A critical perspective on the environmental regulatory requirements for dairy farming in South Africa

RA Diedericks

orcid.org 0000-0001-8571-9396

Dissertation submitted in fulfilment of the requirements for the degree *Master of Science in Geography and Environmental Management* at the North-West University

Supervisor: Prof. FP Retief

Co-supervisor: Mr. RC Alberts

Graduation May 2018

23565322

PREFACE

And acknowledgements

I would like to thank the following people for assisting me with this research report. It would not have been possible to successfully finish this report without their ongoing support and advice.

- Professor Francois Retief, my supervisor, for his academic advice, encouragement, support and patience.
- Mr. Reece Alberts, my co-supervisor, for his expert advice on environmental law.
- Woodlands dairy Sustainability Department, for their interest and support, and for connecting me with the relevant dairy farmers.
- All the participating dairy farmers, who provided priceless insight for the study and inviting me to their dairy farms.
- My fiancé, Wiandi Nell for her love and motivation, and for supporting me and always believing in me.
- Most of all, my mom and dad, for their encouragement, interest and supports both financially and emotionally. Without the help of my parents, this study would not have been possible. I am forever grateful for the opportunity.

ABSTRACT

Farms and farming are intrinsically linked to human civilization and have had a dramatic impact on the planet's landscape and environmental systems. As with any form of intensive agriculture, there are environmental aspects that hold the potential of leading to severe environmental impacts. These impacts are associated with the general management practices on dairy farms. The various impacts activities on dairy farms possibly will have on the environment are discussed in detail and they include water pollution, air pollution, soil pollution, loss in biodiversity, waste generation and the use of energy and non-renewable resources. In the field of dairy farming particular focus is centred on the degradation of water resources, especially as this is a major environmental issue around the world. Environmental regulation in South Africa is still relatively new compared to other fields of law. The applicable laws are discussed in detail and also applied to the environmental impacts caused by the activities on dairy farms to determine the strengths and shortcomings in South African environmental legislation, regarding regulation of the industry. The main aim of the dissertation was to critically reflect on the implications of the environmental regulatory requirements for dairy farming in South Africa. This study concluded that there is a comprehensive framework for environmental legislation and an existence of well-documented regulations connected to environmental protection. However, the implementation and enforcement of these environmental laws on dairy farms is unsuccessful. Environmental law and regulations is lacking, which specifically regulate and resolve the environmental problems relating to the activities on dairy farms. The farmers are also not aware of all the relevant environmental regulations with which they need to comply. This will then lead to the mismanagement of environmental aspects of the farm and the utilisation of inefficient farming methods, which can lead to pollution to the environment. Without sufficient and effective legislation to regulate the industry, activities on dairy farms due to the unregulated nature thereof, may lead to severe environmental impacts.

And key terms:

Case study

Critical perspective

Dairy farming

Environmental aspects

Environmental regulation

Opsomming

Landbou kan direk gekoppel word aan menslike beskawing en het 'n dramatiese impak op die vorming van die aarde se landskap en omgewingsisteme. Soos met enige vorm van intensiewe landbou is daar omgewingsaspekte wat potensiële gevolge kan hê vir ernstige omgewingsimpakte. Hierdie impakte word geassosieer met die algemene bestuurspraktyke op melkplase. Die verskillende impakte wat ‘n melkplaas moontlik op die omgewing kan hê, word volledig in die studie bespreek. Dit sluit in water-, lug- en grondbesoedeling, asook die verlies aan biodiversiteit, afvalgenerering en die gebruik van energie nie-hernubare hulpbronne. In die geval van melkboerdery is die fokus meestal op die agteruitgang van natuurlike waterhulpbronne omdat dit tans wêreldwyd 'n belangrike omgewingsvraagstuk is. Omgewingsregulering in Suid-Afrika is steeds relatief nuut vergeleke met ander regsgebiede. Die toepaslike wette word breedvoerig in hierdie proefstuk bespreek en word ook gekoppel aan die omgewingsimpakte van die aktiwiteite wat op melkplase plaasvind, sodat die sterktes en tekortkominge in die Suid-Afrikaanse omgewingswetgewing omskryf en bepaal kan word. Die hoofdoel van die proefskrif was om krities te besin oor die implikasies van die omgewingsregulerende vereistes vir suiwelboerdery in Suid-Afrika. Hierdie studie het tot die gevolgtrekking gekom dat daar 'n omvattende raamwerk vir omgewingswetgewing bestaan, asook goed gedokumenteerde regulasies wat verband hou met omgewingsbeskerming, maar die implementering en afdwinging van hierdie omgewingswette op melkplase word nie suksesvol geïmplementeer nie. Daar is 'n gebrek aan omgewingswette en regulasies wat spesifiek gefokus is op die bestuur van omgewingsaspekte binne die grense van ‘n melkplaas. Die boere is ook nie bewus van al die relevante omgewingsregulasies waaraan hulle moet voldoen nie. Dit lei direk tot ondoeltreffende boerderymetodes wanbestuur van omgewingsaspekte op die plaas, wat lei tot ernstige impakte op en agteruitgang van die omgewing. Sonder effektiewe omgewingswetgewing en die toepassing daarvan in die suiwelbedryf kan ongereguleerde aktiwiteite op melkplase aanleiding gee tot ernstige omgewingsimpakte.

En sleutelterme:

Gevallestudie

Kritieseperspektief

Suiwelboerdery

Omgewingsaspekte

Omgewingsregulering

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KEY CONSEPTS

"assessment": the process of collecting, organising, analysing, interpreting and communicating information that is relevant to decision-making;

"competent authority": the organ of state charged by this Act with evaluating the environmental impact of that activity and, where appropriate, with granting or refusing an environmental authorisation in respect of that activity.

"compost": means a stabilised, homogenous, fully decomposed substance of animal or plant origin to which no plant nutrients have been added and that is free of substances or elements that could be harmful to man, animal, plant or the environment;

"ecosystem": a dynamic system of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit;

"environmental aspect": element of an organization's activities or products or services that can interact with the environment.

"environmental impacts": any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects.

"fertilizer": means any substance which is intended or offered to be used for improving or maintaining the growth of plants or the productivity of the soil;

"issue": an important topic or problem for debate or discussion.

"pollution": emitted from any activity, including the storage or treatment of waste or substances, construction and the provision of services, whether engaged in by any person or an organ of state, where that change has an adverse effect on human health or well-being or on the composition, resilience and productivity of natural or managed ecosystems, or on materials useful to people, or will have such an effect in the future;

"recycle": means a process where waste is reclaimed for further use, which process involves the separation of waste from a waste stream for further use and the processing of that separated material as a product or raw material;

"re-use": means to utilise the whole, a portion of or a specific part of any substance, material or object from the waste stream for a similar or different purpose without changing the form or properties of such substance, material or object;

CHAPTER 1 INTRODUCTION

This Chapter sets the scene for the research by outlining the background thereto (section1.1); followed by the problem statement (section1.2), research aims (section 1.3), identification of the study area (section 1.4) and a summary of the structure of the dissertation (section1.4).

1.1 Background to the Research

The increase in economic development together with the rise in the South African population has resulted in a larger agricultural sector and can lead to more significant environmental impacts and degradation of natural resources (Steinfeld *et al.,* 2006).

The main purpose of this study was to critically reflect on the implications of the environmental regulatory requirements for dairy farming in South Africa. It also determined whether the current environmental legislation is relative and can be used as an effective management tool within the dairy industry of South Africa.

The various impacts the activities on dairy farms may have on the environment are discussed in detail and they are characterised in different environmental aspects such as water, air, soil, biodiversity, waste generation and energy and non-renewable resources. The applicable laws are discussed in detail and applied to the environmental impacts caused by the activities on dairy farms to determine the strengths and shortcomings in South African environmental legislation, regarding the regulation of the industry.

A qualitative research approach was followed, and information was gathered by means of interviews, observations and being embedded in the researched spaces. Five case study sites were selected and used for primary research. The management of environmental aspects on these farms were investigated to determine whether the farmers are aware of the relevant environmental laws and whether these laws are used effectively to reduce environmental impact that may occur on the selected dairy farms.

This research contributes to the South African agricultural literature, which is currently limited. By highlighting some of the advantages and shortcomings of environmental law for the dairy industry, this research could also assist dairy farm owners who are considering complying with all the relevant environmental laws and regulations, to ensure sustainable farming.

1.2 Problem Statement

Tilman (1999) explains that the tradition of agriculture has been to maximize production and minimize cost of food with slight regard for environmental impacts. The world enters a global food production area and it is likely to increase the production process. It is critical for agricultural practices to be more sustainable and efficient to minimize impacts on the environment (Tilman, 1999).

Dairy farming in the form of factory farming in South Africa is a relatively new practice, but due to cost effectiveness and production speed this industry is growing at a fast pace (Grobler 2012). If the dairy farming industry is not properly regulated, South Africa will eventually suffer severe environmental impacts (DOA, 1998; Garnier et al, 1998). Most dairy farms in South Africa use modern industrial methods to breed their livestock for optimal use of space and other resources to maximise production (Notten & Masson-Jones 2011). Turner (1999) sees the majority of industrial dairy farms to be designed to accommodate many cows in restricted spaces to limit expenses and expedite production. These industrial dairy farms produce a vast amount of waste in the form of animal manure, carcasses, discarded milk, disinfectants and general waste (Turner 1999). If the disposal of these wastes is not executed according to the legal requirements it can lead to negative environmental impacts such as soil erosion, the reduction of soil fertility, water pollution, air pollution caused by methane emissions released by animal manure and carcasses and the degradation of ecosystems (Goutondji, 2007).

In South Africa the demand for animal products such as milk is growing rapidly and the pressure for livestock production can in the near future exceed the capacity of the environment (Nieuwoudt, 1998). It remains critically important for future production of milk on dairy farms to be done in a sustainable manner because the number of animals bred annually will increase, which will lead to an increase in animal waste and demand more space to host all the animals (De Haan et al, 1997).

1.3 Research Aims

The aim of this dissertation is:

To critically reflect on the implications of the environmental regulatory requirements for dairy farming in South Africa

To achieve the research aim stated above, the following sub-research aims will also be addressed by means of a literature review:

- To conceptualize the life cycle of a dairy farm in South Africa with a view to determine the main potential environmental impacts.
- To identify and describe existing environmental regulatory requirements for a dairy farm in South Africa.

1.4 Study Area

The study area for this research was conducted in the Eastern Cape Province. The reasons for choosing this specific region include personal relationship with Woodlands Dairy Sustainability Department (Humansdorp), who has direct contact with farmers in the region. A number of large commercial dairy farms in the region are equipped with the most advanced technology and farming practices. Furthermore, a pilot study was conducted prior to the start of the actual research. The pilot study took place on a farm between Parys and Potchefstroom in the North West Province. The reason for choosing this specific farm includes that the location of the farm is close to the North-West University's Potchefstroom Campus, where the research for this dissertation took place.

1.5 Structure of dissertation

To ensure that the results of this dissertation are presented and interpreted as straightforward as possible, a clear connection is made between the research aims and the literature review. The interpretation of the data from the research methodology is also used to address these aims.

This dissertation is structured according to the following chapters:

- Chapter 1: Introduction and Problem Statement

Chapter 1 serves as the introductory chapter and helps to set the scene for the research. It includes the problem statement; the research aims and the study area. This chapter also includes the structure of the dissertation.

- Chapter 2: Literature Review

Chapter 2 provides a literature review which is based on existing research and information regarding the research aims. A theoretical background study was undertaken through an extensive investigation of local and international literature on the topic *dairy farms* and the *receiving environment*. The literature sources used in this dissertation were all peer reviewed articles, legislation, guideline documents, reports, personal interviews, electronic sources, international and local journal articles, books and book chapters.

- Chapter 3: Methodology

Chapter 3 provides the outline of the methodological design of the dissertation. Empirical research was conducted through data collection methods in the form of a multiple-case replication study. These case studies took place in the form of various interviews and site visits with farmers in the Eastern Cape Province.

- Chapter 4: Results and Discussions

Chapter 4 provides the data analysis and the results that are described in relation to the research aims.

- Chapter 5: Conclusions and Recommendations

Chapter 5 provides the outcome of the dissertation's results that are discussed in relation to the research aims.

