the respondents are intend to break into commercial markets (Figure 5.11).

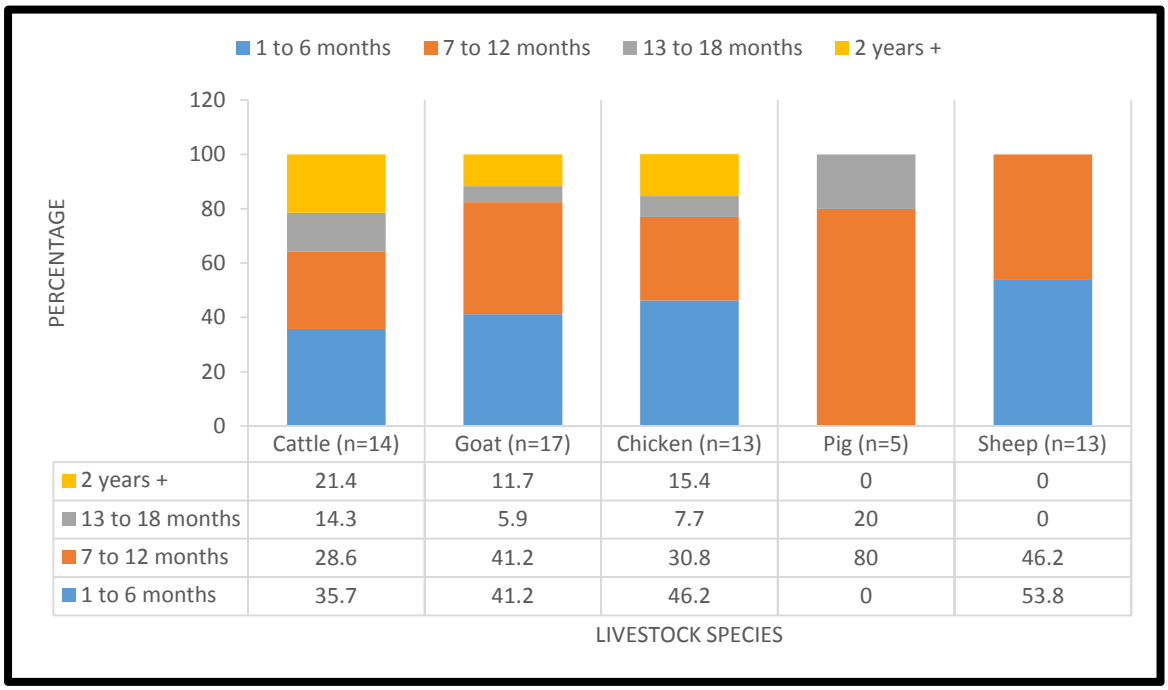


Figure 5. 11. Age at which respondents slaughter livestock.

Plate 5. 5. An emerging farmer transporting calves to a nearby slaughterhouse.

Table 5. 5. Acceptable age at which to slaughter livestock as per the UDM- state veterinarian.

Livestock	Age prescribed for emerging farmers	Study results (emerging farmers)	Lifespan
Cattle	1-2 years	Within the first year	30 years
Goat	3-6 months	Within the first year	16 years
Sheep	3-10 months	Within the first year	15 years
Pigs	3-6 months	Between 7 and 18 months	15 years
Chicken	6 weeks	1Within the first year	10 years

Waste obtained from on-site slaughter activities was dealt with in the same manner as other organic wastes. Farmers did not differentiate between wastes but rather concentrated waste using one disposal method. For example, farmers that employed composting as a disposal method, added to the compost site whenever organic waste was available. Since the on-site slaughter of livestock is assumed to occur seldom, it is therefore not treated as threat to natural resources.

5.4. The influence of policy on emerging farmers

This section looks at the effect that policy has on emerging farmers from the perspective of emerging farmers and that of municipal officials. During the data collection process four municipal officials were interviewed as key informants. These key informants were stationed in the following governmental departments:

- Manager of municipal function – uMgungundlovu district Municipality
- Waste Manager – Department of Environmental Affairs
- Deputy Director – Department of Water Affairs
- State Veterinarian – uMgungundlovu district Municipality

Despite their various positions in different departments. These key informants shared similar view surrounding the husbandry methods employed by the informal sector of the South African livestock industry.

5.4.1 Agriculture as a solution to past injustices

The challenges the questionnaire participants were found to face on a daily basis varied drastically, however there was one trait that was apparent in each case; all participants have, or have had at some point in their farming career, intentions of growing their farm to enter into the commercial sector. This being said, many emerging farmers are currently apprehensive to do so given the current situation of land reform within South Africa and the instability that newly implemented policies have caused. When participants were asked questions regarding land ownership they expressed fear with regards to their safety and food security. One respondent stated that the "security of not just our futures but our lives are now at risk and I have to re-evaluate the future of my family and business ventures". These fears stem from the reopening of the 1994 Restitution of land claims Act on the 30 June 2014, which will last five years, to rectify the failures of previously implemented land reform policies.

Agricultural policy and legislation is not aimed at emerging or subsistence farmers. This is clearly evident by the struggles these individuals face. Farmers that took part in the questionnaire stated that municipal departments sometimes pay unexpected visits and implemented policies and bylaws which they cannot afford to abide by. This was expressed by all pig farmers included in the study. In two instances farmers have invested in a different livestock species to avoid the challenges that stem from pig husbandry. Of the farmers surveyed only 22% have knowledge of the livestock husbandry guidelines prescribe by the KZNDAE. Since this information is accessible via the KZNDAE website, it is safe to assume that majority of emerging farmers and subsistence farmers do not have access to this information and are not aware that there are guidelines available to assist them in implementing best practices that would assist in the transition to commercial farming. Like national policy and legislation, the KZNDAE guidelines are also adapted in most aspects to commercial farming practices. However due to land reform policies, an effort is being made to assist rural farmers through the installation of dip tank facilities and initiatives like vaccination programmes (UDM- state veterinarian).

In line with literature, apartheid injustices were apparent in the education amongst the older individuals within the sample population. Six percent of the sample population had no schooling whatsoever (Figure 5.2), all of which lie within the 36+ age group. Similarly, 20% of the sample population indicated that they had only received a primary education (Grade 0-

Grade 7) (Figure 5.2). Of this, 60% lie within the 36+ age group. A lack of education means that individuals rely on farming knowledge that was passed down from previous generations to successfully run a farm. A lack of education however limits the ability of an individual from converting their farming practices into an income and thus enforcing the stability of their livelihood. According to agricultural academic, within rural areas, children are faced with the decision of going to school or leaving school in order to find work to help support a poverty stricken household or help with agricultural activities. This situation has not changed with the abolishment of apartheid. In addition, the implementation of the Bantu Education Act of 1954 during apartheid, enforced that even those that were able to attend school, received an education of poorer quality (Keswell, 2005:2).

Agricultural practices have also been implemented as a medium of rectifying past injustices and giving poorer communities the opportunity to establish sustainable livelihoods whilst benefiting the country at a national level by increasing food security. Agricultural department key informants indicated this as being the reason behind government and municipal institutions having invested a great deal of time and money into improving not just the emerging livestock industry but the South African livestock industry in general.

5.4.2. Support given to emerging farmers

Results indicated that only 30% of farmers received financial support from outside sources. The most common form of financial support however was not from municipal or NGO initiatives, which only four percent and sixteen percent of the sample population received respectively, but rather loans obtained from banks and help from surrounding commercial farmers and private institutions. A large majority (86%) of those that received support felt that this was enough to support their livelihoods as it allowed them to invest in more land and livestock.

Investment in the livestock farming sector as is largely centred on the commercial livestock sector (uMngeni – farm association manager). Despite this there are opportunities for small scale farmers. For example, Commercial farm manager, indicated that his institution amongst others provide assistance to neighbouring emerging farmers in terms of finances, land usage and education without any incentives. DAE- waste manager however indicated that currently municipal institutions appear to be more focused on the commercial sector in terms of industry

control and mitigation of environmental challenges and waste management as it is most likely that larger farming operations that are responsible for environmental injustices created by the livestock farming industry but also because there is greater sense of control and willingness to participate in the commercial sector than with emerging farmers.

According to the DWA, policy on the registration of small private non-commercial farm waste disposal sites, it is stated that "the risk of pollution posed by small non-commercial farm disposal sites to the quality of the water resource, especially the quality of drinking water, is regarded as negligible" (DWAF, 2001:1). This statement is made on the assumption that environmentally feasible disposal methods such as sump-attenuation dams, small pits and solute settlers, are employed and that the burning or burial of waste is done at insignificant volumes. These assumptions in conjunction with the views expressed by key informants, gave a clear indication that the farming practices, in particular waste management practices, used by livestock emerging farmers is considered negligible and is of low priority. The European Commission (EC) (2012:6) disagrees with this lack of industry interest in emerging farmers stating that rural emerging farmers are not only the producers of food but are also responsible for the management of the environment and therefore provide a service to present and future generations (EC, 2012:8). Emerging farmers in EU countries are therefore responsible for environmental wellbeing through their implemented farming practices and provided with incentives for not only controlling pollution levels but for improving their local landscape.

A lack of municipal interest was apparent amongst local emerging farmers with 96% of the survey participants stating that they had not received any assistance from a municipal source. One of these farmers stated that the municipal departments made it difficult to grow as a farmer with the implementation of policies that are suited to commercial farmers and as he could not afford to abide by municipal policies he had subsequently for his pigs and invested in cattle and goats. He states, "Emerging farmers simply do not have the resources to comply with all municipal requirements and are therefore faced with pressure from the municipality." This is where support from other organisations come into play.

5.5. The role of emerging farmers in national and local food Security

The focus of this section is to explore the role of rural emerging farmers in the local and national food security of South Africa. Livestock is a staple source of food security and local economic growth. Livestock therefore serves as a direct source of food in addition to an income source. Livestock products listed in the study survey included: milk, meat, hide, cheese, yogurt, feathers, manure, eggs and wool (Table 5.6).

Table 5. 6. Products obtained from livestock (n=50).

Livestock	Product
Cattle	Meat, milk, hide, manure, dairy products (cheese, yogurt)
Goat	Meat, milk, hide, dairy products
Chicken	Manure, eggs, meat
Sheep	Wool, meat
Pig	Meat
Duck	Meat, feathers

Larger herds consisted of cattle, goat and chickens in both male and female households. These livestock breeds are popular within the livestock markets and easier to maintain. Female headed households keep a variety of livestock breeds (Figure 5.4), as this increases their livelihood resilience. In addition, female headed households keep a similar, if not larger herd of livestock compared to male headed households (appendix 9). This contrasts to previous studies that have shown that woman keep smaller animals and smaller herds thereof as a result of traditional laws that states that woman should not handle specific livestock. Furthermore, smaller animals are easier to deal with and more manageable within female headed households therefore literature assumes that this would be the expected choice of female farmers. The employment of help has assisted greatly in this regard. Survey results indicated that 78% of women had employees to help on their farm site. Furthermore, 80% of the respondents have their family perform chores around the farm site. In a study conducted by de Villiers (2005:72) in Obonjaneni, KwaZulu-Natal, revealed that 88% of male respondents indicated that their spouses participated in agricultural activities whereas only 22% of the female respondents indicated that their spouses took part in household agricultural activities. The reasoning being these statistics again lies in that the men of the household leave to urbanised areas in pursuit of a larger income.