Table 1-1: Structure of dissertation

STRUCTURE OF THE DISSERTATION			
Research Aims	Methodology (see chapter 3)	Data Analysis	Chapters (see section 1.5)
Sub-aim: To conceptualize the life cycle of a dairy farm in South Africa in order to determine the main potential environmental impacts.	Documentation / Literature review	Phase 1 Introduction Phase 2 Define and prepare	**Chapter 2**: **Literature Review:** 2.1 International overview of dairy farming 2.2 Dairy farming in South Africa. 2.3 Life cycle of dairy farming in South Africa 2.4 Environmental aspects related to dairy farming
Sub-aim: To identify and describe existing environmental regulatory requirements for a dairy farm in South Africa.	Documentation / Literature review	Phase 2 Define and prepare	2.5 Environmental Regulatory Framework for dairy farming 2.6 Conclusion
Main Research Aim: To critically reflect on the implications of the environmental regulatory requirements for dairy farming in South Africa.	Documentation / Literature review	Phase 3 Design, collect and analyse data Phase 4 Case study review	**Chapter 3**: **Methodology:** 3.1 Case study approach 3.2 Case study design. 3.3 Identification of case studies 3.4 Research methods: interviews and site visits 3.5 Cross-case analysis 3.6 Limitations to the research **Chapter 4**: **Results & Discussion** 4.1 Farm 1 4.1.1 Water, Air, Soil, Biodiversity, Waste, Energy 4.7 Overall performance of selected farms

Table 1-1: Structure of dissertation (continued)

STRUCTURE OF THE DISSERTATION			
Research Aims	Methodology (see chapter 3)	Data Analysis	Chapters (see section 1.5)
	Documentation / Literature review Interviews and farm visits Multiple-case replication design Cross-case report	Phase 5 Conclude and Recommend	**Chapter 5: Conclusion and Recommendations**: 5.1 A critical perspective on environmental regulatory requirements for dairy farms 5.2 Challenges for dairy farmers 5.3 Final conclusions and recommendations

CHAPTER 2 LITERTURE REVIEW

This Chapter's main focus is centred on addressing the following research sub-aims:

- To conceptualize the life cycle of a dairy farm in South Africa to determine the main potential environmental impacts.
- To identify and describe existing environmental regulatory requirements for a dairy farm in South Africa.

The outline of this chapter is as follows:

Chapter 2 starts off by giving a brief overview of dairy farming globally and in South Africa Section (2.1 & 2.2). The life cycle of dairy farming in South Africa is summarized in section 2.3 followed by a range of environmental aspects related to dairy farming (section 2.4). Finally, the Environmental Regulatory Framework for dairy farming in South Africa is included in section 2.5.

2.1 International overview of dairy farming

Dairy farming is practised across the world and milk from dairy cows represents up to 91% of the total milk production globally (MPO, 2016). Merrington et al., (2002) argue that the production of milk plays a key role as a fundamental source of proteins for human diets and has an important socioeconomic role in communities around the world. The global dairy industry is composed out of a large number of countries with their own traditional production practice and unique end user markets (Tanji & Enos 1994). The global average number of cows per farm is generally around 1–2 cows; but, as the farm business model transforms from purely nutrition to market production, the herd size, and labour strength will increase (MPO, 2016). Dairy production is distinctive from other agricultural commodities because raw milk is produced on a daily basis, for 365 days of the year. The introduction and regular development of modern technologies, such as the milking parlour, the global production trend is to increase heard and farm sizes (MPO, 2016). When comparing global farm sizes, the largest average farms size is in the United States (Fonterra, 2015). Dairy production is crucial for economic growth and development of sustainable communities in rural areas around the world. However, the development requires large capital investments, available local markets and a well-trained labour force, which are constant challenges on a global scale (PMMI, 2013).

According to Radostis (2001), animal production systems have improved globally over the last decade. Various agricultural programs in the form animal health care, animal production management, monitoring and control systems for animal products and the fabrication of animal products has helped to evolve the agricultural sector globally (Richards & Ku-Vera, 2007; Dresner

2008). The implementation of these programs differs in many ways within developing countries on the one side, or on developed countries on the other side (Kofer *et al.*, 2004).

Agricultural practices from around the world transformed over the last century. The global overview of dairy production was first characterized as a pasture-based and low-input system with low milk production in the 1930–1940's, which are sharp contrasts to today's modern high input: high-output systems (Van de Haar and St-Pierre, 2006). According to Capper (2014) the historical methods of dairy farming can be seen as more environmentally friendly than today's technological farming practices. In order to achieve an environmentally and economically sustainable dairy supply, farmers need to identify practices and systems to use the available resources more efficiently and minimize potential impact on the environment.

The global dairy industry has developed a constant drive to optimize production which has led to a willingness to adopt modern technologies that allow more to be done with fewer inputs and is seen in the form of machineries. Farmers are producing more milk per cow and dairy processors are increasing output and reducing operating costs. Due to a global focus on efficiency, the dairy industry has shown steady growth and is one of the fastest growing sectors over the past decade (PMMI, 2013). Primary the reasons for the increase in global demand for dairy products are the westernization of diets which include more dairy products together with the broader display and appeal of dairy products. The total world milk production is estimated to increase by 19% from 2010 to 2020 (692 million tons in 2010 to 827 million tons in 2020) (PMMI, 2013). Internationally the major milk producing regions are the European Union, India, New Zealand, Australia, and United States of America. The largest producers of milk are Europe with156 billion litres annually, second are India with 131 billion litres and third the United States with 91 billion litres. New Zealand is the 8th largest producer with 21 billion litres annually, these top eight represents 55% of the global production annually (Fonterra, 2015). Dairy farming systems varies greatly across these major dairy producers from India's conventional model with an average herd size of less than two, EU's high producing system where farming activities are concentrated to small confined areas and the heard spends most of time inside barns with a high use of supplementary feeds. New Zealand has a low cost, outdoor pasture-based system where the cows are not concentrated but can rather roam freely on pastures (Fonterra, 2015).

There are three key production systems in dairy farming around the world. It can generally be seen as open based grazing, mixed farming and industrial systems. The Grazing production system are normally based on grassland were the livestock can graze freely and on the surrounding land. The farmer plants diverse types of grass throughout the year, in the form of kikuyu, sorghum, rye-grass, clovers and chicory. The grazing system shows a lower productivity rate than the other systems. Mixed farming is an integrated system, were the livestock and crop production activities are integrated. The farmer plants grasslands were the livestock can roam freely and additional crops (maize, soya and cotton) for extra feed for the livestock. The mixed farming system helps strengthens the agricultural system in a more productive manner. The industrial systems are entirely detached from grasslands. The livestock are kept in confined spaces where they eat and sleep, in order to ensure optimum production. The industrial system poses a serious risk of potential pollution to the surrounding environment.

2.2 Dairy farming in South Africa

The National Department of Agriculture states the number of dairy farms in South Africa stood at approximately 4000 farms in 2005 and started to decline at an annual rate of 0.9% per year from 2000 – 2005 (NDA, 2003, 2005). In South Africa available agricultural land are scarce and expensive. The average herd size on dairy farms in South Africa is 130 cows per farm, while the average annual production per farm is 640 tons of milk. There are mainly four predominant dairy breeds across South Africa and they include Jersey, Holstein, Guernsey and Ayrshire (see Annex 1). Milk production on a farm is very labour-intensive and presents employment to several people. The highly sophisticated equipment used for milking requires skilled and well-trained workers. Great commitment is also needed from farm workers and management, because the cows must be milked at least twice a day, right through the year (Milk SA, 2014:13). The South African dairy farming industry comprises on a number of socioeconomic activities with over 4 000 milking producers directly employing 60 000 farm employees and further lead to the proving of 40 000 indirect jobs within the value chain of milk processing (NDA, 2003, 2005). The dairy industry is the fifth largest agricultural sector in the country and plays a critical role in bringing about food security in South Africa (Milk SA, 2014:13). Milk is a crucial part of several big and small farming enterprises. For the larger commercial farmers milk is the main source of income, while for the many smaller farmers it serves to feed the household and produce an extra income (Milk SA, 2014:04).

With specific regards to dairy farming in South Africa, the consumption and demand for milk products is gradually increasing and can be linked to the growing middle class higher per capita income (MPO, 2008). Over the period 2000 - 2005 milk production in South Africa experienced an annual growth of 0.3% and produced 2.56 million tons of milk in 2005. However, the total amount of dairy farmers has decreased significantly from 1997 to 2008 and is the result of higher costs involved with more advanced technologies (FSSA, 2008). The existing farmers had to adapt to these changes and has resulted in increased intensity whiting dairy farms, as the farmers attempt to supply to the ever-increasing population demand, while at the same time aim to generate a beneficial profit from their farming businesses. As a result of intensification within the dairy farms all over South Africa, the interest has also turned to sustainable farming and environmental impacts. Section 2.4 will explore the impacts that dairy farming can have on the environment, as will section 2.5 discuss the various legislation that are geared towards ensuring minimum impacts to the environment. The contribution of milk production operations in South Africa are approximately 0.5% of global milk production (DEAF, 2011). The Milk production in South Africa makes a very small contribution to the overall global production but in terms of the significant values of agricultural production in South Africa, it is seen as the fifth largest agricultural industry in the world. Milk is produced to a large extent more cheaply in more developed countries in the world than is South Africa. Developed countries receive subsidies from their government and therefore imported milk from the US and EU is cheaper than in South Africa. The dairy farms and companies in those countries are generally paid a guaranteed marked price for designated quantities of their dairy products. These dairy companies further receive a subsidy to bridge the gap between domestic price and global market price. Dairy farmers within Europe are also paid subsidies to use certain products.

South Africa are exports of dairy products, however does not always produce enough for the needs of the country, because whey and milk powder are imported on a regular basis (NDA, 2003 & 2005). The production of dairy products in SA is characterized by a solid economy and exceptional infrastructure. Livestock health on commercial farms is well controlled by an extensive network of veterinary services. Dairy farms situated near wildlife farms, can face the threat of major trans boundary diseases, such as a permanent risk of Foot and Mouth disease and is prevalent in wildlife in the Kruger National Park (Connor & van Der Bossche, 2004; McCrindle *et al.*, 2006).

The large commercial farms are designed to host thousands of livestock in a restricted space. When looking at typical farming sectors, it is important to look at the differences in the physical environment which is important to determine the spatial variations in agriculture activities. The differences in ecosystems such as soil and climate can give rise to distinctive agricultural regions or types of farming areas within a country or province. Rainfall plays a significant role in the availability of food and grazing for livestock production systems (see figure 2.1). Therefore, the production areas are most suitable in the coastal areas because of the mild temperatures and good rainfall, which result in excellent quality pastures for the cows to feed (Kunene & Fossey 2006; DOA, 2008b). The inland areas of South Africa are generally less climatically favourable for dairy farming and these farms make use of self-produced silage, grain and hay fed with concentrates in a Total Mixed Ration system (TMR) and is also seen as intensive feedlot production systems (Coetzee & Maree 2008). Dairy farming systems occur throughout South

Africa, where areas with the highest concentration of dairy farms occur in the North West, Eastern and Western Cape, Free State, KwaZulu-Natal Midlands, the southern parts of Mpumalanga and close to the Gauteng metropolitan area. The largest commercial dairies are primarily found in close proximity to the metropolitan areas and alongside the coast, for the most part the Eastern Cape coastline (Goutondji & Leopoldine, 2007; FAOSTAT, 2005(c) & (d); SA Government, 2007). According to Lehohla (2005) the total amount of dairy livestock In South Africa is approximately 713 557 and the Provincial breakdown is illustrated in Figure 2.2. In summary the Western Cape Province contributed 27% of total milk production in South Africa and is followed by KwaZulu-Natal and Eastern Cape which took up 24% each respectively. The Free State contributed 13% and the rest of the reaming Provinces making up the rest.