Local markets are difficult in terms of access to customers. Many livestock farmers have therefore found alternative, less traditional methods of reaching their target market. For example, farmers were found to sell livestock products at local farmers markets such as Shongweni Farmers Market and livestock exhibitions, such as the Royal show. Many farmers travelled fair distances to attend these markets to gain access to a customer base.

Within the bigger picture, livestock husbandry increases national food security as it creates a market within which the local poor can indulge in and receive quality products; as well as creates jobs for community members thus improving livelihoods within the community and by creating and income and sustain farming households. Results indicated that 50% of respondents keep livestock as a personal source of food. In addition 80% sold or shared meat and other livestock products (80%) (Figure 5.12). Those households that shared food were households where livestock farming was the main or only source of income.

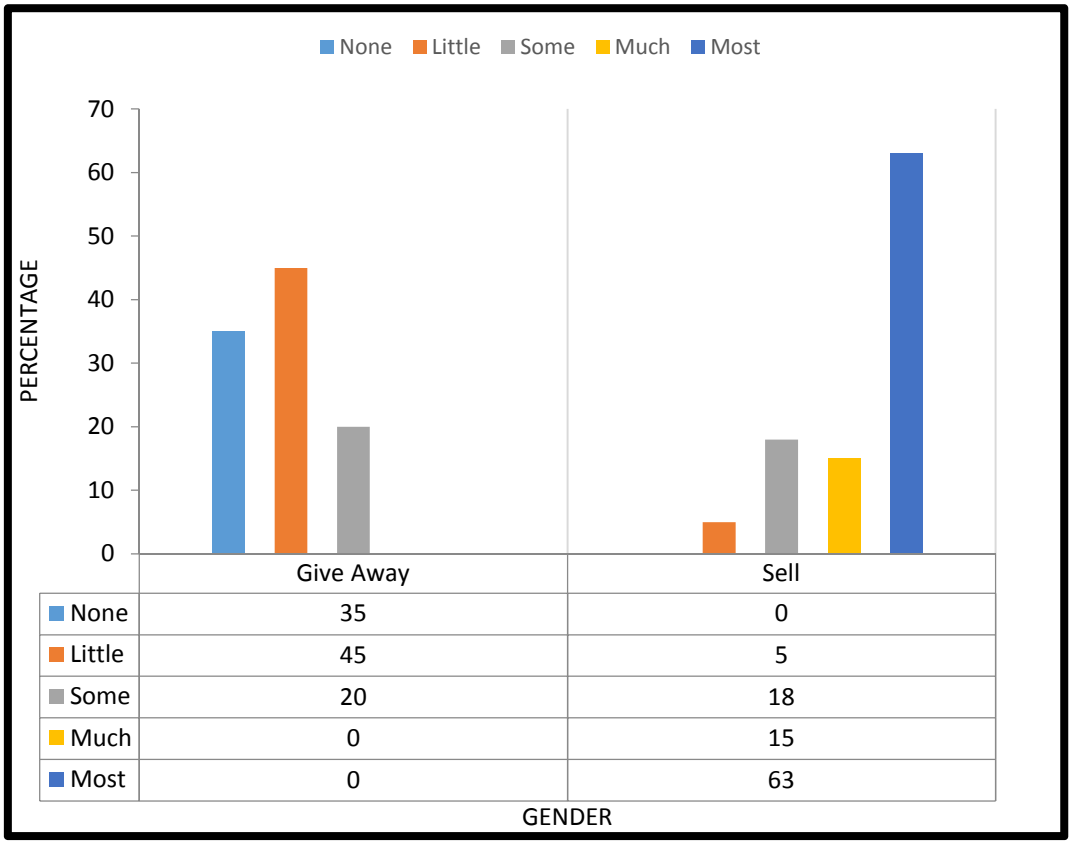


Figure 5. 12. Percentage of animal products sold and shared with community members (n=50).

Thirty percent of the sample population indicated that livestock farming as their primary source of income. Of this, 13% stated that livestock farming was able to sustain their livelihood. Amongst the respondents, 82% employed community members. Collectively at least 170 community members are employed amongst the 50 respondents that took part in the study (Figure 5.13). This alone is evidence of the vital role that emerging farmers play in terms of stabilising livelihoods within their community.

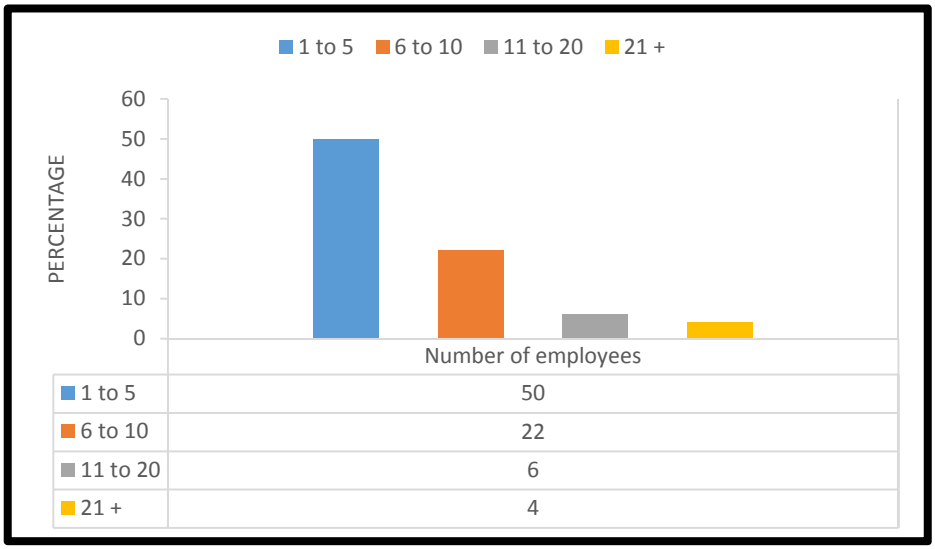


Figure 5. 13. Number of employees employed by respondents (n=41).

5.5.1. The importance of proper waste management to local food security.

Results indicated that 38% of the respondents indulged in cropping in addition to livestock farming indicating that multiple livelihood strategies are employed in the area. Being faced with challenges such as climate change, farmers increase their resilience by indulging in multiple strategies. When asked if they thought that livestock farming was more beneficial to their livelihood than cropping, 36% of the sample group disagreed (Figure 5.14), whereas 24% agreed. Forty percent of the sample group remained neutral. The reasons behind this may be either that they were not sure or had not indulged in cropping. The nutritional quality of the products produced is as significant as access to food. De Villlers (2005, 70) claims that within the KwaZulu-Natal Midlands, 35% of households had children who had stunted growth. This is a direct indication of poor quality agricultural production.

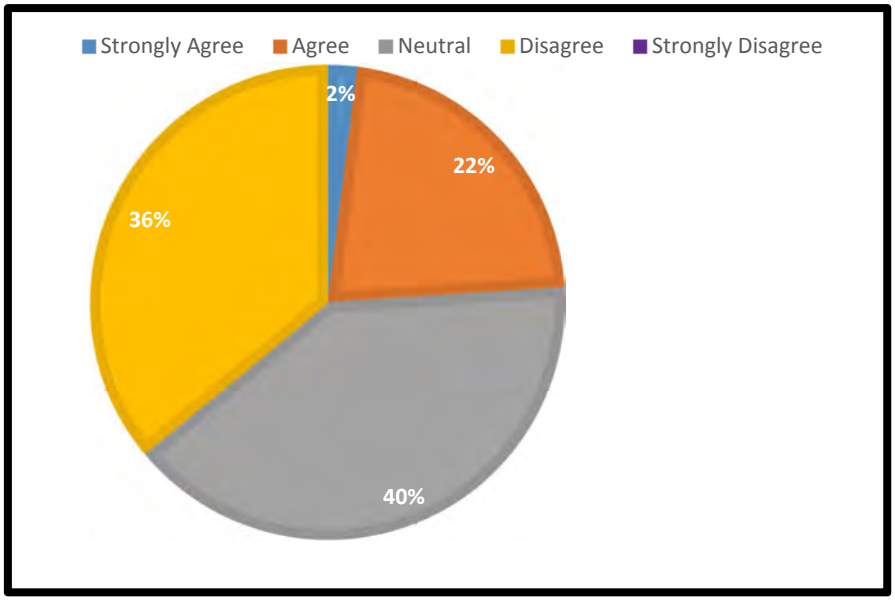


Figure 5. 14. Livestock farming more beneficial than cropping (n=50).

The use of livestock manure proved to be more popular than chemical fertilisers with 42% using manure only to fertilise their crops (Figure 5.15). Twenty eight percent of the respondents employed both manure and chemical fertiliser (Figure 5.15). According to Makhabela (2004:348) this is done as a result of manure not providing enough nutrients to soil. Conversely the inappropriate use of manure and fertilise man result in excess nutrients within the soil leaching into water bodies and cause eutrophication (Martinez *et al.*, 2009:5529)

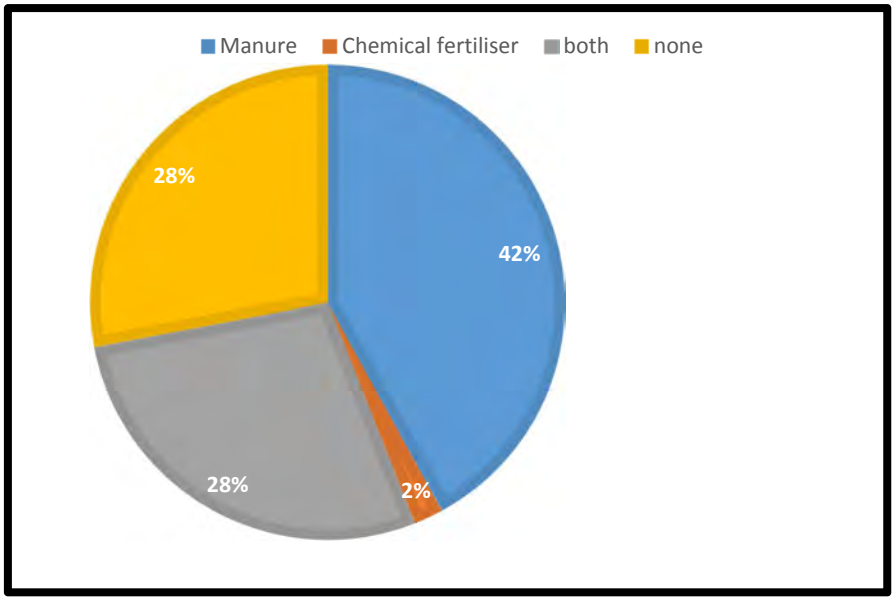


Figure 5. 15. Means of fertilising of crops (n=50).