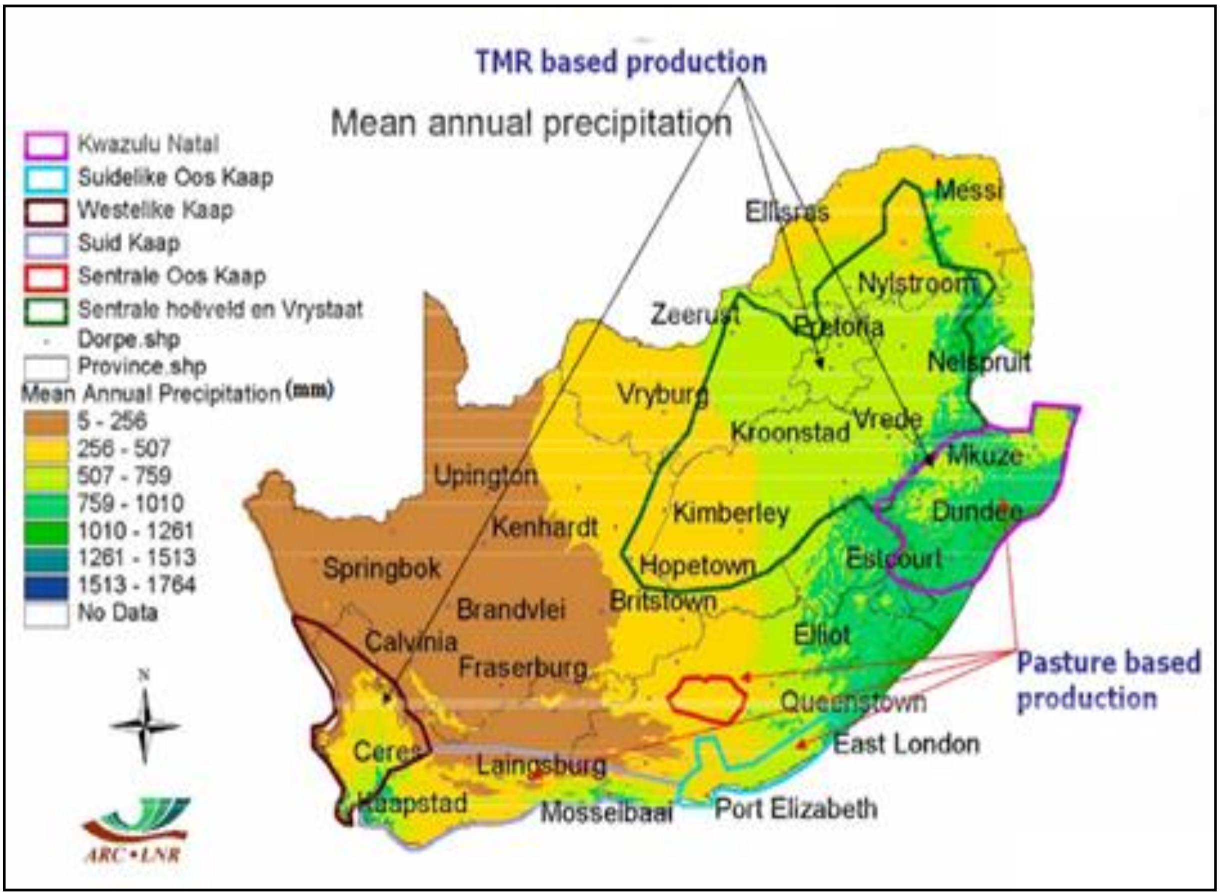

Figure 2.1: Milk producing regions in South Africa

Source: Milk Producer Organisation (2008)

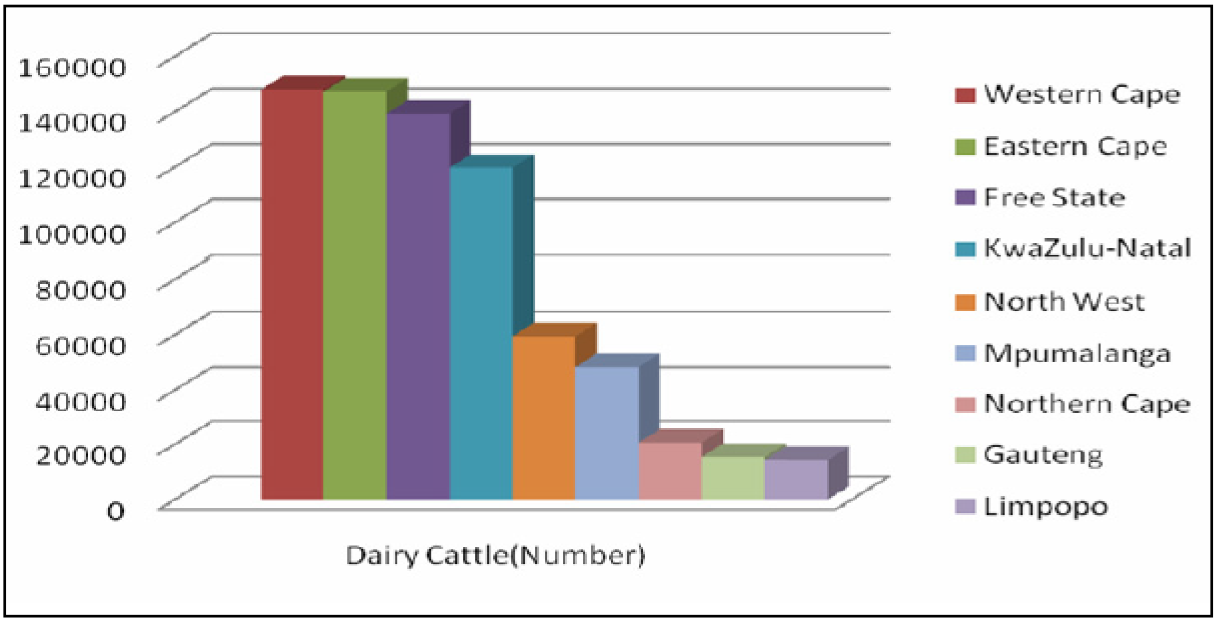

Figure 2.2: Number of dairy livestock per province

Source: Lehohla (2005)

Dairy farming in South Africa generally consists of three different agricultural systems as mentioned above in section 2.1. In South Africa livestock are generally bred by applying modern industrial methods with a view to optimally use land space and resources for maximum production. There are fewer dairy farmers in South Africa than before, but the existing farmers produce a vast amount of milk because they have enlarged their herds and make use of the most advanced technology (Milk SA, 214:13). Dairy farming systems in South Africa are restricted by the available water supply and can range between highly technology-intensive farming to more wide-ranging traditional livestock management on communal grazing. The farming system depends mainly on the availability of land, money, rainfall and underground water (EIA, 2003; NDA, 2003 & 2005). A dual agricultural economy is prominent in SA and can be characterized by a predominantly subsistence-orientated sector located in the rural areas and a well-developed commercial sector in high rainfall areas.

In SA, dairy livestock are generally fed on open pastures and silage and/or roughage is added for extra feed. The livestock are supplemented with vitamins, minerals and salt according to the objective of the livestock system. Natural pastures are frequently used for small-scale breeding herds (FAOSTAT, 2005 (c) & (d); Maree & Casey, 1993). According to Steyn (1999), using milk from cattle was originally part of a traditional farming system in South Africa and several breeds were used for dual purposes, rather than dairy breeds. The marketing of dairy production as a farming system on its own occurred after the Second World War. Milk and milk products were in high demand and were vital to feed the ever-growing urban populations. Large commercial cattle farms are currently separated into dairy farming and stock farming systems (Maree & Casey, 1993; Steyn, 1999).

The dairy processing industry in South Africa is branded as a deregulated industry. The price of milk was deregulated in 1983 and resulted in lower prices, but regulations in the dairy industry continued to impose strict health-precaution regulations. The annual per capita production of milk has decreased over the last decade which reflects the change in profitability of dairy farming (SA Online, 2006). Between the periods 1995 – 2003, exported dairy products ranged between 87,000 and 232,000 tons. During the year 2002 production of milk was higher than the consumption of milk, by between 2 and 2.5 million metric tons. However, during the year 2003 the imports were 162,000 tons while exports were 87,000 tons (Collins, 2004; FAOSTAT, 2005(c) & (d)).

2.3 Life cycle of a typical dairy farm in South Africa

Section 2.3 of this dissertation will support the sub-research aim, namely: conceptualizing the life cycle of a dairy farm in South Africa to determine the main potential environmental impacts, by identifying the potential negative environmental issue that occurs along the production processes of raw milk, which fall within the boundary gate of a typical dairy farm in the Tsitsikamma region of South Africa. It is important to first understand how a typical life cycle assessment (LCA) works to be able to identify these negative environmental issues.

The LCA is a calculated method for assessing environmental impacts along all phases of the life cycle of a product, process or service (ISO, 2006). The LCA was developed to assess negative environmental impact of industrial sectors and production processes. The LCA was first applied to the crop production from the1990s (Huijungs et al., 1996) and for the production of milk from the 2000 (Haas et al., 2001). The LCA has quickly become an internationally accepted method, used in the agricultural sector to assess environmental impacts and recognize hotspots along the production chain (Thomassen et al., 2008). The hotspot is defined as an aspect that highly contributes to environmental impacts (Guinee et al., 2002).

The conceptual framework of LCA is generally well-defined by ISO normalisations (ISO, 2006), although the LCA studies vary in their methodologies and implementations. The LCA ability to address potential environmental impacts such as resource use and environmental consequences of emissions right through a product’s life cycle, from raw natural material through production, product use, end-of-life treatment, recycling to final disposal, which has also been dubbed the cradle-to-grave process (ISO, 2006).

The above-mentioned environmental inputs and outputs generally refer to the demand for natural resources and the generation of emissions and solid waste. Generally, a life cycle system consists out of the technical system of processes and transportation used and required for the extraction and production of raw materials and the use and after use of the product (waste management or recycling).

When examining environmental impacts, one of the most successful approaches regularly used, is the Life Cycle Assessment (LCA) (Finnveden et al., 2009). In general, LCA accounts for complete environmental emissions, and converts them into more logical environmental indicators, which are based on environmental cause-effect mechanisms (International Standard Organization, 2006). De Vries and De Boer (2010) report that over the last couple of years LCA has become a vital tool for evaluating environmental performance of dairy agriculture systems worldwide. It is therefore important to understand how the LCA of a dairy farm in South Africa works, in order to help in assessing the relevant environmental impacts of the different dairy farms investigated.

An overview of the life cycle of a typical South African dairy farm production as investigated in this current dissertation is shown in Figure 2.3. The life cycle of this dissertation includes the production of raw milk through farming activities and the life cycle only illustrates what inputs are used and what outputs are delivered (from farm gate to farm gate). Primary data were obtained from the dairy farming prediction through site visits and data questionnaires. This figure illustrates the major inputs to the dairy farm from outside the farm boundary, either from natural systems or those created by humans. Additionally, some inputs will produce externalities during manufacturing before entering the farm system. The figure also illustrates the major outputs that leave the farm gate and regularly are the only parts of the dairy production process that are acknowledged (i.e. milk and revenue).

Dairy intensification has required increased inputs in order to increase production, such as larger amounts of fertiliser, supplementary feeds and water for irrigation systems. Other agri-chemicals such as pesticides, animal supplements and animal remedies for infections/diseases, are also needed.

Water is crucial for successful dairy farming to take place, as dairy cows need a constant supply of clean water to drink and pastures require a vast amount of water to grow. Water is also used to wash the milking parlour after milking to keep all the equipment clean and hygienic. A large volume of water must be available on a dairy farm at all times; therefore, farms must harvest as much water as possible. Rain water generated by runoff water from the catchment areas in the mountains is captured and stored in large dams. Water from boreholes is also used to fill up the storage dams or directly used as irrigation on to the pastures or crops. The most effective way of irrigating a large area is through centre pivots. The pivots are used to irrigate the pastures, which mainly consist of perennial ryegrass, clovers and chicory. The cows grace freely on the pastures, and manure from the cows is left on the pastures and can be seen as an extra source of organic fertilizer.

At the dairy, where the cows are milked twice a day, a large amount of manure is collected. This manure gets separated into the solid parts which get stored and later spread on the maize fields while the liquid manure gets spread in the irrigation water through the pivots on the pastures.

Agricultural inputs such as seed, fertilizer, pesticides, herbicides and lime are all important in the production of the pasture and maize. The maize gets cut into silage and fed to the cows during winter time when there is a shortage of food due to the slow growth of the pastures during winter. Concentrate (approximately 6 kg/day) is fed to the cows while being milked. This feed consists mainly of minerals, protein and energy sources which come from outside the farm gate and gets dumped on the farm in the form of manure.

Most soils in the Tsitsikamma area of South Africa are naturally low in nutrients due to their constant agricultural use and development. Therefore, adding nutrients to increase plant growth and lime (calcium oxide) to reduce acidity to soils is common in dairy production. Significant sources of nitrogen applied to dairy farms include nitrogen fertilisers, dung and urine from grazing animals, and farm dairy effluent discharges (Davies-Colley et al., 2003). Nitrogen fertiliser has been used to supplement (or completely replace) clover fixation in order to increase pasture production (Roberts & Morton, 2009). In this way, N fertiliser can work as a form of supplementary feed when animal requirements exceed pasture growth (Roberts & Morton, 2009). Applying effluent collected from the milking shed onto the land cycles nutrients back into the soil. This practice can decrease the amount of fertiliser application required; lowering fertiliser costs (Wang et al., 2004). However, farmers often over-apply fertilisers and effluent which results in environmental impacts.

Dairy farms make use of electricity on a daily basis to run machinery and equipment used in the milking parlour. ESCOM supplies the bulk of the electricity while solar energy is starting to play a stronger role due to the high price charged by ESCOM. Fuels are also used and required on a daily basis for running machinery such as trucks and tractors to manufacture feed on and off the farm and to transport feed over long distances to farms.

The main outputs of a dairy farm are milk, meat in the form of cull cows and bull cows but also methane gasses. These gasses are released directly by the cows when they ruminate and when the manure is handled at the dairy.

Conceptualizing a typical dairy farm assisted the researcher in identifying environmental issues along the production of raw milk on a dairy farm. The results suggest that the environmental aspects of dairy farming can lead to severe impacts on the receiving environment if not managed appropriately. These negative environmental issues are identified and thoroughly discussed in section 2.4 of this dissertation.

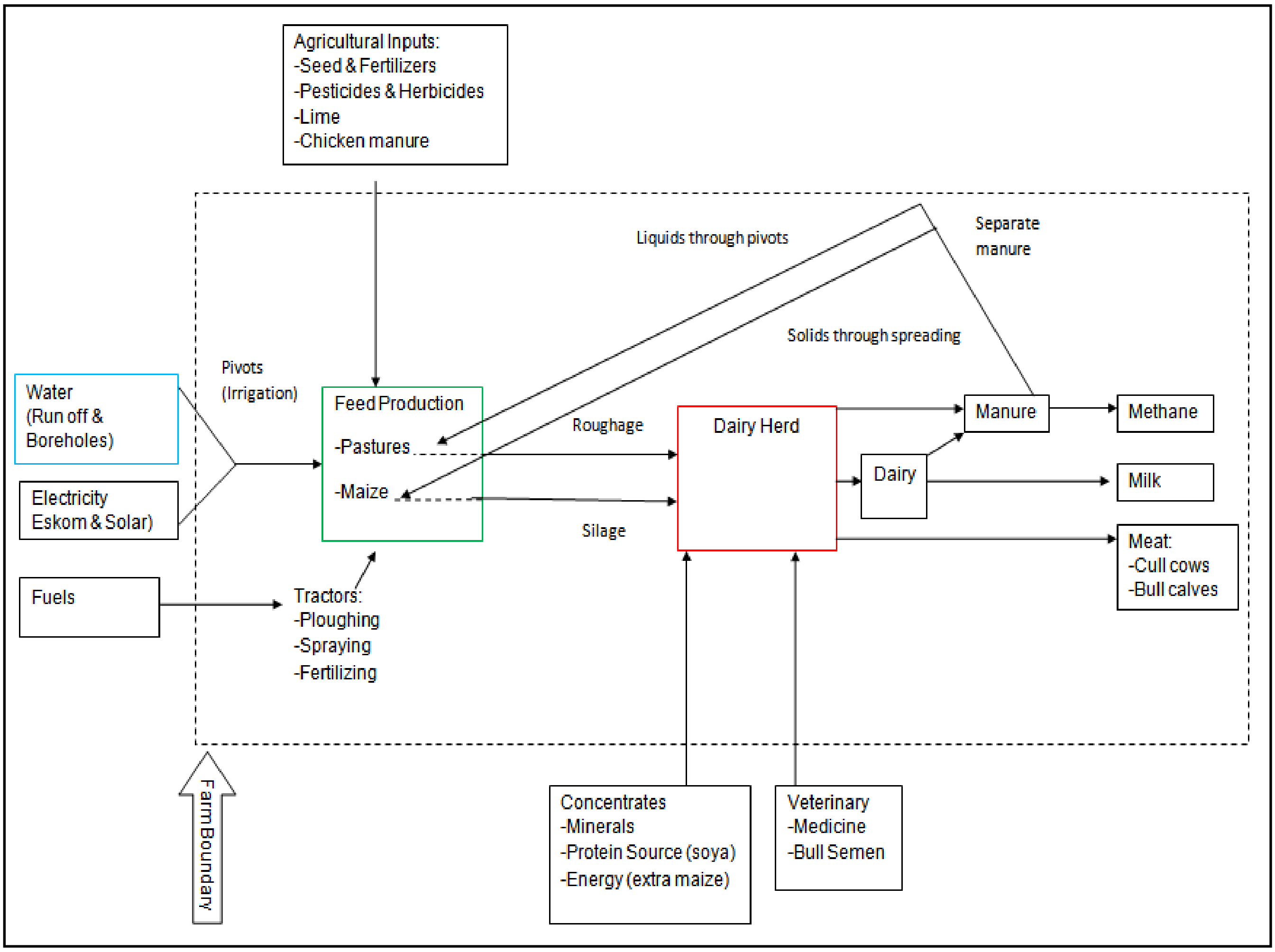

Figure 2.3: Life cycle on a dairy farm in South Africa

2.4 Environmental aspects related to dairy farming

To understand environmental aspects and impacts it is important to first understand the language of ISO 14001, where an environmental aspect is described as "an element of an organization's activities, products, or services that has or may have an impact on the environment." Environmental impact is seen as any change to the environment, whether adverse or beneficial, which results from an organization's activities (EMS, 2002). The aspects of dairy farming activities often lead to direct or indirect environmental impacts, which in turn lead to degradation of the surrounding environment.

In recent years livestock sectors gradually received more attention on the topic of its environmental impacts. The publication “Livestock`s Long Shadow” (Steinfeld et al., 2006) pointed out that livestock uses a vast amount of natural resources and is a prominent source for environmental pollution. The publication placed livestock farming even more under the spotlight after the study of Steinfeld et al. (2006) revealed that livestock farming contributes to 18% of total global anthropogenic greenhouse gas emissions. This study receives even more attention especially in times when climate change is a prominent topic.

Global concerns about environmental impacts are seen as a priority within the political, economic and social agendas, and are particularly linked to agriculture practices. All forms of food production have a significant environmental impact as populations worldwide continue to increase. It is essential to produce high-quality food products which will meet the population demand and make efficient use from a restricted natural resource supply while minimizing effects on the environment (Capper et al., 2008).

According to “*The Guide to Good Dairy Farming Practice”* published by the FAO/IDF (2004), any form of dairy farming and milk production must be managed in balance with the receiving environment surrounding the farm (FAO / IDF, 2004). The increase in dairy production observed globally and within South Africa, must take into account any potential hazards which can be directly linked to pollution of the surrounding environment (Steinfeld *et al.,* 2006; FAO, 2007). The increase in dairy production is linked to the growing demand for dairy products and results in the increase in pressure on the available natural resources such as water and soil more than ever before. Dairy farmers worldwide tend to have approximately 270 million cows to be able to produce milk. The milk production process from “cradle to grave” has a significant impact on the environment in several ways. The significance of these impacts is determined by farmers’ practices on and management of their farms (WWF, 2012).

One of the sub-aims of this dissertation is to focus on the relevant environmental impacts of dairy farming as it emphasises the challenges related to the pollution. If aspects on dairy farms are not managed well, they may lead to the following forms of pollution and/or environmental impacts:

- The manure produced by dairy cows generates greenhouse gas emissions in the form of ammonia and may contribute to acidification and climate change;

- The mismanagement and/or handling of fertilizers may lead to groundwater pollution and surface run-off caused by over-application of pesticides, fertilisers and organic slurry on pastures and can result in the degradation of natural water resources;
- The unsustainable use of pastures and/or feed production may lead to overgrazing and degradation of critical ecological areas such as wetlands, prairies and forests; and
- Changes in land utilisation and the extension of field margins to river banks may lead to soil and bank erosion as well as siltation of rivers, loss of habitats and biodiversity (Turner, 1999).

To critically analyse the legal dimensions to the environmental impacts, it is important to indicate where environmental aspects can result in environmental impacts. The environmental impacts will also be discussed in greater detail bellow:

2.4.1 Water

Freshwater resources have most certainly been the most affected by intensive agriculture around the world. Blackwell et al. (2006) point out that evidence exists that dairy farming has contributed significantly to the degradation of freshwater. These impacts reduce freshwater plant and animal diversity, reduce productivity of water, threaten public and animal health and diminish aesthetic and recreational values of waterways (Blackwell et al., 2006).

Dairy farming activities beyond doubt have an impact on natural water resources, especially in light of the definition of pollution as set out by The National Water Act 36 of 1998:

> "Pollution means the direct or indirect alternation of the physical, chemical or biological properties of a water resource so as to make it-
>
> (a) Less fit for any beneficial purpose for which it may be expected to be used; or
>
> (b) Harmful or potentially harmful-
>
> (aa) to the welfare, health or safety of human beings;
>
> (bb) to any aquatic or non-aquatic organisms;
>
> (cc) to the resource quality; or
>
> (dd) to property."

The aspects of dairy farming activities that have or may have an impact on natural water resources are mostly caused by mismanagement or ineffective use of irrigation, fertilizer and liquid slurry. This aspect is subsequently described:

It has been reported that South Africa's water ecosystems have been severely degraded by, amongst others, the discharge of untreated effluent which is increasing continuously (DEAT, 2006). The mismanagement of liquid slurry from the livestock on dairy farms leads to untreated effluent seeping into waterways and watercourses (Figure 2.4), causing water pollution, especially in higher rainfall areas and on sandy-soil areas (Briggs & Courtney, 1989). The concentration of herds in smaller surface areas increases the potential for pollution from slurry and washings (Turner, 1999; Subak, 1997; Kuhn, 2000). Poor management and improper maintenance of the waste storage systems also lead to direct water pollution on the farms, as the dams tend to break and leak effluent into the surrounding water resources (Red Meat Abattoir Association, 2012; Torr, 2009).

Figure 2.4: Water pollution caused by effluent run-off from storage lagoons

Source: Researcher's own photographs

Carpenter (1998) advices that pollution of a water resource originates from a certain point source, which point source is easy to identify and is mostly within a small or confined area. The above-mentioned point source may include any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, vessel or other floating craft from which pollutants are, or may be, discharged (Kanamugire, 2010; Altaner, 2016).

The pollutants may also enter through non-point sources, which consist of larger areas of a more diffuse nature (Carpenter, 1998). An example of a major non-point source of pollution is combined sewer systems (Kanamugire, 2010; Altaner, 2016) – the reason being that these sewer systems have a single set of underground pipes and are used for collecting manure and storm water runoff from the farm roads for wastewater treatment (Grobler, 2012: Torr 2009). Torr (2009) further states that when storm water runoff exceeds the capacity of the sewers, it causes the sewers to block and eventually spill untreated sewage into surface waters, resulting in freshwater contamination.

The high levels of nitrogen and phosphor contained in the liquid slurry can affect the quality of surrounding groundwater and lead to severe degradation of aquatic and wetland ecosystems (Turner, 1999). The water polluted with faecal pathogens also affects the drinking quality of water and recreational uses thereof due to the serious health effects posed to humans involved (Davies-Colley et al., 2003; Kuhn, 2000). The contaminated water also effects livestock and leads to reduced growth, morbidity or even mortality and is not a new concerning topic (Smith et al., 1993). While it has been 24 years since this statement was made by Smith et al. (1993), it still holds significance today.