5.5.2. Heath care and pest control

Health care is extremely important to livestock farmers, particularly in rural areas where the loss of livestock greatly affects the resilience of one's livelihood. Due to a lack of finances, majority of farmers (56%) had their livestock checked by a veterinarian when necessary. (Figure 5.16). Sixty six percent of respondents administered vaccines for various reasons to their livestock. Those that did not stated a lack of financial security as a reason as well as they did not feel it was necessary. Those that did vaccinate their livestock did so for a magnitude of common diseases, including pasturella and blue tongue (Table 5.7).

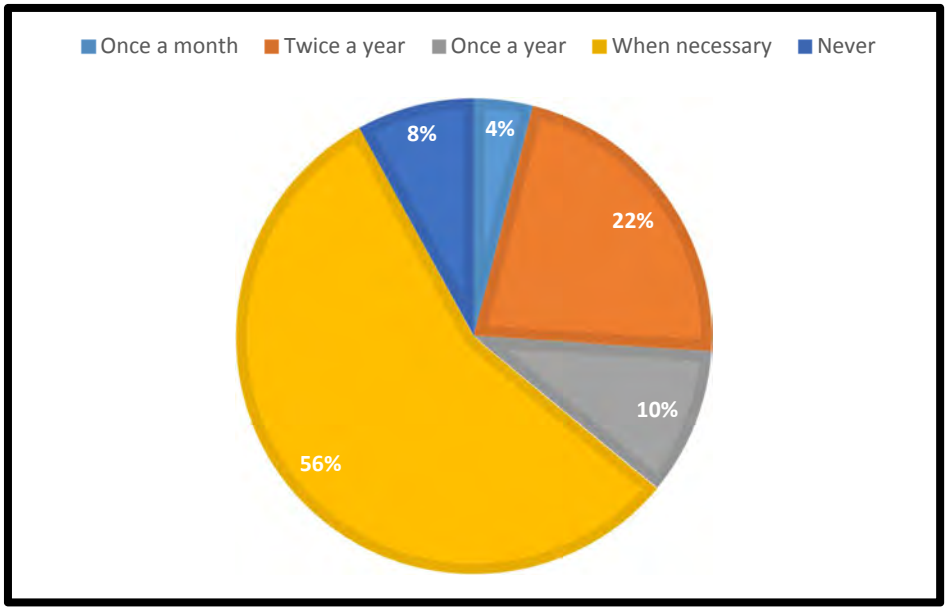


Figure 5. 16. Frequency of visits by a licenced veterinarian (n=50).

Table 5. 7. Disease perceived to be a threat to livestock in the KwaZulu-Natal Midlands.

	Cattle	**Goat**	**Sheep**	**Pig**	**Chicken**
Vaccination for..	Pasturella	Pasturella	Pasturella	Diamond skin	Fowl pox
	Blue tongue	Bacterial sours	Blue tongue	Fever	
	Worms	Joint illness	Pulpy Kidney	Mange	
	Foot and mouth	Pneumonia	Foot and mouth	Diarrhoea	
	Mange	Worms	Worms	Pests	
	Pests	Pests	Pests		
	Anthrax	Mange	Scabby mouth		
	Red gut		Scapie		
	Tick borne fever		Epididymitis		
	Rift valley fever		Rift valley Fever		
	Botulism				
	Blackquarter				

According to UDM- state veterinarian, emerging farmers utilise a number of animal care options. These include licenced veterinarians; traditional healers; advice from neighbouring farmers; and department store medication and pesticides. The most commonly used avenue is department store bought products (UDM- state veterinarian). Pest control is a significant problem to livestock emerging farmers as it threatens the health of their livestock; the quality of products and damages the hide. Ninety seven percent of the respondents employed dipping as a form of pest control. Within the sample group that indulged in dipping as a control method 30% had access to a public or a personal dipping tank station. The remaining farmers resorted to paying neighbouring farmers for the use of facilities or employed at home dipping kits bough at local department stores. Dipping intervals varied from farmer to farmer, however the majority dipped their livestock when it was required (63%) (Figure 5.17). Alternative pest control methods used were: pour on dips; spray dips; and injections. With regards to the waste management of excess dosing or dipping products, none of the farmers included in the study took precautions to avoid environmental pollution or had measure in place to dispose of pesticides.

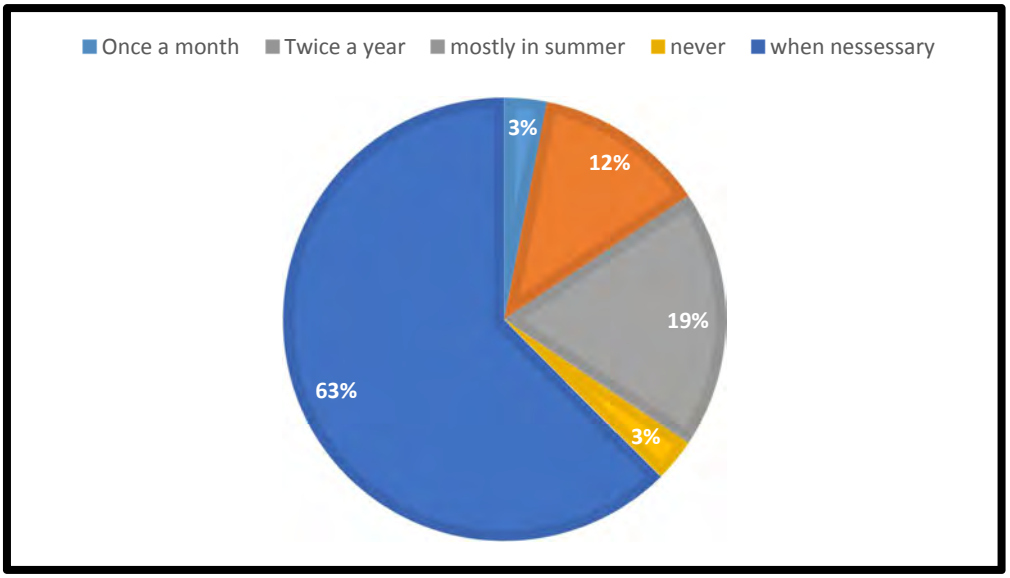


Figure 5. 17. Regular dipping of livestock (n=50).

Livestock dips contain chemicals such as cypermethrin, which according to United Kingdom regulation (2006:1), have the potential to cause pollution in water sources and affect wildlife in various manners. Within the United Kingdom, dipping solutions that contain cypermethrin were temporarily banned in order to preserve and rehabilitate rivers (United Kingdom regulation, 2006:1). According to United Kingdom regulation (2006:1) cypermethrin can kill insects and crustaceans even at low concentrations. Furthermore, sheep have been found to die after drinking affect water sources, therefore it has the potential to kill invertebrates as well (United Kingdom regulation, 2006:1). Other chemicals that may be harmful to the environment in varying degrees include organophosphates, arsenic- based compounds amongst others. Both UDM- state veterinarian and DAE- waste manager expressed similar opinions in that they feel that farmers should refrain from dipping their livestock too often as this lowers the resistance of livestock to local diseases. This is supported by international policies that encourage non-chemical methods of pest control, but is only effective for farmers who keep indigenous livestock breeds. These livestock are more resilience to local pests, climates and vegetation therefore farmers, such as those keeping imported dairy cows, would be obligated to take precautions.

The exposure of farm workers to agricultural health hazards has come into focus over the last decade with the enforcement of labour laws in South Africa. Farm workers are required to use protective clothing when handling livestock to prevent physical harm and infection. During the

survey process however only one farm site was noted to employ protective equipment during slaughtering activities. The use of sanitation and protection, like waste management, is subject to the current financial status of the farm.

5.5.3. Protection of livestock

The theft of livestock affected 82% of the sample group at some point or another. The loss of livestock means a loss of resources that would otherwise bring some form of income or security. Furthermore, of the farmers that had experienced a decrease in one of their livestock herd, 62% was due to theft. Farmers have been noted to have lost up to 50 sheep in one night to theft, with no hope of retrieving it. With little help from the local authorities farmers have employed security measures such as electric fences, security guards/ herders and dogs. Within the sample population, 86% employ fencing as a form of control of livestock (Figure 5.18). Furthermore manual herding of livestock by family member or employees is common within rural areas to ensure the safety of livestock (Plate 5.2). In cases where these practices cannot be afforded livestock roam free (24%) (Figure 5.18). Precautions however have not deterred the crime levels. The fencing of plots of land is widely implemented not only to protect livestock but is also used to control livestock grazing patterns and plays a crucial role in land rehabilitation practices (i.e. Rotational grazing). According to emerging farmers free range grazing presented the best distribution method of manure, in terms of finances and work load, therefore farmers used the fencing of portions of their property as the main form on control of livestock to distribute fertilizer and control land remediation. Other reasons that were cited for a decrease in livestock herds included slaughtering and the sale of livestock.

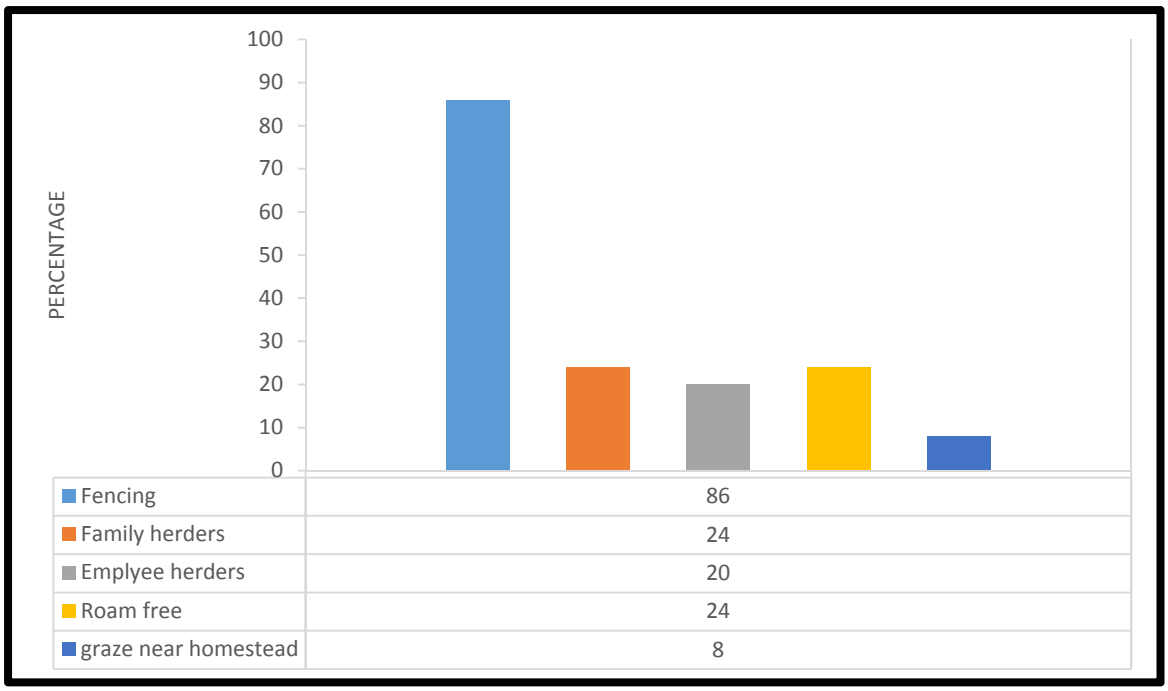


Figure 5. 18. Supervision of livestock during grazing (Multiple responses) (n=50).

In Botswana, the Department of Animal Production, Ministry of agriculture, have implemented the Trace-Back System to combat the theft of livestock (Practical Action, 2004). This system employs a digital ID that uses radio frequency identification technology (Practical Action, 2004). The microchip used is coated in ceramics and swallowed by livestock. To ensure the use and success of the project, legislation was created that forces farmers to identify livestock before it is slaughtered or sold (Practical Action, 2004). Theft is also a problem experienced by commercial farmers however they are in a better financial position to recover from the losses. In South Africa there are tracking systems for sale to farmers however it is not required under policy or legislation and deemed an expensive option for emerging farmers (approximately ZAR15,000 ($1,200) to protect a herd of 10 livestock for 6 months).

5.6. Knowledge Network system of emerging farmers within the KwaZulu-Natal Midlands

In this section the use of traditional knowledge in current farming system is discussed. Given that the subjects of the study originate from various backgrounds, traditional knowledge was considered as agricultural knowledge passed down from the previous generations either through everyday family life or cultural traditions.

Fifty two percent of the sample group indicated that their livestock had traditional significance. Furthermore indigenous traditional farmers have a vast traditional knowledge surrounding the characteristics of livestock that assist them in livestock husbandry. This knowledge for example helps farmers determine which cattle produce the most milk. Traditional uses of livestock noted by respondents varied depending on the culture (Table 5.8). Within Zulu households, for example, cattle are an indication of wealth. In addition livestock are used in cultural traditions such as *lobola*, and slaughtered at ceremonies in celebration. Cattle are generally slaughtered at weddings whereas goats are consumed at funerals and cleansing ceremonies. Other ceremonies that include the slaughter of livestock within the Zulu culture include, coming-off-age ceremonies and child birth. Other cultural significance in terms of livestock encountered in the study was a livestock trader, who purchased and sold livestock to the Muslim community. He slaughtered livestock in the traditional manner to cater to a specific needs of his consumer base. He kept various types of livestock and also sold livestock to other farmers and breeders, based on customer needs.

Table 5. 8. Traditional knowledge used in livestock husbandry observed from the questionnaire.

Tradition	Culture
Thin skinned cows are used in diary production	Zulu
Castration of cows and goats increases weight gain	Zulu
Livestock with kind look have a tendency to perform well	Zulu
Flat boned cows have healthy meat	Zulu
The slaughter of livestock pleases ancestors.	Zulu
The individual performing the slaughter of livestock must be Muslim	Muslim
Livestock are cut at the throat and blood drained before the head is cut of	Muslim
Halaal slaughter methods keep meat fresh for longer	Muslim

In terms of the use of livestock, the main reason for livestock husbandry amongst emerging farmers that kept various species of livestock was for monetary reasons (Figure 5.19). In addition 48% of farmers within the sample group considered their livestock to play multiple roles. For example, cattle may be bred for consumer purposes however are also a symbol of wealth within the Zulu community. In addition a farmer may keep chickens as pets (for personal reasons) whilst harvesting eggs.

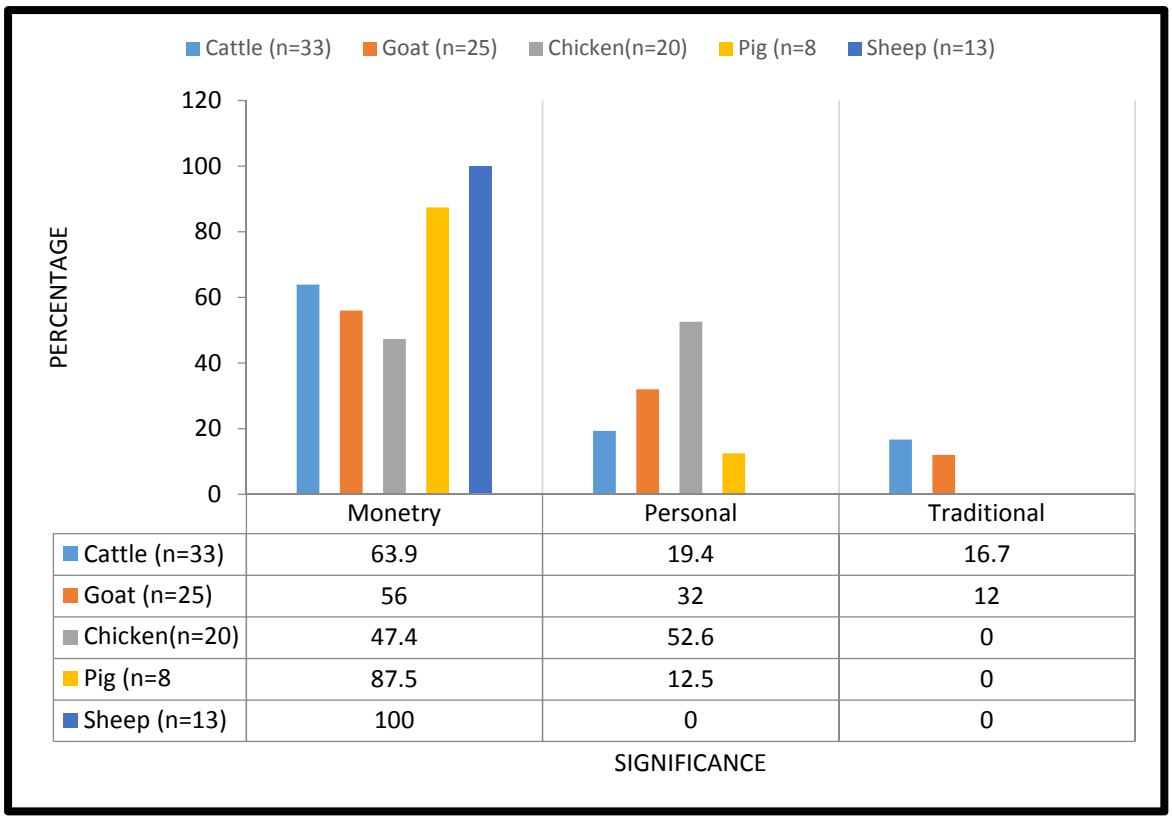


Figure 5. 19. Significance of livestock (multiple responses) (n=50).

Results suggest that women headed households are more likely to keep livestock for multiple reasons (Table 5.9). The International Fund for Agricultural Development identified women headed households and smallholder farmers (emerging and subsistence farmers) as two of the three groups that are most vulnerable to food insecurity, citing stagnated agricultural production, economic and social difficulties, and the migration of male household heads to urbanised areas as reasons (Mtshali, 2002:39). The other vulnerable group being nomadic pastoralists (Mtshali, 2002:39).

Table 5. 9. Use of livestock (n=50).

		Purpose		Total
		Single	**Multiple**	
Gender	**% Female**	24	32	56
	% Male	14	8	22
	Total	52	48	100

The results obtained by de Villiers (2005, 79) differed from this study in that cattle were found to be most popular for cultural purposes (37%) followed by the production of milk and meat

(29 and 13% respectively). In addition, farmers were noted to keep livestock for the purpose of financial insurance (17%). The difference in results can be attributed to the locality of this study area, given that it is a distance away from urbanised cities compared to that of this study.

In a study performed in 2006 by Kunene and Fossey (2006, 1), livestock farmers utilised traditional herbs such as *sarcostemma viminale* (igotsha) and *Rhocissus tredentat* (isinwazi) to stimulate the production of livestock products. For example, to increase milk production in cattle, increase growth and improve reproduction rates. Within this study however farmers were noted to rely mostly on department store drugs to treat livestock (56%) whereas only 16% of the sample population utilised traditional methods (Figure 5.20). Many farmers utilised more than one health care service largely due to cost however results show that modern medicines and services are preferred (Figure 5.20). Eighteen percent of the sample population claimed that they employed traditional knowledge with regards to their husbandry methods. Some of the traditions mentioned were not employed by farmers themselves however they are aware of subsistence farmers that firmly do indicating that the use of traditional knowledge is not always implemented. Forty eight % of the respondents stated that family members had relocated to a more urbanised location in search of better opportunities. This however indicates a further loss of indigenous knowledge. Other countries, such as the United Kingdom, are faced with similar dilemmas in that the younger generations are relocating to cities in search of job opportunities and a glamourized lifestyle leaving the agricultural sector with a shortage of labour (EC, 2012:9).

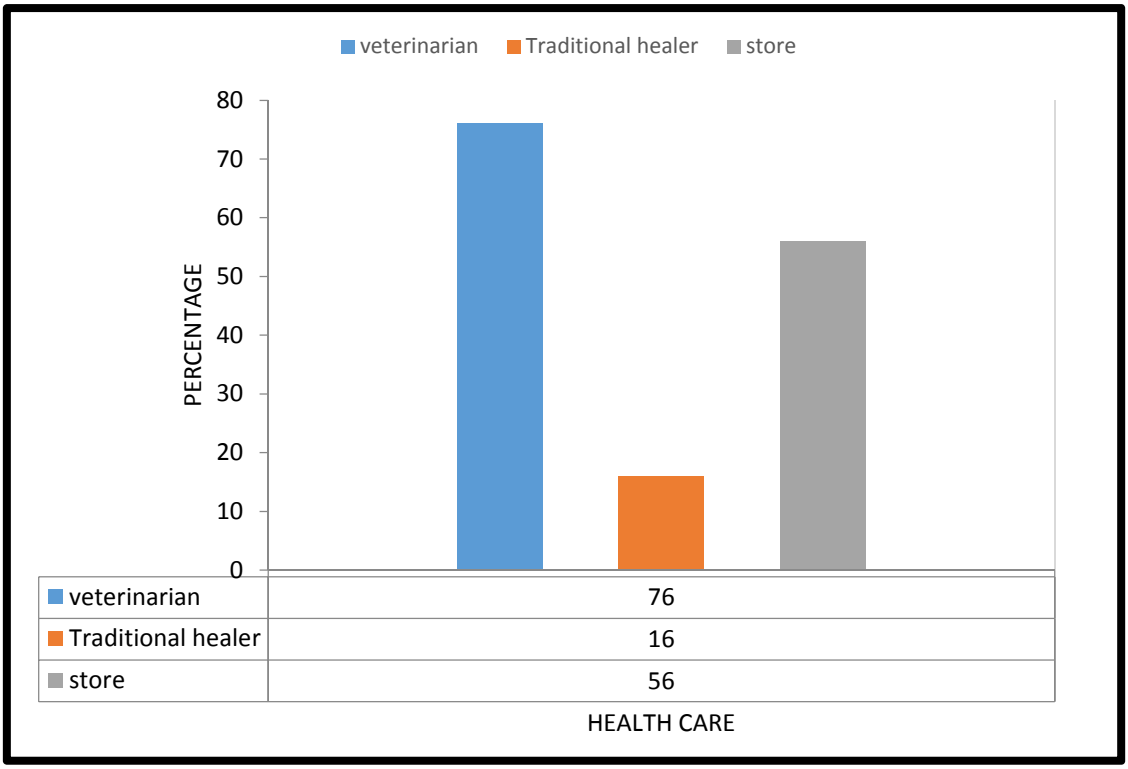


Figure 5. 20. Preferred livestock health care services (multiple responses) (n=50).