The mismanagement of chemical and organic fertilizer can lead to over-application of fertilizer to pastures (Ford & Taylor, 2006). Heavy application of manure and fertilizer to soils for an extra source of nutrients will cause runoff from pastures and can also severely contaminate the surrounding natural water resources (Goutondji, 2007; Carpenter, 1998).

A study conducted in New Zeeland has revealed that elevated nitrate (NO3) levels are found in several shallow groundwater aquifers and are especially found in high herd-stocking areas and below dairy farms (Ministry for the Environment, 2007b). Cassells and Meister's (2000) study has shown that leaching of one kg nitrate will pollute up to 88.5 cubic metres of underground water (88,496 litres) and the water will transform from a zero-nitrate level to a level 11.3 mg/L nitrate. The contamination of nitrogen in the drinking water can have a serious impact on people consuming the water and can lead to certain types of cancers, such as blood disease in infants (Carpenter 1998). Unnecessarily high levels of nitrogen and phosphorus in surface water will have a significant impact on the natural water and the ecosystem within (Carpenter, 1998). Extreme levels of nitrogen will lead to an increase in plant growth and can result in algal blooms and an excess of aquatic weeds, leading to enhanced phytoplankton growth known as eutrophication (Marsh, 2012b; Tilman, 1999). Eutrophication will lead to highly fluctuating oxygen levels in water and is harmful and deadly to aquatic species and hazardous for human consumption. Eutrophication also results in poor water clarity, and the degradation of the aesthetic appeal of fresh water (Chadwick & Chen, 2002; Smith et al., 1993). The environmental impacts of extreme levels of nitrate in aquatic ecosystems is identified in a list of ecological effects in and include the outbreaks of nuisance species, loss of biodiversity, change in structure of food chains and destruction of fisheries (Tilman, 1999, p. 5995).

An added problem linked to excess nutrients is the time it takes between nutrients applied to pastures and reaching groundwater, rivers and lakes, which is also known as "lag time". The lag in time can cause problems in calculating the nutrient inputs to freshwater and can severely delay the success in management to controlling nutrient levels. Lakes and dams can be a useful tool in determining the impact of land use on water quality. Vant and Huser (2000) declare that nutrient levels in lakes and dams can directly reflect on the land-use within the catchment area. Though, it is reported that the impacts from present land use may not be evident in lakes for years to come because of the lag times for nutrients to reach water sources. Time lag between the action taken and the direct consequential effects on water resource quality will differ depending on catchment size, location and activity in the catchment area. Even if significant changes are made now to reduce nutrient run-off from pastures, it is still evident that nutrient levels will increase due to past activities and result in a delayed and continuous impact on the water quality (Vant & Huser, 2000; Turner, 1999).

Irrigational systems on a dairy farm can have two major environmental impacts when not managed effectively. Firstly, irrigation systems make use of great volumes of water on a daily basis and lead to the reduction of water levels in dams. When water levels are not monitored, and a vast amount of water is used for irrigation within a brief period of time, it can have negative effects on the receiving environment. Irrigation decreases the natural water flow, thereby raising temperatures and changing the sediment movement, causing numerous water quality issues such as reduced water clarity, damage and smothering of aquatic organisms and habitats (McEwan & Joy, 2011 & 2013). The movement of excess sediment results in reducing light transmission through water; thereby causing reduced visual clarity and availability of light for photosynthesis (Davies-Colley & Smith, 2001). A decrease in photosynthesis will result in reduced plant biomass and food availability which can have a negative impact on the total ecosystem. Secondly, irrigation allows farmers to grow additional pasture and allows them to have more livestock on the pastures. The extra livestock will result in more manure and urine deposition on pasture and increase nitrate leaching. Linked to this intensification of pastures is the application of excess fertilisers to support pasture growth and boost milk production; thus, irrigation increases the threat of nitrate-leaching (Green et al., 2012). The potential for nitrate runoff also increases through irrigation and can result in either surface runoff or sub-surface flow, which occurs when unnecessary volumes of irrigational water is applied (McDowell et al., 2011).

Any form of dairy farming consumes large volumes of water to grow feed, to provide drinking water for cows and to manage manure generated in the milking parlour. The management of aspects concerning water resources is vital because, as Steinfeld *et al.* (2006) put it, water resources have become scarcer since the last century and some of the main reasons are the pollution of natural water resources and soil erosion caused by rapid run-off from agricultural practices.

2.4.2 Air

Eckard et al. (2010) explain that it has been estimated that agricultural practices account for 10-35% of global greenhouse gas (GHG) emissions and of this, livestock is responsible for the largest part at nearly 80% of global agricultural emissions. From 1990 to 2005 worldwide agricultural emissions amplified by 17% (Intergovernmental Panel on Climate Change, 2007; Monteny *et al*., 2006). Dairy farming is a significant source of certain pollutant gases, which are variously associated with air pollution, global warming, ozone depletion and soil acidification (McCarthy, 2001; Turner, 1999).

Subak (1997) argues that all dairy farming operations generate air pollutants and odours and the way livestock, and their manure are managed will determine the impacts thereof on the environment and on human health. The size in the farming operation will have a direct effect on the significance of the air quality impacts. These aspects are often difficult to manage or to monitor and when these aspects are mismanagement it will lead to significant air pollution (McCarthy, 2001).

Methane and nitrous oxide are the two-major agricultural GHG emissions associated with dairy farming. Methane and nitrous oxide are to a large extent more potent than carbon dioxide (McCarthy, 2001). In relation to potential warming, methane is 21 times more destructive than carbon dioxide (Li, 2005). Li (2005) mentions that methane has a much shorter lifespan (10-12 years) than nitrous oxide (120 years) when released into the atmosphere. Methane is formed by the digestive processes ruminant in warm-blooded animals such as sheep, cows, goats and deer, and is known as enteric fermentation. The concentration of livestock will increase the enteric fermentation and the amount of methane generated on a farm. On dairy farms the cows are concentrated when they spend a significant part of the day in one confined space, for instance the milking parlour (Figure 2.5) or feed-based areas. Methane is also produced through the releasing of animal waste to the environment. These emissions from animal wastes contain methane from organic fertilizer deposited on pasture and methane from nitrous oxide emissions produced by animal faecal material in waste storage systems such as the anaerobic pond systems. Nitrous oxide is primarily produced from excessive nitrogen fertiliser, dung and urine application to soil (Pinares-Patino *et al*., 2009). The mismanagement through excessive application of fertilizers to soil and overfeeding dietary practices of nitrogen to livestock will lead to extreme levels of nitrous oxide released into the atmosphere.

Dairy farming operation are also responsible for the release of carbon dioxide through diesel exhaust particulate matter emissions from manure spreaders, tractors, semi-trucks and other various farming equipment. More carbon dioxide will be emitted through emergency generators, stationary diesel and other combustion sources (WWF, 2012).

The operational activities on a dairy farm give lead to large volumes of GHG emissions, which results in atmospheric impacts when not managed effectively. The management of aspects related to air pollution is vital and according to Steinfeld *et al*. (2006) the farmers will receive more pressure to mitigate emissions due to the ever-growing concern about global warming becoming more prominent.

Figure 2.5: Concentration of cows in milking parlour
Source: Researcher’s own photographs

2.4.3 Soil

The intensification of dairy cultivation has direct impacts on soil and production of crops, which will have an effect on the potential future land use (Hoffman & Todd, 2000). When aspects concerning the management of soil are not managed effectively, major problems regarding soil erosion and loss of soil fertility will be experienced (Hoffman & Todd, 2000). These negative issues are discussed below:

Four key issues have been identified as causing damage to soil and threatening the loss of soil resources. These are overgrazing, soil compaction, excessive fertility and accumulation of contaminants (Taylor, 2011). These issues are particularly problematic for dairy farming as the mismanagement of soil will lead to an impact on soil fertility and have a direct impact not only on the receiving environment but on the total production of the farm (Mackay, 2008; Pande, 2002).

The intensification of dairy farming has resulted in a vast number of animals kept in limited spaces near the farm border. Dairy farming is one of the major contributors to soil erosion globally (Turner, 1999). The open-based pasture systems used in dairy farming are known to transform natural vegetation into pastures and/or crop production areas (Gold, 2004). When the pastures on dairy farms are not well-managed and rotated regularly, overgrazing of land will take place (Gibson, 2006). Gibson (2006) further states that overgrazing will greatly contribute to severe loss of vegetation, fertile topsoil and organic matter which may take decades to replace and eventually lead to land degradation. Soil erosion is regarded as one the most unsettling environmental problems in South Africa (Hoffman & Todd, 2000).

Overstocking of cows and using heavy machinery, together with other mismanagement practices such as frequent ploughing for rotational grassland will cause soil compaction (Taylor, 2011). Compaction has severe physical impacts on soil quality and may limit production and lead to increased runoff of contaminants. Taylor (2011) points out that soil compaction is identified as a major issue due to the large area of land affected and potential impact associated with it. When soil is unable to support the weight forced onto it, compaction will arise (Ledgard et al., 1996). Compaction will intensify when soils are wetter, when livestock graze during dry season rotations and at higher livestock rates (Mackay, 2008; Pande, 2002). The most prominent impact that results from compaction is the decrease in plant cover which leads to exposed soils which will affect the physical properties of the soil (Nguyen et al., 1998; Pande, 2002). According to Mackay (2008), soil properties are affected by the decline in the amount of macropores, known as air pockets in soil. The decline in macropores will result in reduced drainage and aeration (Mackay, 2008). Drewry (2006) explains that the reduction in water storage can lead to increased runoff into surface waters; thus, soil erosion (Nguyen et al., 1998) and surface ponding of water on land (Mackay, 2008; Pande, 2002). According to Taylor (2011) the result of these effects can lead to flooding and sedimentation on land and in waterways and will result in environmental impacts (explained in 2.4.1). Furthermore, compaction will affect soil infiltration; thus, soil drainage (Mackay, 2008). The damaged soil structure can also limit root growth and nutrient uptake of plants, which will affect plant productivity negatively and result in less feed for livestock (Merrington *et al*., 2002; Rejesus & Hornbakerer, 1999).

The application of high-volume non-organic fertilizers together with other agricultural chemicals to pastures often contains heavy metals and can result in an imbalance in the nitrogen turnover of soil (Almasri, 2007; Merrington et al., 2002). Plants are reliable on nutrients to grow and the major nutrients required on dairy pastures are nitrogen (N), phosphorus (P) and potassium (K) (Rejesus & Hornbakerer, 1999). Nitrogen can be fetched from the atmosphere by plants, but phosphorus must be added to increase production (Thorr, 2009). Sparling and Schipper (2004) reported that a significant amount of nitrogen build-up and high levels of potassium were found in the soils under dairy pastures, which hold the potential of increasing leaching and runoff into the surrounding environment. Increasing levels of nitrogen and phosphorus in soils are likely to be contributing to increasing nutrient levels in fresh water causing detrimental ecosystem effects (explained in 2.4.1).

Merrington *et al*. (2002) point out that dairy farms can have a severe impact on soil quality when grazing systems and fertilizer application are not well-managed. The aspects linked to the management of soil are critical, as a decrease in soil quality will have a negative effect on the overall production and life cycle of dairy farming.

2.4.4 Biodiversity

Demand for the increase of food production results in the degradation of natural habitats which are rich in flora and fauna. The transformation of natural areas into cultivation has led to degradation of land and resulted in the loss of several rare plant and animal species (Gold, 2014). According to DEAT (2006) about 80% of South Africa's land is used for agricultural practices and 69% thereof is used for grazing of large livestock, which puts pressure on natural plant resources (Hoffman & Todd, 2000).

Loss of biodiversity and desertification of land surface takes place on a global scale and is prominent in agricultural practices as a result of overgrazing, deforestation and poor agricultural practices (McLaughlin, 1995). The aspects of the management of total available uncultivated land together with the management of sensitive ecosystems will have an effect on the outcome of biodiversity on a dairy farm.