Eight percent of the sample population claimed to use traditional knowledge in the disposal of waste. These disposal methods included the use of manure to coat floors. This was done by "mixing cow dung with sand gathered from ant hills and spread across the floor". Thereafter the floor is polished with a stone. Other traditional waste disposal methods included the burial of waste however generally in terms of traditional livestock husbandry and waste management, livestock are self-sustaining and low maintenance.

Overall farmers did not differentiate between traditional and modern husbandry practices indicating that the majority of emerging farmers implement simplistic, cost effective methods. With 36% of female and 14% of male respondents indicating the implementation of traditional methods, results showed that female headed households handled livestock in a more traditional manner than the male respondents. Results from a study carried out by Mtshali (2002, 211) in Ubombo and Umthumzini, KwaZulu-Natal concurred with results, finding that in both areas gender acted as a significant factor in livelihood security and that women had a richer indigenous knowledge than their male counterparts. According to Mtshali (2002, 211), "women take heavy responsibilities of reproductive, productive and community management risks. Men often find wage employment in order to make financial contribution to the

household but they do not ensure that the household is food secure". Similarly all respondents that implemented traditional knowledge were over the age of 35. Key informants did not know much regarding the cultural significance of livestock in KwaZulu-Natal, focusing on policy and best practice. Therein lies a gap in the livestock industry and the lack of recording of indigenous knowledge.

5.7. Conclusion

Overall, the study describes that farmers live in various situations and circumstances despite being faced with the similar challenges and employing similar farming methodologies. Results indicate that historical factors play a significant role therein as a result of a lack of skills training coupled with additional challenges that have not been mitigated. With the use of thematic analysis the results showed clear trends in terms of waste management. Farmers generally employed waste management practices that were cost effective and convenient to their lifestyle. There was a clear indication the farmers that were more stable, were more involved in implementing best practices with regards to both livestock husbandry and waste management and were more aware of threats to their surrounding environment. Emerging farmers are limited by two significant factors, their circumstances, in terms of resources and market access, and finance. All farmers interviewed were keen to establish themselves within the commercial livestock industry, given the opportunity, and many keen to do so using organic practices and with the use of environmentally friendly technologies as they recognise that future markets are more conscious of the manner in which livestock are reared. With a lack of resources and education the challenges that emerging farmers face are heightened. With mounting challenges, waste management best practices have been ignored.

CHAPTER SIX: CONCLUSION

6.1. Introduction

To conclude, this chapter summarises the outcomes and key findings of each objective of the study. In addition, recommendations were identified during the study are given in order to encourage the exploration and mitigation of waste management practices through financial and livelihood security in the emerging livestock industry.

6.2. Key Summary

The aim of this study is to evaluate the existing waste management practices and the triple bottom line impacts on the emerging livestock industry in the KwaZulu-Natal Midlands. Waste management is closely linked to livelihood security in terms of South African emerging livestock farmers. Being faced with a range of challenges and a competitive market, emerging farmers are forced to prioritise issues rather than make environmentally sound decisions. South African agriculture has been employed as a political tool to correct past injustices through the improvement of livelihoods and job creation. In addition, smallholder agriculture plays a vital role in achieving food security in local communities and has the potential to respond to climate change through land remediation and organic husbandry practices. Through the implementation of proper waste management practices emerging farmers have the opportunity to create a closed sustainable system in which waste is fed back into the agricultural system, thus avoiding resource degradation.

The triple-bottom-line (people, planet, prosperity) bases sustainability on three dimensions (economic, social and environmental). Emerging farmers are directly affected by their natural resources. Proper waste management therefore improves upon all three dimensions by contributing to food security and energy production

Objective One: To investigate the waste management practices and environmental impacts of the emerging livestock industry within the KwaZulu-Natal Midlands.

Using SLA, the study has shown that if waste management best practices are implemented the strategic outcomes have the potential to improve upon the asset base of rural livelihoods, therefore decreasing vulnerability to challenges. The recycling of waste has multiple effects on the asset base of rural farmers. Waste acts as a vector for the magnification of diseases and pests. The proper disposal of waste therefore improves upon the health of livestock, therefore preserving physical assets and improving human capital with better quality animal sourced products. Agricultural waste is energy rich and therefore be recycled to produce energy rich products such as biogas, manure and animal feed. Through the appropriate use of organic agricultural waste as manure and biogas, natural resources (natural capital), soil is preserved through the application of nutrients. Moreover, the pollution of water and air is avoided therefore improving the nutritional value of crops and securing food security of future generations (human capital). The production of energy rich by-products also increases financial assets by decreasing costs incurred and creating an additional income.

Waste management practices employed by emerging farmers in the Kwazulu-Natal midlands were simple, cost effective and easily implemented. Waste that farmers encountered during livestock husbandry included: excrement; slaughter waste in the form of blood, carcasses, entrails and hide; pesticides; feed waste; and sludge. Majority of the agricultural waste encountered is organic in nature and therefore recyclable. Other wastes, such as pesticides were considered negligible as a result of that they were utilised by farmers when required in minimal quantities. Farmers dealt with organic waste usually with one unspecialised disposal method that was suited to their lifestyle, irrespective of potential hazards to the environment or policy.

Objective Two: To determine the waste management technology needs of the emerging livestock industry.

The technology needs of emerging could be vastly improved on with the investment of digesters, chemical disposal methods and the implementation of municipal collection services. Of the on-site methods considered in the study: composting, rendering, incineration, burning, burial, incineration and biodigestion, the methods only three were implemented by emerging farmers (composting, burning and burial), of which one is recommended by policy (composting). Farmers also resorted to the dumping of agricultural waste on vacant land to avoid the responsibility of disposal. This demonstrated that emerging farmers do not consider

waste disposal as a means of health and environmental protection. It is therefore not safe to assume that disposal methods which are recommended (composting) are executed in the correct manner. This places significant strain on local resources when bearing in mind the number of emerging and subsistence farmers in the KwaZulu-Natal Midlands.

The study indicates from results and literature that market access is a significant limiting factor in sustaining emerging farmers. Many farmers do not know how to obtain access to customers and therefore sell their product. Herein lies the need for governance and co-operatives.

Objective Three: To determine the impact of policy on emerging livestock farmers and whether it supports or hinders their sustainability.

South African agriculture has become an integral part of correcting past in justices. By redistributing land amongst those that were previously disadvantaged by apartheid law. Indigenous people are given the opportunity to improve upon their livelihoods. However with insufficient legislation and support in place South African livestock farmers struggle to cope with customer access, climate variability and natural resource preservation, therefore underutilising the resources they have available. Furthermore, South African agricultural policy has written by commercial livestock industry officials and therefore does not take into account the challenges and needs of emerging farmers. Despite this, most policies are still implemented within the emerging farmer industry which creates further challenges for farmers. Waste management policy is aimed at commercial industry. The commercial sector process significant volumes of waste and therefore poses a significant threat to environmental health. Local authorities therefore find it more worthwhile to organise the commercial sector rather than emerging farmers, who in most cases cannot comply with policies such as polluter-pays. The implementation of policies was irregular within the KwaZulu-Natal Midlands, with farmers in some communities claiming that department officials visiting regularly and in some not at all. In both respects, farmers have stated however that municipal and department bodies do not give enough support. Authorities however do see that emerging farmers are struggling and are therefore trying to mitigate this and the fails of land reform projects by implementing new legislation around land reform. However, a lack of resources limits the areas that they are able to reach.

Objective Four: To evaluate the contribution of the emerging livestock industry to local food security.

The study proved that emerging livestock farmers play a significant role in local food security. Despite markets being saturated by the commercial sector, farmers have been able to sustain their livelihoods and that of the local community. The reasons for which farmers keep livestock varied with the use for livestock. Irrespective of these reasons, livestock husbandry supports food security through the production of waste that can be used to facilitate the rehabilitation of soil therefore ensuring the food security of future generations; and creating employment opportunities for the local community. Amongst the sample population (50 respondents), approximately 170 local community members were employed. In addition livestock farmers shared and sold animal products to community member therefore supplementing the diets of others and improving local food security. The use of livestock excrement for the fertilisation of crops is common amongst livestock farmers within the KwaZulu-Natal Midlands however many farmers still use inappropriate means of disposal (such as burning and illegal dumping) facilitating the degradation of natural resources. Emerging farmers are directly reliant on their immediate resources, with 38% of the respondents obtaining water from on-site boreholes. In addition, the improper management practices facilitate the manifestation of diseases that threaten livestock populations and human health. Farm workers are the most vulnerable to these diseases, therefore threatening the local working population and economy.

Objective Five: To determine the knowledge network that is used in waste management practices of the emerging livestock industry.

There was a lack of traditional knowledge with regards to livestock and waste management despite livestock playing such an integral role in the cultures encountered. Most farmers employed husbandry and waste management practices that were the most cost effective rather than traditional or environmentally friendly ones. However, due to the lack of education amongst the older generation, as a result of past injustices, it is however apparent that there are still farmers that employ traditional knowledge, in their day to day lives. Results indicated that women are more likely to implement indigenous knowledge in their farming practices and are therefore more likely to preserve these practices by passing it down to future generations. Traditional knowledge that came through in results related to the well-being of livestock and

indigenous theories regarding livestock products. With a large number of youth leaving for cities it is probable that there will be a further loss of traditional knowledge.

6.3. Recommendations

By simply looking at South African agricultural policy one can assume that South African agriculture is embedded in politics. Decisions within the agricultural sector are therefore currently based on politics rather than environmental health and food security. If implemented correctly, with appropriate skills training, land reform programmes will alleviate poverty within the rural regions of the KwaZulu-Natal Midlands. From the study results it can be seen that agricultural skills training needs to explain and emphasize the importance of agriculture in securing national food security. It is important that once agricultural land is distributed to indigenous people, that it is utilised to benefit the country and not just the livelihoods of individuals. It was evident practically and from the results that emerging farmers were not aware of their role in preserving ecological systems, nor how to go about sustainably preserving resources. In addition, farmers lacked a comprehensive understanding of waste management best practices and the effects that improper waste management will have on finite resources and future generations therefore emphasising the need for agricultural education and training.

The lack of an authoritative presence and policy governing waste management practices at an emerging level has resulted in the practice of disposal systems that are convenient rather than environmentally sound. International policy has tackled this in rural areas by providing incentives to farmers that practice organic and traditional agriculture. Through the enforcement of such policies, farmers are encouraged to preserve natural resources and the country aesthetics of rural areas through sustainable practices. Given that the KwaZulu-Natal Midlands is marketed as a tourist destination, the implementation of similar policies would preserve the aesthetics of the Midlands meander thus creating job opportunities within the tourism sector, assist farmers financially and help create an industry in which all small-scale farmers could co-exist rather than strive to dominate the local livestock industry.

With land reform dominating national budgets, it is important to encourage a system in which emerging farmers can be self-sustaining. Finances play a fundamental role in the agricultural practices employed by emerging farmers. Many farmers included in the study indicated that

finances was their biggest insecurity. A waste management plan that is suited to the needs of farmers (simple and cost effective) therefore needs to be introduced within rural areas in conjunction with awareness programmes and a mitigation authority. This authority should strive to educate farmers of the importance of waste management, focusing on how waste management can improve the resilience of their livelihoods and that of future generations, rather than enforce unreasonable objectives that discourage farmers from complying. Survey results indicate that composting it popular amongst rural farmers. The composting of organic waste provides an incentive in the form of fertiliser production. Moreover, it is easily implemented through the construction of burial pits and a long term solution to waste management. To introduce other waste management methods, such as biogas digestion, incentives therefore need to be provided. Given the current energy crisis of South Africa, such management systems can provide a cheaper alternative source of energy to those that contribute and therefore supplement national energy use.

The management of waste needs to be emphasised to emerging farmers. The waste produced by emerging farmers may be negligible compared to intensive livestock husbandry organisations, but still poses a threat to local natural resources and still has the potential to attract pests to the farms site, endangering farm workers and livestock.

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APPENDICES

APPENDIX I: Questionnaire to emerging farmers within uMgungundlovu District Municipality

University of KwaZulu-Natal, Westville

School of Agricultural, Earth and Environmental Sciences

Stakeholder Questionnaire:

Livestock Farmers

My name is Sasha Sankar and I am a student from the School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal. The aim of this survey is to inform my masters research entitled:

"An Investigation into the Waste Management Practices of Emerging Livestock Farmers: The case of the KwaZulu-Natal Midlands"

Please answer the following questions:

Section A: Biographical Information

1. Gender?

Male	
Female	

2. Age? _____

3. Location?

Richmond Municipality	
Msunduzi Municipality	
uMngeni Municipality	

4. How long have you lived in this area? _____

5. Please state your highest level of education

No formal Schooling	
Primary	
Secondary	
Tertiary	

6. Please list any other training that you have had, specifically in farming techniques?

1.	
2.	
3.	
4.	
No training	

7. How did you obtain this land for livestock farming purposes?

Bought Land	
Obtained permission from a community leader (*iNkhosi* or induna)	
Inherited	
Other _____	

8. Please indicate (tick) below the farming practices in which you partake:

Farming Practice	
Cattle	
Diary	
Sheep	
Goats	
Pigs	
Chickens	

Egg production	
Cropping	

9(a). Do you have access to municipal treated water (tap water)?

Yes	
No	

(b). If not, how do you obtain clean water?

River	
Dam	
Borehole	
Other _____	

10. Do you have access to electricity?

Yes	
No	

Section B: Waste Management Practices and associated environmental impacts

1. Please indicate how do livestock obtain their feed (tick)?

Free range grazing (left to roam within the area)	
Rain fed pastures	
Irrigated pastures	
Feedlots (purchased hay)	
Other _____	

2. Please elaborate on how your livestock feeding systems change with seasons?

	Summer	**Winter**
Cattle		
Goats		
Chickens		
Pigs		
Sheep		

3(a) Do you generate any feed waste (tick)?

Yes	
No	

(b) If yes, how do you dispose of this?

_____

_____

4(a) Do you use any land remediation techniques such as rotational grazing to preserve the land on which your livestock graze?

Yes	
No	

(b) Please elaborate

_____

_____

5. Please list the waste associated with your livestock?

	Cattle	**Goats**	**Chickens**	**Pigs**	**Sheep**	**Other**
Waste 1						
Waste 2						
Waste 3						
Waste 4						

6(a) Do you use livestock waste for other purposes within your household?

Yes	
No	

(b) Please elaborate

_____

_____

7. How do you dispose with animal waste such as offal (gut contents), bones and blood?

_____

_____

_____

8. How would you dispose of spoiled food products?

_____

_____

9(a) Do you have access to a landfill site (tick)?

Yes	
No	

(b) If yes, do you use it to dispose of your waste (tick)?

Yes	
No	

10. What livestock waste do you dispose to landfill?

1. _____
2. _____
3. _____

11 (a) Do you use water as a medium for waste disposal?

Yes	
No	

Please elaborate

_____

_____

_____

12. Do you sell manure?

Yes	
No	

Section C: Waste Management Technology Needs

1. Do you utilise any of the below mentioned methods to dispose of livestock waste (tick)?

Compost	
Burn	
Bury	
Recycle	
Other _____	

Please elaborate if you recycle

_____

_____

2. Please tick which you think are the biggest challenges you face with regards to livestock farming (tick)?

Finances	
Theft of livestock	
Climate	
Lack of technology	
Waste Management	
Access to water	
Food Availability	
Other _____	

3. Your household is currently able to cope with these challenges (tick)

Strongly Agree	
Agree	
Neutral	
Disagree	
Strongly Disagree	

4. How often are your livestock checked by a licensed veterinarian (tick)?

Once a month	
Twice a year	
Once a year	
When necessary	
Never	
Other _____	

5. Are there any dip tanks present within your area that you have access to (tick)?

Yes	
No	

6. How often do your livestock visit the dip tank (tick)?

Once a month	
Twice a year	
Once a year	
When necessary	
Never	
Other _____	

6(a). Do you dose or administer vaccinations to your livestock (tick)?

Yes	
No	

(b). If yes, complete the following table

Animal	**Vaccination for**	**Frequency**

7. Do you take any OTHER measures to ensure that your livestock are safe from pests (tick)?

Yes	
No	

If yes, please elaborate

_____

_____

8. Do you receive any financial support from outside sources?

Yes	
No	

9. Do you use you livestock for labour intensive activities such as tilling?

Yes	
No	

10. Do you slaughter your livestock on-site or using an abattoir?

On-site	
Abattoir	
Both	
Other _____	

11(a) Approximately how many of your livestock do you slaughter within a month?

(b) At what age are the following livestock considered suitable for slaughtering?

	Cattle	**Goats**	**Chickens**	**Pigs**	**Sheep**	**Other**
(a) number						
(b) age (months)						

12. How do you store meat and other consumable livestock products? Please explain

_____

_____

13(a) Would you like to expand the area of your farm?

Yes	
No	

(b) Why?

_____

14. Have any of your livestock meat or products been contaminated in the last 10 years?

Yes	
No	

If yes,

(b) with? _____

(c) what was the result? _____

(d) how did you treat your livestock? _____

15. How do you treat your livestock when they are ill (tick)?

Visit a veterinarian	
Visit a traditional healer	
Visit your local farming department store	

16. What personal health care facilities do you have access to?

Traditional healer	
Local pharmacy / clinic	
Doctor	

Section D: Agricultural Policy

1. Have you attended any support groups or training sessions organised by co-operatives?

Yes	
No	

2. Has a co-operative or NGO helped your community in any way?

Yes	
No	

Is yes, please elaborate

_____

3. Has your local municipality helped your community in any way?

Yes	
No	

4. Are you registered under the Fertilizers, Farm feed, Agricultural Remedies and Stock Act?

Yes	
No	

5. Are you aware of the control measures encouraged by the Department of Agriculture and Environmental Affairs for livestock husbandry?

Yes	
No	

6(a) Do you receive any financial support from outside sources?

Yes	
No	

(b) Is this enough to support your farm?

Yes	
No	

Section D: Food Security and Health

Please provide the following information regarding your livestock in the table below:

1. How many head of the following do you keep?

2. Do you keep these livestock for monetary (M), personal (P) (*as a pet)* or social (S) reasons (*for cultural reasons*)?

3. Please list what products do you obtain from these livestock that are useful to your household?

	Cattle			**Goats**			**Chickens**			**Pigs**			**Sheep**		
1. (head/ number)															
2. (tick)	M	P	S	M	P	S	M	P	S	M	P	S	M	P	S
3. Products															

4. Has your herd size changed in the past five years? Please elaborate on how and why?

	Cattle	Goats	Chickens	Pigs	Sheep	Other*
Increased (tick)						
Decreased (tick)						
Reason for change						

5. Is livestock farming your primary source of income?

Yes	
No	

6. Does the sale of livestock provide enough to sustain your household?

Yes	
No	

7. In this question, please state the degree to which you agree or disagree with the statement (Your options are strongly agree, agree, neutral, disagree and strongly disagree)
Livestock farming is more beneficial to my household than cropping?

Strongly Agree	
Agree	
Neutral	
Disagree	
Strongly Disagree	

8. Do you keep livestock as a source of food?

Yes	
No	

9. Do you sell or give away your animal sourced products?

Yes	
No	

10. Please indicate (tick) the proportion of meat that you give away or sell?

	None	Little	Some	Half	Much	Most
Sell						
Give Away						

11. Please indicate (tick) how you control where your livestock graze?

Fencing	
Family herders	
Employed herders	
Do not, they roam free	
Graze near the homestead	

12. Do you use manure or chemical fertilizers on your grazing fields? (tick)

Livestock Manure	
Chemical fertilisers	
Both	
None	
Other _____	

13. How many employees do you have? _____

14. How do you pay them?

Money	
Housing	
Animal sourced products	
Other _____	

15. Does your family partake in farming activities?

Yes	No

Section E: Knowledge Network

1(a). Are livestock important within your community in terms of social standing?

Yes	
No	

(b) If yes, please list for what reason?

Cattle	Goats	Chickens	Pigs	Sheep	Other

2(a) Do you use any traditional husbandry methods?

Yes	
No	

(b) If yes, please list here

_____

_____

_____

3. What traditional uses do you have for your livestock? *Please list*

_____

_____

_____

4. Do you use any methods to ensure that your livestock gain weight or continue to produce products such as milk and eggs? For example: the administration of traditional substances, hormones, vitamins or performing procedures, such as castration.

Yes	
No	

If yes, please list methods here

_____

5(a). Do you use any traditional waste disposal or recycling methods?