According to Piggott et al. (2012) the interactions of the ecosystem are complex and can be influenced by numerous effects known as "stressors". Matthaei et al. (2010) state that by addressing only the effects of one "stressor" in isolation it will produce an unrealistic result. Matthaei et al. (2010) found that when "multiple stressors" are combined to evaluate cause of effect on biodiversity, the results are more realistic in natural rivers and streams impacted by dairy agriculture land-use practices. The sediment level and stream flow affect invertebrate abundance in stream channels (Matthaei *et al*., 2010). Matthaei *et al*. (2010) study also found that a decrease in flow combined with increase in sediment levels reduced total invertebrate abundance in rivers. Furthermore, threats identified for aquatic species include habitat loss and degradation and is particularly due to intensification of agricultural land use and agricultural mismanaged practises such as contaminants in water, increase sediment, declining water quality and water abstraction (Piggott *et al*., 2012).

Historical impacts on land from dairy farming include native forest removal (particularly lowland forest) and wetland drainage (Turner, 1999). These changes resulted in large scale habitat removal and biodiversity loss and occurred mainly during land transformations to agriculture decades ago (Hoffman & Todd, 2000; McLaughlin, 1995). Agricultural practices have transformed natural landscapes into simplified, disturbed and nutrient-rich systems (Tilman, 1999:5995). Modern agricultural practices apply external inputs to control pests, crops and soil fertility (Tilman, 1999). The once natural ecosystems that contained a vast amount of different plant and insect species have been replaced by one crop or species known as monocultures (Tilman, 1999). According to Lee *et al*. (2008) agriculture practices furthermore lead to the adding of exotic species into local species ecosystems and do not assist global or national biodiversity's, especially if the number of indigenous species decreases.

Dairy farming can have a significant impact on the biodiversity of any area where activities related to dairy farming is not well-managed. The aspects around the management of "multiple stressors" are critical, as a combination of different farming activities will result in major impact on the total ecosystems of the area (Matthaei et al., 2010).

2.4.5 Waste Generation

"Waste" is the term used in order to describe by-products generated by dairy farming activities and can in general not be sold. These by-products include: solid manures, slurries, wastewaters, discarded milk, disinfectants, detergent and silage leakage (Nicholson, 1994; Steinfeld *et al*., 2006). The mismanagement of these agricultural wastes can result in several significant environmental impacts along the life cycle of dairy farming. The aspect around waste management is critical for sustainable farming, because if waste is not well managed it can lead to water pollution, land degradation and air pollution, which hold serious threats to humans and environmental health.

The mismanagement of agricultural wastes can result in transfers of organic matter and nutrients to nearby water sources and can be identified as point source and non-point source (Carpenter *et al*., 1998). When the transfer and storage of dairy wastes is not executed and well-managed, point source pollution will occur through leakages and spills of storage facilities (Figure 2.6). According to Giason *et al*. (2002) when the intensity of dairy farming increases together with the number of livestock on a single farm, attentions has already to the management of manure and the impacts it may have on the environment. According to the research of Nicholson (1994) on systems of storage and disposal of wastes on a dairy farm, results found that pollution incidents occur through flaws in the management of waste storage facilities and are insufficient in terms of construction, size and location. Therefore, all water resources adjacent to areas of waste generation, storage or application to pastures may potentially be at risk of point source pollution.

The non-point source pollution can occur through the spreading of organic slurries on pastures in the form of manure from dairy parlour. When the spreading of slurries is not managed effectively it can result in run-off from pastures and will contaminate natural water resources. Merrington *et al*. (2002) states that in modern intensive farming of livestock, the save disposal and storage of wastes is of great concern to farmers, because the wastes contain substantial amounts of Nitrogen and Phosphorus. Organic pollutants from dairy farming accounted for roughly 90% of all recorded farming pollution and caused more incidents than all the other agricultural sources combined in the UK (Merrington *et al*., 2002). According to Hoffman *et al*., (2001) the most regular causes of organic pollution includes the release of untreated dairy wastewater to the surrounding environment, poor containment of wastes and surface run-off from fertilizers and slurries following spreading to pastures. Dairy wastewater is typically generated by the runoff from holding areas, silage pads, milking parlour wastewater and feeding areas and consists out of a mixture of milk residue, manure, feed and cleansers (Northcott, 2004). The waste that gets flushed out during the cleaning on the dairy parlour, are the primary contributors to eutrophication of ground and surface waters on dairy farms.   The process and major impacts of eutrophication is explained in section (2.4.1).

According to a study done by Chung *et al*. (2013) the methane emissions from dairy parlour waste stored in anaerobic ponds ranged between 2-3 times higher than the estimated 0.315 Mt CO2-e used in the New Zealand Inventory. This is a major problem bearing in mind that manure collected in milking parlour is not the only source of dairy waste. When additional sources of waste are added to the life cycle of dairy farming in the form of waste or discarded milk, manure from feed and stand-off pads, chemicals from washing and sterilization, landfill sites and supplementary feed waste, the emissions will increase to about three to six times higher than reported (Chung *et al*., 2013).

Dairy farmers make use of their own landfill sites on farms, because of the long distance from farms to municipal landfill sites. These landfill sites can result in server environmental impacts if not managed with great caution and reasonable measures (Sabahi *et al*., 2009). The main environmental crisis arising because of landfills sites is groundwater contamination from leaches (Sabahi *et al*., 2009). According to Ibitoye (2001) landfills directly render the soil and land where it is situated, and it also destroys the nearby soil areas because the toxic chemicals spread over the adjacent soil with time. Aside from the methane gas produced through landfill sites, other household and agricultural chemicals that end up in landfills like ammonia and bleach can generate toxic gases that will result in a significant impact to the air quality within the landfill vicinity (Akinbile, 2012). Landfill sites can also supply feral animals with a source of food and shelter, which can lead to the spread of exotic diseases to regional agriculture livestock.

The constant daily generation of dairy waste is extremely challenging for dairy farmers and the management of aspects around waste must be handled with great caution. If the aspects are not managed effectively, through untreated effluent channelled to the open environment, no regular effluent sampling and no effective monitoring system of chemical cleaning, it will result in significant contamination of surface and underground water.

Figure 2.6: Manure storage in dairy lagoons.
Source: Researcher's own photographs

2.4.6 Energy and non-renewable resources

The energy consumption of dairy systems is relevant to this dissertation because of high carbon dioxide emissions together with high consumption of energy and non-renewable resources which result in the ever-growing demand for electricity. The global demand for electricity alone will amplify the energy demand by more than 70% in 2040 (International Energy Agency). At the same time, the key forms of energy are produced from non-renewable resources and are a major source of environmental impacts such as Global Warming. According to the Food and Agriculture Organization of the United Nations (FAO) the demand for dairy products is expected to increase by 58% from the year 2010 to 2050 (Torr, 2009). The increase demand of dairy products will lead to increased production from farms and can only be accomplished by adding more livestock to the herd or by increasing the yield per herd (Burger, 2008; Kanamugire, 2010). As the farms develop and intensify through mechanized and automated products, the direct use of electricity per farm will increase and will result in environmental impact. It has never been more essential for dairy farms to use energy more effectively (Burger, 2008: Subak, 1997). The aspects around energy and non-renewable resources must be managed on a responsible way, by looking at future consumption of energy through greener and cleaner energy sources.

Animal agriculture such as dairy farming makes use of energy on a direct and indirect manner. The direct usage is from diesel to operate machinery such as tractors or through electricity to operate electrical equipment indoors and irrigational systems outdoors. The milking parlour uses a vast amount of electricity on a direct manner and includes high pressure water pumps, cooling of milk tanks, water heaters, rotary milking platforms, electrical feeders and lighting. The indirect use is through diesel to transport feed over long distances to the farm when needed. The biggest uses of energy on dairy farms are the milk harvesting and cooling process, lights and the ventilation system. There are opportunities in each of these areas to improve energy efficiency while maximizing milk quality and animal well-being (Corscadden *et al*., 2014).

Energy conservation and the use of renewably produced energy are at the top of many nations' political agendas. There is increased pressure from consumers for dairy farmers to minimize their impact on global warming by reducing energy consumption (Ludington, D, & Peterson R, 2005). Even though energy use is not a substantial portion of the total production costs on a dairy farm, it makes economic and environmental sense to make the most efficient use of energy on the farm (Clark, S. & House, H, 2010). Energy-use changes can start small and can be done by means of energy audits and proper maintenance. The energy audits performed by a third party or by means of a self-audit can determine whether investing and implementing modern technologies are more cost effective and can result in reduced carbon footprint of the farm. Proper maintenance will maximize performance and energy efficiency (Corscadden *et al*., 2014). If the aspect concerning energy consumption and the constant use of non-renewable resources is not managed affectively, it can, over an extended period, result in environmental impacts.

2.5 Environmental law in South Africa

The protection of environmental resources is of growing concern to agricultural producers and consumers worldwide (Merrington *et al*., 2002). South Africa has an obligation to meet international standards and commitments to be identified as a globally responsible country (South Africa, 2000). The commercial dairy systems in South Africa are aware of the regulations concerning the production of dairy products through assistance of a well-organized private sector.

This private sector works directly with governmental institutions at national, regional and local levels. These governmental institutions are mostly committed to the quality control and monitoring of milk production in South Africa. National laws and regulations are strongly implemented and most of them follow the International regulations for the very reason that South Africa is actively involved in the importation and exportation of dairy products. The South African legislation connected to dairy production and environmental protection is well-documented. However, the implementation and enforcement of the environmental laws on dairy farmers is not successful or well-investigated (Steinfeld *et al.*, 2006; Strydom *et al.,* 2001). The lack of implementation of this legislation has been noted for the containment of dairy run-off on farms as well as the use of chemicals, which are both related to environmental care. It was recommended that in South Africa, the implementation of the relevant legislation regarding environmental care at farm level be improved and better implemented, aligned with the international norms and standards, because South Africa has a significant commercial dairy farming sector (Glawzeski, 2005; Strydom *et al.,* 2001; Slabbert, 2007). Therefore, South African authorities need to reduce pollution and improve waste management for it to be fully included in the global community (South Africa, 2000).

The development of environmental legislation and policies, coupled with the included environmental rights within the Constitution of the Republic of South Africa Act, 108 of 1996, has led to a comprehensive framework for environmental laws. However, according to Hoogervorst *et al*. (1999), these laws have been unsuccessfully enforced in the agricultural sector and more awareness is needed, especially within the dairy sector. The study of Grobler (2011) further states that there is a definite need for environmental law and regulations, which specifically regulate and resolve the environmental impact related to activities on dairy farms in South Africa. Without effective and sufficient legislation to specifically regulate the industry, the activities on dairy farms can lead to significant impacts on the receiving environment. The South African government is gearing up to involve as many as possible key stakeholders in the promotion of environmental sustainability in the agricultural sector (Torr, 2009:30). This approach is crucial if a positive relationship is to exist between the agricultural sectors and the receiving environment within the borders of South Africa. Farmers need to be aware of the significance of sustainable agricultural practices and incorporate the relevant environmental legislation into their farming activities. Through successful interaction with key stakeholders, implementation and management of environmental legislation, the impacts on the environment can be managed and mitigated.

Alberts and Nell (2013:37) point out that environmental law forms the basis of environmental management. It lays down the prescriptive rules within which environmental management ought to take place, and what must happen when departures from the prescribed legal norms and requirements occur. Therefore, Environmental law defines how and to what extent the people and organisations must conduct their activities and themselves in matters distressing the environment. Environmental law further sets the norms and the sanction for the departure therefrom, whilst environmental management is rather seen as the tools and mechanisms used to give effect to the norms and to make sure that departure therefrom does not take place, and if it does, the implemented measures will halt and rectify these departures (Alberts & Nell, 2013:38).

In the interest of comprehending Environmental Law in South Africa it is essential to fully understand the regulatory framework or hierarchy of regulatory control as illustrated in Figure 2.7.

Environmental law provides for prescriptive norms that are general or specific in nature. These general norms are for example seen as the duty of care and the duty to prevent damage and degradation of the receiving environment. The specific norms and substantive measures are presented in terms of regulations, standards and norms and permit conditions amongst others. The general duty of care is prominent in a variety of Environmental Law and is for example established in section 28 of the National Environmental Act, section19 of the National Water Act and in section 19 of the National Environmental Management Waste Act. The general duty of care applies to all human activities that do cause, those that may have the potential to cause and those that have already caused environmental impacts or degradation to the receiving environment.