Yes	
No	

(b) If yes, please list here

_____

_____

_____

Thank you for your participation. Please note: ALL INFORMATION SUPPLIED IS CONSIDERED CONFIDENTIAL, if you have any questions or any further inputs please feel free to contact the investigator of this study:

Sasha Sankar

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APPENDIX II: Key Informant Interview- Commercial farmer

University of KwaZulu-Natal, Westville
School of Agricultural, Earth and Environmental Sciences

Topic: An Investigation into the Waste Management Practices of Emerging Livestock Farmers: The case of the KwaZulu-Natal Midlands

Researcher: Sasha Sankar

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1. Please describe the waste encountered during livestock husbandry practices on you farm site and the manner in which these wastes are disposed of?
2. Please describe how the farming and waste disposal practices employed on your farming site impact the local environment?
3. What impact does improved farming technologies have on the efficiency of you farm?
4. How important is farming skills and knowledge in terms of success of your farm as a business?
5. Has current policy limited your ability as a livestock framer?
6. Please describe your relationship to neighbouring emerging farmers?

APPENDIX III: Key Informant Interview- Livestock Researcher

KI QUESTIONNAIRE:
LIVESTOCK RESEARCHER

University of KwaZulu-Natal, Westville
School of Agricultural, Earth and Environmental Sciences

Topic: An Investigation into the Waste Management Practices of Emerging Livestock Farmers: The case of the KwaZulu-Natal Midlands

Researcher: Sasha Sankar

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1. How would you define emerging farmers?
2. What is the main reason that emerging livestock farmers keeping livestock?
3. Is there a National drive that calls for integrated plans that link agriculture with, for example, job creation, food security and growing the economy?
4. In your opinion, is waste management a significant environmental problem with emerging farmers?
5. What type of waste are you aware of/typically expect from emerging livestock farming and how are these wastes usually dealt with?
6. What are the essential technology needs of emerging farmers?
7. In your opinion, is there a need for technology that specifically addresses waste management practices with regard to livestock farming and the wastes generated thereof?
8. What legislation if any applies to emerging farmers?
9. Are there any gaps in policy pertaining specifically to practical issues impeding emerging farmers from participating in markets?
10. Please explain the role of cooperatives (Who is involved, why and what the expected outcome is?) within this emerging farmer sector.

APPENDIX IV: Key Informant Interview- Director of a local farmers association within the uMngeni Municipality

University of KwaZulu-Natal, Westville

School of Agricultural, Earth and Environmental Sciences

Topic: An Investigation into the Waste Management Practices of Emerging Livestock Farmers: The case of the KwaZulu-Natal Midlands

Researcher: Sasha Sankar

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1. Please describe the predominant waste management practices employed in uMgungundlovu District Municipality
2. Please describe current waste management technologies employed by livestock farmers
3. Is there a National drive that calls for integrated plans that link agriculture with, for example, job creation, food security and growing the economy?
4. Are there any gaps in policy pertaining specifically to practical issues impeding emerging farmers from participating in markets?
5. Within uMgungundlovu District Municipality is traditional framing as predominant as traditional family farming? Would you say that the emerging farmers sector has an impact on the national economy and food security?
6. What is the relationship between the commercial and emerging sector?
7. Please explain the role of cooperatives (Who is involved, why and what the expected outcome is?) within this emerging farmer sector.
8. What projects are currently implemented by this organization in terms of benefitting emerging and subsistence farmers?
9. What sort of challenges to local farmers face?

APPENDIX V: Key Informant Interview- Manager of municipal function of uMgungundlovu District Municipality

University of KwaZulu-Natal, Westville

School of Agricultural, Earth and Environmental Sciences

Topic: An Investigation into the Waste Management Practices of Emerging Livestock Farmers: The case of the KwaZulu-Natal Midlands

Researcher: Sasha Sankar

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1. What are typically the most problematic types of waste generated in the rural Midlands?
2. Please detail the types of waste services available to these rural communities (household and landfill).
3. Who is the Waste Management Officer designated by the municipality to supervise on site waste disposal?
4. Is the illegal dumping of agricultural waste a common occurrence?
1. Please describe the treatment and disposal methods of waste recommended to framers.
2. What kinds of monitoring and compliance measures exist to deal with livestock waste generation and disposal?
3. How is waste being dealt with from a legal/legislative perspective in terms of policy?
4. Have you experienced any outbreaks of disease in the area related to livestock farming, and if so, how was this dealt with. Is this a common occurrence?
5. To what extent does the duty of care clause stated in municipal bylaws apply to rural farmers?
6. There are a lot of municipal recycling programmes being implemented within the district. How are these programmes received by the local rural community?

APPENDIX VI: Key Informant Interview- State Veterinarian Representative of uMgungundlovu District Municipality

University of KwaZulu-Natal, Westville

School of Agricultural, Earth and Environmental Sciences

Topic: An Investigation into the Waste Management Practices of Emerging Livestock Farmers: The case of the KwaZulu-Natal Midlands

Researcher: Sasha Sankar

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1. What is your role in terms of the well-being of livestock and rural emerging livestock farmers?
2. What livestock farming waste management practices are predominant within the rural sector of KwaZulu-Natal/ uMgungundlovu District Municipality?
3. What are the essential technology needs of emerging farmers?
4. Do they employ any technologies or practices to minimize their waste?
5. Are there any projects within the midlands aimed at supporting the livelihoods of rural farmers?
6. What formal health care options do farmers have access to in terms of their livestock?
7. What are the recommended practices in terms of the disposal of pesticides?
8. What are the typical cases or types of health-care needs are veterinarians approached with?
9. How important are traditional medicinal practitioners to the community? Are they preferred to veterinarians?
10. Are there any partnerships between veterinarians and traditional medical practitioners? Please explain
11. What diseases are threats to livestock within the midlands?
12. What precautions do farmers take against livestock disease and pest control?
13. What are the prescribed precautions that farmers should take in terms of pest control?
14. What measures does the state have in place in the event of an outbreak?
15. What are the legal requirements in terms of pest and disease control?
16. Are there slaughter ages prescribed to farmers within the district? If so, please elaborate

APPENDIX VII: Key Informant Interview- Waste manager at the Department of Agriculture and Environmental Affairs

University of KwaZulu-Natal, Westville
School of Agricultural, Earth and Environmental Sciences

Topic: An Investigation into the Waste Management Practices of Emerging Livestock Farmers: The case of the KwaZulu-Natal Midlands

Researcher: Sasha Sankar

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1. Approximately how many emerging farmers are there within the uMgungundlovu district?
2. What livestock farming practices are predominant within the rural sector of KwaZulu-Natal/ uMgungundlovu District Municipality?
3. What are the technological needs of emerging farmers?
4. How does the department support emerging farmers?
5. Are local commercial farmers required to help their surrounding community in any way?
6. What are typically the most problematic types of waste generated in livestock husbandry in the Midlands? Why?
7. Please detail the types of waste services available (household and landfill).
8. Please detail waste disposal practices recommended to rural farmers?
9. How and where are used pesticides used in pest prevention disposed of?
10. Are there any monitoring procedures to determine it agricultural waste could pose harm to the environment?
11. What are the typical cases or types of health-care needs of emerging farmers?
12. How important are traditional medicinal practitioners to the agricultural community?
13. What diseases are threats to livestock within the midlands?
14. What precautions are recommended to farmers?
15. What are the legal requirements in terms of pest and disease control?

APPENDIX VIII: Key Informant Interview- Deputy Director at the Department of Water Affairs

University of KwaZulu-Natal, Westville

School of Agricultural, Earth and Environmental Sciences

Topic: An Investigation into the Waste Management Practices of Emerging Livestock Farmers: The case of the KwaZulu-Natal Midlands

Researcher: Sasha Sankar

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1. Are emerging farmers registered by the DWF?
2. Approximately how much water is utilised by agricultural practices?
3. Do emerging farmers generally comply with policies implemented by the DWA?
4. What alternative water sources are available to farmers located in rural areas?
5. Is water quality acceptable with water sources in the uMgungundlovu District Municipality?
6. Does the department have any concerns regarding water use by emerging farmers?
7. What are typically the most problematic types of waste generated in livestock husbandry in the Midlands? Why?
8. Please elaborate on known waste disposal practices used by rural farmers?
9. What are the prescribed methods of disposal of livestock and livestock products in terms of the DWA?
10. How is water contamination dealt with?
11. Have there been cases of water contamination by an emerging farmer?
12. How does the department propose to mitigate the use of haphazard waste disposal practices?
13. Does the department implement the polluter pays principle to emerging farmers?
14. Are there any monitoring procedures to determine it agricultural waste could pose harm to the environment?
15. What are the dangers of water contamination?