However, there are several activities which pose an even more serious environmental risk and are deemed to necessitate a higher level of regulatory control measures. These more rigid regulatory measures are over and above the reasonable measures as set out in general duty of care. The activities falling within this regulatory sphere are for example regulated by generic norms and standards, general authorisations and regulations.

Nevertheless, also numerous activities occur which potentially can pose an even more serious environmental threat, and which requires more significant regulatory measures, for example environmental assessments (EIA's), issued with specific site authorisations, licences or permits to set out the substantive regulatory provisions applicable to that activity at a specific site. Certain strategic level decision support tools also exist within this regulatory sphere, such as Environmental Management Frameworks (EMFs), Strategic Environmental Assessments (SEAs), coastal management plans, bioregional plans and other spatial planning tools which can also assist in categorising activities which cannot take place within a specific context and is usually geographical due to their possible damage to a sensitive environmental feature.

Hence it is clear that all human activities regulated by environmental law in South Africa, as briefly discussed above, will fall within one of the hierarchical regulatory spheres as illustrated in Figure 2.7. The level of control applicable to these activities will differ from sphere to sphere and ranges from reasonable measures to extremely prescriptive and site-specific conditions. Through this regulatory cycle the government will identify the need for, adopt, and enforce law in general, and by implication environmental law in particular (Alberts & Nell, 2013).

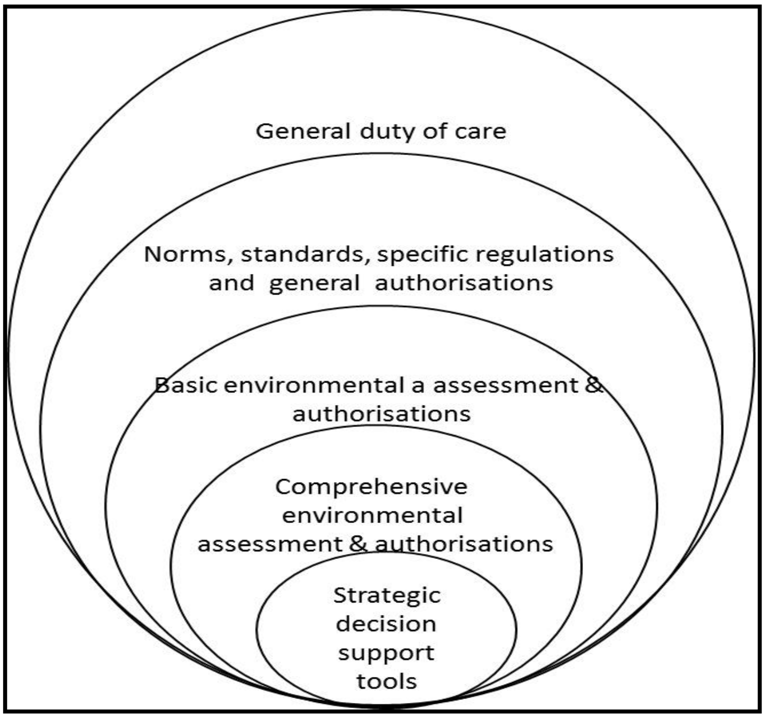

Figure 2.7: Framework for Environmental Law in South Africa
Source: Alberts & Nell (2013)

Section 2.5 of this dissertation will assist in addressing the sub-research aim to identify and describe existing environmental regulatory requirements for a dairy farm in South Africa by investigating the applicable environmental legislation regarding activities on dairy farms. The objective is to determine whether South African environmental law makes provision for the necessary provisions required to adequately regulate the dairy farming industry and effective enforcement procedures. Various policies and legislations are applicable to all types of dairy farms in South Africa and are summarised in the hierarchical regulatory spheres in Annexure 1. It is important to note that the environmental legislation discussed in this dissertation concluded on December 2015 and all new amended legislation after this date is not included. The following environmental legislation contains provisions which regulate the various activities on dairy farms:

2.5.1 National Environmental Management Act 107 of 1998

The National Environmental Management Act (NEMA) provides co-operative environmental governance and is mainly based on the principles as set out in the Constitution, namely that everyone has the right to an environment that is not harmful to his or her health or well-being. NEMA further supplies the enablement, administration and enforcement of other environmental laws such as the following Specific Environmental Management Acts:

- National Environmental Management: Biodiversity Act (10 of 2004): Supports conservation of animal and plant biodiversity, including the soil and water which it depends on.
- National Environmental Management: Protected Areas Act (57 of 2003, amended No. 31 of 2004): Supports conservation of soil, water and biodiversity.
- National Environmental Management: Air Quality Act (39 of 2004) Air Quality Act (39 of 2004) : Replaces the Atmospheric Pollution Prevention Act (No. 45 of 1965).
- National Environmental Management: Waste Act (59 of 2008): Aims to prevent pollution and ecological degradation; thus protecting the environment and our health.

The National Environmental Management Act (NEMA) controls and regulates any human activity which holds the potential to have or could have a severe impact on the receiving environment. Section 2 of NEMA formulates provision for principles of environmental law; these principles have become more relevant in environmental issues. Some of these principles are seen as norms and are applicable to dairy farms due to the emerging environmental impacts of the activities on the farms.

Section 2(4)(a)(ii) states that pollution or degradation of the environment must be avoided and if not possible, it must be minimised or remedied.

Section 2(4)(a)(iv) states that waste should be avoided and if it is not possible to avoid the production of waste, it must be minimised and re-used or recycled where possible, or otherwise, be disposed of in a responsible manner. This principle evidently states that if waste cannot be avoided it must be disposed of in the most responsible manner; therefore, the waste generated by livestock on a dairy farm should be managed and disposed of in harmony with the principles as set out by NEMA.

The principles in section 2 of NEMA that are relevant to dairy farming are the precautionary principle, preventative principle, duty of care principle, polluter pays principle and cradle to grave principle. These principles supply guidance to the administration, interpretation and implementation of the NEMA Act and other environmental legislation related to the protection and management of the environment along with human health in South Africa. These principles furthermore provide a framework within which environmental management must take place, and their applicability to the dairy farming industry will be discussed as follows:

Precautionary Principle:

This precautionary principle is provided for in section 2(4)(a)(viii) of NEMA and states:

> *A risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions.*

This principle mainly requires or expects that an organisation to provide proof that the activities they desire to commence with, will not lead to significant environmental pollution (Kidd, 2011). According to Nanda and Pring (2003) when the organisation can't provide the required proof that no environmental degradation will take place, they will not be authorized to continue with the project or specific activity. Glazewski (2005) accentuates that the precautionary principle is seen to be a decision-making tool and is mostly more relevant in the developed countries; though, it has recently also expanded its applicability to developing countries. The precautionary principle is regarded as extreme but has the ability to successfully avoid pollution of the environment. To effectively apply this principle, it is essential for some assessments to be conducted with a view to predict potential harmful impacts. With regard to dairy farming it is vital that all generated waste be considered hazardous or harmful to the human health and environment, until proven otherwise (Oosthuizen & Bell, 2009). Dairy farms must ensure that generated waste on the farm is classified by the most hazardous constituent, to ensure that precautionary measures are taken.

Preventative Principle:

In agreement with the preventative principle, action needs to be taken at an early stage and preferably before any damage has been caused to the environment (Nanda & Pring, 2003). The principle allows the acceptance of environmental standards and for access to information of environmental impact assessments to be gained (Birnie & Boyle, 2009). The preventative principle also takes the form of a variety of effective systems which consist of liability rules and penalties. The cost of not complying with the required environmental legislation and standards could be severe (Birnie & Boyle, 2009). It remains fundamental that preventative measures be included in any organisation's management plans and that all potential problems are taken into account to guarantee that impacts are prevented in future practices. Dairy farms must make sure that they obtain the required preventative measures to ensure that the generated waste and fertilizers used, do not give lead to any environmental pollution or degradation.

"Duty of Care":

The prevention, minimisation and remediation of environmental impacts caused by pollution of human activities are stipulated in section 28(1) of NEMA and state the following:

> *Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.*

Section 28 ensures that compliance with environmental “duty of care” principles is stipulated and relevant whether or not activities are listed in environmental law. According to Sinclair (2008) this principle is relevant to everyone and not exclusively to businesses or industries subject to environmental authorisations. The aforementioned provision further states that any person who is in charge of any activity which has led to environmental impacts must take reasonable measures to remedy the source of pollution and minimise or prevent any further contamination to the environment (Sinclair, 2008). The reasonable measures referred to are stipulated in section 28(3) and contain the investigation, assessment and evaluation of impacts on the receiving environment; the control or prevention of emission; the elimination of the sources of pollution; and finally, the remediation of the polluted environment (De Villiers, 2007). This principle is relevant to an owner, the person who has the right to make use of the property or the person in control of the activity (Van der Linde, 1998). This principle is retrospective; hence also relevant to historical pollution (Kidd, 2011) and refers to pollution initially originated years ago and currently still has a damaging impact on the environment or human health or well-being (De Villiers, 2007). The person responsible for causing the initial pollution, which still subsists, will be held liable for costs involved to remediate the damaged environmental. The Director-General can take reasonable steps, as set out in section 28(7) to remedy the problem. If the responsible person fails or refuses to meet these terms, the costs related to the remediation will be claimed from the liable party (Kidd, 2011). It is accepted that "duty of care" must be applied to activities on dairy farms at all times, which will require from the land owner of the farm to take reasonable steps with the purpose of ensuring that pollution to the environment is prevented, minimised or remediated. This can be realised by successfully maintaining the manure storage facilities and by training staff to ensure that leakages or excessive emissions do not occur. Pollution caused by dairy farms could also be retrospective of nature and can result in long-term pollution and significant degradation to the environment. An example hereof is previous farming activities resulting in groundwater pollution (Turner 1999), as discussed in section 2.4.1 of this dissertation.

Polluter Pays Principle (PPP):

The meaning of the PPP is evident in its name; the responsible person whose actions or activities damage the environment or human well-being must be held liable. Nanda and Pring (2003) emphasise that the responsible person can be held liable for payment of the costs involved forin the remediation of pollution or any other form of environmental degradation which has a negative impact on health or well-being, as well as for the prevention or minimisation of additional environmental degradation or pollution consequent to the initial cause (Beech, 2013).

Cradle-to-grave principle:

Another important principle is the "Cradle-to-grave" principle, which states that people should be held responsible for the waste produced by them or their facilities, even after disposal thereof (Kidd, 2011). The applicable section in NEMA is section 2(4)(e), which states that:

> *Responsibility for the environmental health and safety consequences of a policy, programme, project, product, process, service or activity exists throughout its life cycle.*

It is vital that a paper trail be maintained throughout the entire waste disposal cycle. The aforementioned will enable the party in question to prove that they have adequately complied with the applicable law (Red Meat Abattoir Association, 2012). Therefore, it is of vital importance for the managers of dairy farms to ensure that they keep a paper trail and comply with the applicable laws as far as possible. The necessary paper trail consists of records, statements and a proper system which captures all the necessary information with regard to when, where and how the waste was disposed (Red Meat Abattoir Association, 2012). Without the aforementioned documentation a person cannot prove that the necessary steps have been taken to prevent pollution or environmental degradation.

The above-mentioned principles may be applied to regulate and enforce compliance in the dairy farming industry and furthermore provide guidance with proper decision making.

These principles may also encourage proper and responsible management practices, which may subsequently lead to the prevention or minimisation of pollution or environmental degradation. In addition to the above-mentioned principles NEMA also makes provision for another vital principle in terms of section 2(4)(i), which states:

The social, economic and environmental impacts of activities, including disadvantages and benefits, must be considered, assessed and evaluated and decisions must be appropriate in the light of such consideration and assessment.

Chapter 5 of NEMA further provides for integrated environmental management and supports the application of suitable environmental management tools to ensure that integrated environmental management of activities takes place. Environmental impact assessments (EIAs) comprise a pro-active and systematic process by means of which potential environmental impacts, both positively and negatively associated with certain activities, are assessed, investigated and reported. EIA's are conducted to analyse and predict the nature and extent of the consequences of a particular activity or development on the receiving environment. The process contributes to giving effect to the objectives of integrated environmental management as decision makers are informed of the desirability of such activities and on the conditions which authorisation of the activity should be subject to, where relevant.