APPENDIX IX: FIGURES 9.1- 9.8

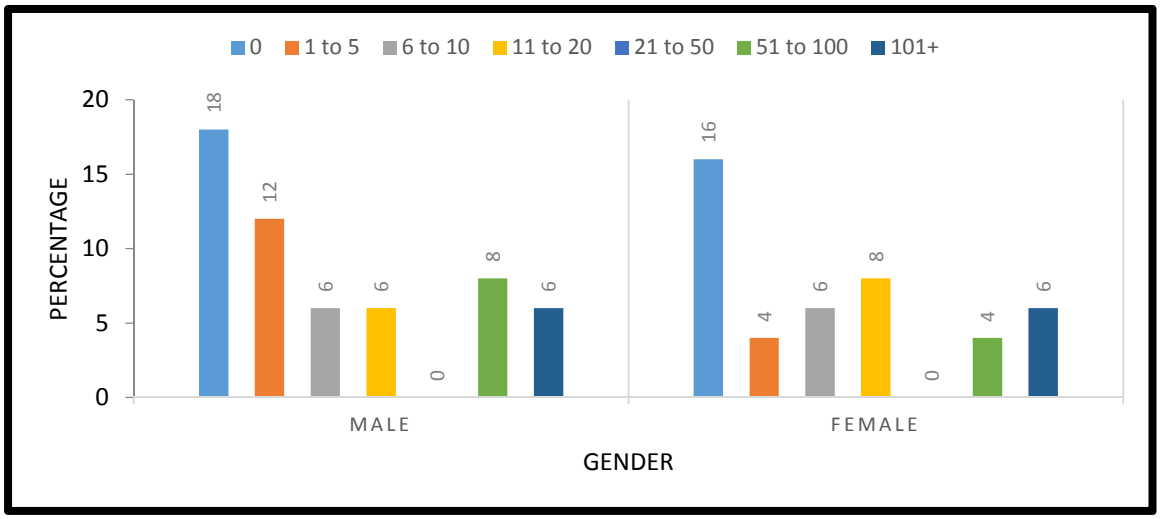

Figure 9.1. Percentage of male and female headed households that owned cattle

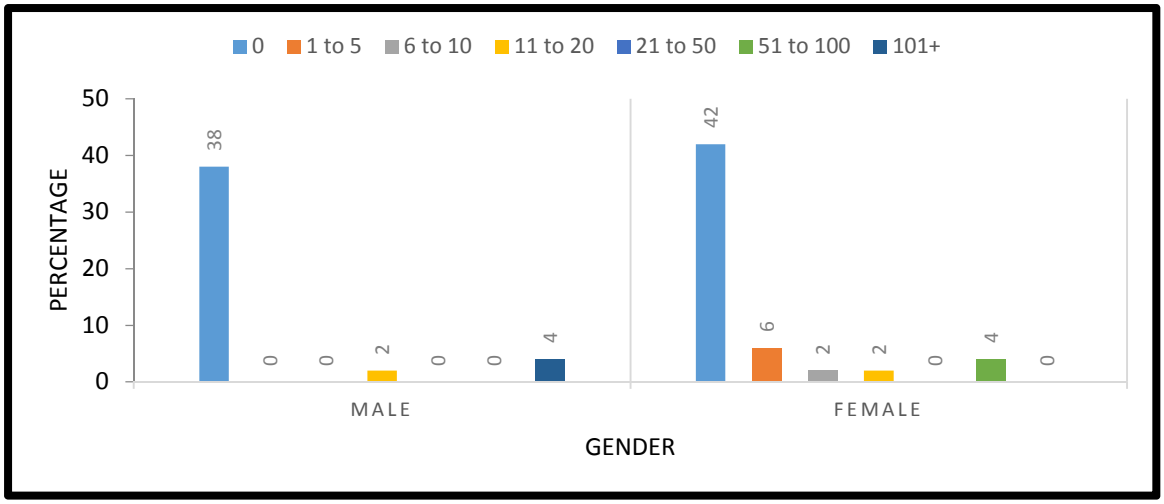

Figure 9.2. Percentage of female and male subjects that partake in dairy farming

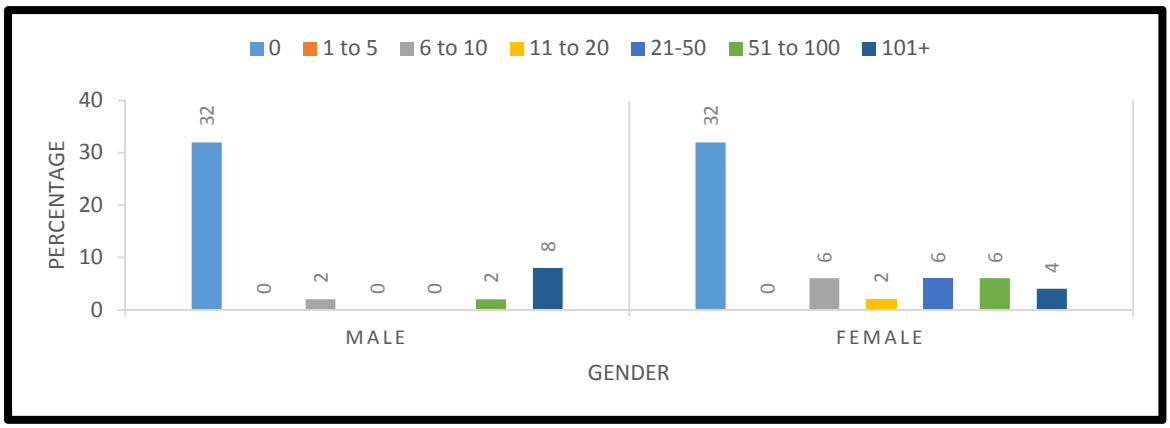

Figure 9.3 Percentage of male and female households that keep sheep

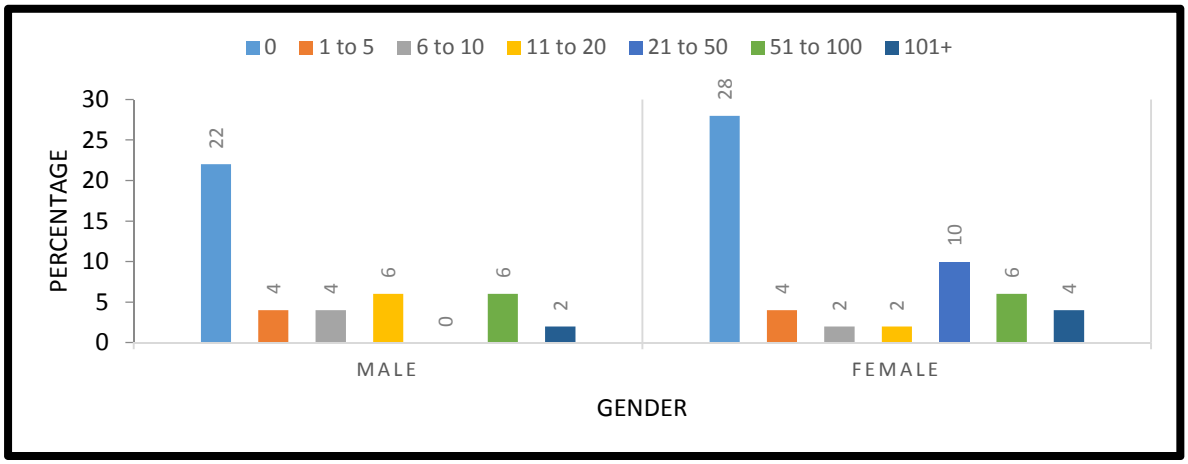

Figure 9.5. Percentage of male and female households that keep goats

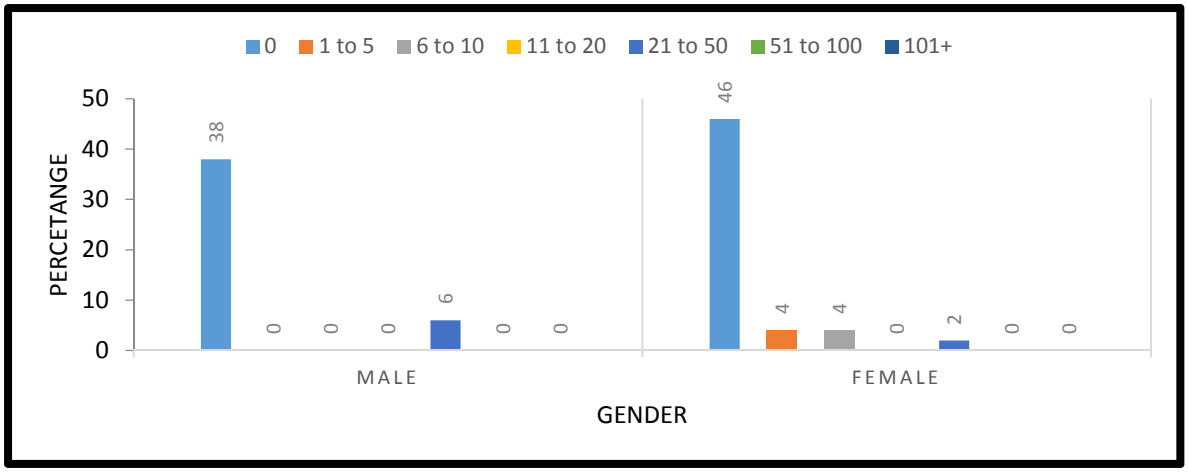

Figure 9.6. Percentage male and female headed household that partake in pig husbandry

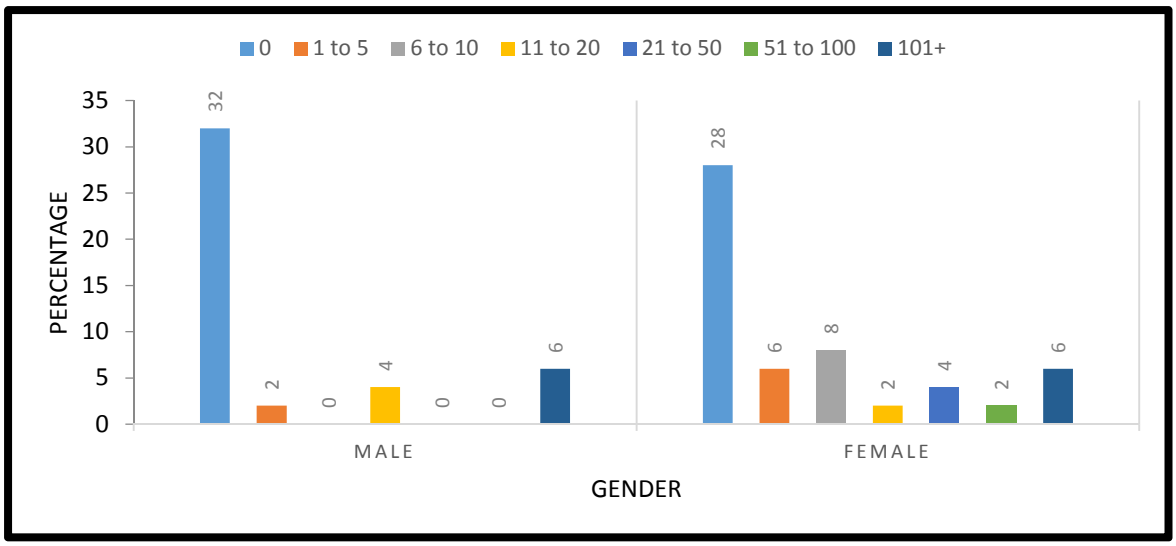

Figure 9.7. Percentage male and female headed households that partake in chicken farming

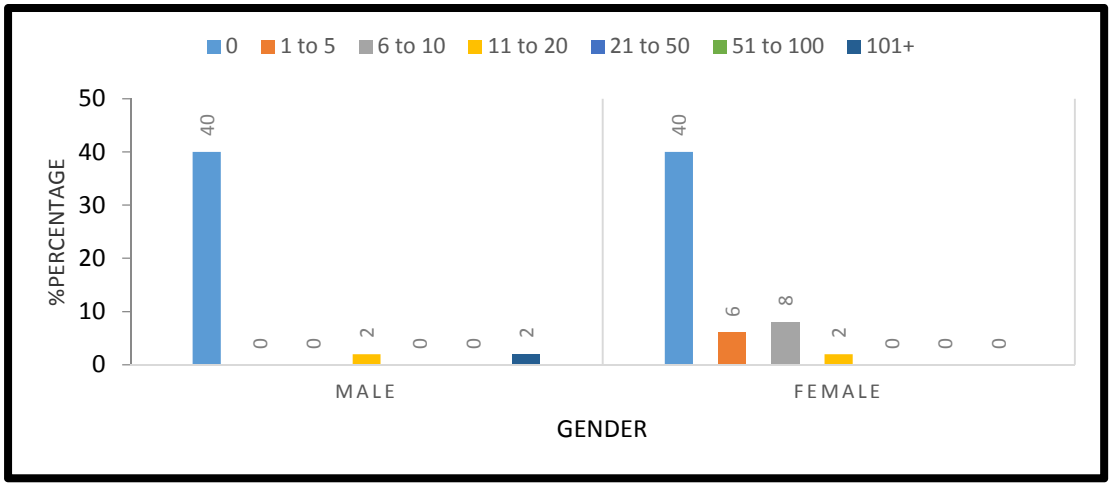

Figure 9.8. Percentage male and female households that partake in egg production