To give effect to the above, several listed activities have been identified which may have a detrimental effect on the environment and require authorisation prior to such activities commencing. Three separate listing notices, detailing the listed activities, are published in GN R983, GN R984 and GN R985 in GG 38282 of 4 December 2014 respectively and are promulgated in terms of Section 24(5) of NEMA. There are certain activities which may potentially lead to environmental degradation; therefore, it is important for an impact assessment to be conducted to determine the social, economic and environmental impact of the specific activity. Dairy farming triggers a number of activities listed in NEMA. All the activities triggered on a dairy farm are illustrated in annexure1. The dairy farmer must be aware of these listed activities and the role they place as a management tool in the agricultural sector. Farmers must also comply with these listed activities as soon as a listed activity on the farm is "triggered". The activities are divided into three different listing notices in accordance with the severity of the activity on the environment. The three listing notices are summarised as follows:

The activities that are typically found in listing notice one (1) may hold the potential of negatively impacting the environment. However, due to the nature and scale of such activities, these impacts are commonly known and are easy to manage. Typically, these activities are considered less likely to have significant environmental impacts and therefore do not require a full-blown and detailed Environmental Impact Assessment. Listing notice one (1) stipulates the activities requiring a basic assessment report (BAR). A Basic Assessment Report is a more concise analysis of the environmental impacts of the proposed activity than Scoping EIA Reports. The BAR must provide the Competent Authority with enough information to consider the Application and to reach a decision on whether or not the activity may take place.

The activities listed in listing notice two (2) are typically much larger in scale or are more likely to result in significant environmental pollution and cannot be easily predicted. They are therefore higher risk activities that are associated with potentially higher levels of pollution, waste and environmental degradation. Listing notice two (2) stipulates the activities requiring both scoping and an Environmental Impact Assessment (EIA) and the full range of potential impacts need to be established by means of a scoping exercise prior to it being assessed. A Scoping Report (including Plan of Study) requires a description of the proposed activity and any feasible and reasonable alternatives, a description of the property and the environment that may be affected and the manner in which the biological, social, economic and cultural aspects of the environment may be impacted upon by the proposed activity; description of environmental issues and potential impacts, including cumulative impacts that have been identified, and details of the public participation process undertaken.

Listing notice three (3) contains activities that will only require an environmental authorisation by means of which a basic assessment process if the activity is undertaken in one of the specified geographical areas indicated in the said listing notice. Geographical areas differ from province to province. For purposes of this dissertation, only the Eastern Cape geographical area is investigated for dairy farms and summarized in annexure 1.

Section 24F of NEMA, titled *Offences relating to commencement or continuation of listed activity*, states that no person may commence with a listed activity without environmental authorisation from the competent authority. Section 24G provides the Minister or MEC with the power, on application by a party who has committed an offence under section 24F of NEMA, to direct that party to prepare what is essentially an environmental impact report. Section 24G is known as *consequences of unlawful commencement of activity* and is a controversial component of South Africa's environmental framework legislation, which allows for ex post facto environmental authorisation. Section 24G enables an individual or company that had commenced with a listed activity without legal authorisation to avoid prosecution by applying to the Minister or MEC for *ex post facto* environmental authorisation (Paschke & Glazewski, 2006:23).

Dairy farmers must comply with section 24F when they realise that they have previously "triggered" an activity as listed in NEMA without the required environmental authorisation. Dairy farmers can take the general steps of a section 24G application to gain authorisation of the activity. The guilty farmer seeking retrospective environmental authorisation applies to the Minister or MEC for a directive requiring the applicant to compile an EIA report containing certain information (Paschke & Glazewski, 2006:23). An administrative fee is determined by the appropriate authority in order to apply for the authorisation. After the applicant pays the administrative fine, the Minister or MEC reviews the applicant's report and then either orders the activity to be discontinued and requires environmental rehabilitation to take place within a specific time period; or grants an environmental authorisation which is normally subject to certain conditions. However, applying for *ex post facto* environmental authorisation is voluntary, and authorities may not force offenders to apply. Nevertheless, at any time, enforcement action can be taken against environmental offenders (September 2012:8).

NEMA makes adequate provision for the principle which provides guidance to dairy farm owners or managers, which ensures that management of the farms is done in an environmentally sustainable manner. NEMA also makes provision for the applicable basic assessment or EIA procedure to be followed for commencement of the listed activities on a dairy farm, in order to determine to what extent, the activities may damage the environment, and human health and well-being. The aforementioned is a very helpful part of environmental law as it is of significant importance to determine what impact the activities on a dairy farm will have on the environment or human health and well-being. It is essential for the relevant authorities to take the necessary steps to ensure that the owners or managers of dairy farms comply with the provisions of NEMA and prevent potential pollution or remedy pollution which had already occurred.

2.5.2 National Environmental Management: Waste Act 59 of 2008

Waste management is one of the critical elements of sustainable development, primarily because sound waste management practices contribute to sustainability. Legislation regulating waste management in South Africa has historically been fragmented and still is, to some extent. However, the coming into effect of the National Environmental Management: Waste Act (Act No. 59 of 2008), presents more holistic approaches to waste management regulation. The overall purpose of the Waste Act is to change the law regulating the management of waste with a view to protect both the health of people and the environment. The Waste Act does this by laying down minimum requirements for any person who undertakes an activity which produces waste or a person who handles any waste which has already been produced to comply with. This includes storage of waste, transportation, processing, including people who are reusing or recycling waste. The State has an obligation, required by the Constitution, to protect the environment and prevent ecological degradation and it does that by formulating different regulations with which everyone must comply. It is appealing to note that the Act also introduces a part that deals with polluted or contaminated land and requires anyone who has polluted land to take responsibility to assess the extent of contamination and to pay for the cleaning and rehabilitation of such land. The overall objective of this Act is to improve waste management in South Africa. The Act introduces the waste management hierarchy as the basis for waste management decision-making. The National Environmental Management Waste Act (NEM:WA) regulates the management and disposal of waste.

The general duty of care is prominent in NEM:WA and relevant to all dairy farmers, the duty of care sections is listed in annexure 1. These sections state that farmers must manage the generated waste on the farm with reasonable measures and respect to the environment, especially when it comes to the storage of general waste and recycling of waste. There are also various norms and standards relevant to dairy farming and is listed in annexure1. The general notices require that farmers ably to the norms and standards set out for waste disposal, remediation of contaminated land and standards for storage of waste.

The NEM:WA further provides for Environmental Authorisation in the form of a licensing regime specific to waste management activities. The Waste Act has commenced an improved system for licensing of waste management activities, in order to control these activities and to ensure that they do not impact on human health and the environment. It replaces the historical system of permits issued in terms of the repealed Section 20 of the Environment Conservation Act, 1989 (Act No. 73 of 1989) (ECA). The NEM:WA waste management categories determine the environmental assessment procedure required to obtain a licence. Two categories of waste management activities are listed under the NEM:WA. Category A is the management of general waste and the activities require a Basic Assessment as defined in the NEMA Regulations. Category B is the management of hazardous waste and requires a full Environmental Impact Assessment in terms of the NEMA regulations. The management of waste generated on a dairy farm falls within the ambit of the listed activities set out in Category A of the applicable regulations. The list of activities that are relevant to Environmental Authorisation is illustrated in annexure 1. For example, the storage of general waste in lagoons as discussed in section 2.4 and illustrated in Figure 2.6, is relevant to all dairy farmers as livestock generate a vast amount of manure on a daily basis. A waste management licence is required for each of these listed activities and must be obtained before commencement of the activity in question. Before a waste management licence can be obtained, a basic assessment must be conducted to ensure that there are adequate facilities for purposes of proper waste management and disposal.

The management of dairy waste is seen as a significant problem for any dairy farmer. The waste generated in the form of manure from cows can result in severe environmental impacts if not managed, stored and reused accordingly. To minimise these impacts dairy farmers must comply with the Waste Act and undertake the necessary legal licensing of any activities as listed in NEM:WA. The regulations of the NEM:WA can be adequately applied to the activities on dairy farms and the penalties can certainly act as a deterrent against actions or omission which may lead to damage or pollution. The NEM:WA further makes provision for a site assessment that needs to be conducted by an independent person, when there is reason to believe that the waste produced causes or has caused pollution. As previously discusses in section 2.4 of this dissertation, the waste generated by the dairy farm may potentially result in severe environmental impacts. The site assessment report must be submitted to the competent authority and be considered to determine whether the liable party will be directed to remediate the pollution or take the reasonable measures to prevent or minimise further pollution. The aforementioned may prove to be a very effective enforcement tool.

The NEM:WA requires of an organ of state, such as the municipality, to submit a waste management plan, but neglects to require that the business owners (in this case the dairy farm owner) also draft a waste management plan. A detailed plan to manage waste and prevent pollution is crucial. The main purpose of the Act is to ensure that the environment and health and well-being of the public is protected, which is a constitutional right that must be fulfilled. NEM:WA may regulate the waste related activities on a dairy farm to some extent, but it was found that South African environmental legislation, regarding the regulation of disposal and handling of waste, on a dairy farm is currently insufficient. There is a definite need for specific legislation or regulations regarding the management and disposal of waste on any large-scale farm.

2.5.3 National Water Act 36 of 1998

The National Water Act (NWA) is enforced by the Dept of Water Affairs to support the development, protection, management, usage, conservation and control of all natural water resources in a sustainable and reasonable way (Grobler, 2012).

The NWA regulates all activities relating to water resources and the usage thereof, which includes environmentally sustainable disposal of, for example, wastewater.

The waste generated by livestock on dairy farms are mostly solid manure, however when the manure is combined with water or any other liquid like it becomes slurry or a form of harmful wastewater as discussed in section 2.4.1. Thompson (2006) states that if the management of this slurry is not effective, it will result in spill or deposit to land or water in high volumes as illustrated in Figure 2.4. This will certainly lead to pollution and ultimately have a harmful effect on the receiving environment (Kidd, 2011). Hence it is clear that the effluent (slurry) produced on a dairy farm qualifies as pollution in terms of section 1 of NWA.
Section 1 (xv) of the NWA defines pollution as the:

> *direct or indirect alteration of the physical, chemical or biological compounds of a water resource as to make it unfit for any beneficial purpose for which it may reasonably be expected to be used; or harmful or potentially harmful to any aquatic or non-aquatic organisms; to the resource quality or to property.*

If the waste generated by farms renders the fresh water sources and makes it unfit for the purpose which it is meant for, such as household usage, it has polluted the water resource and the land owner can be held liable for payment of a fine or imprisoned, depending on the circumstances and severity of the impact (Thompson, 2006).

The general duty of care in NWA is relevant to all dairy farmers and is listed in annexure 1. Section 19 of the NWA resorts under general duty of care and makes provision for the prevention of water pollution. This section also gives effect to section 28 of NEMA and states that the owner or person, who solely manages the land, is responsible for ensuring that all reasonable measures will be taken to prevent pollution of a water resource from occurring or continuing to occur as a result of activities on the land. These measures should ensure that further pollution does not occur and also remedy the damage caused to the water resource. Section 19(4) to section 19(8) of NWA states that if a person should fail or not adequately comply with a directive issued under the competent authority, the catchment management agency may take the necessary measures to remedy the specific problem at hand and may claim all the costs incurred while remedying the problem. The costs may be claimed from the person or persons who directly contributed to the pollution or damage to the environment. Section 20 of the NWA covers emergency incidents regarding the pollution of water resources and includes any incident or accident in which a substance pollutes or holds the potential of polluting a water source. The farmer responsible for the incident has under the duty of care legislation, the responsibility to remedy the pollution. The action to be taken includes containing and minimizing the effects of the incident to all reasonable measures. Permissible water use under section (22(1)) of NWA is also listed under duty of care and states that a farmer must comply with any applicable waste standards or management practices prescribed under the NWA.

The use of natural water is controlled by regulating the way water can be used by a person or business. The National Water Act regulates water use through registration of water use and through several types of authorisations. To control water use, the Department of Water Affairs needs to know what water use is taking place and how much water is being used from the different water resources in South Africa. To gain this valuable information, the existing lawful water users are required to register their water use if they are taking and storing water, or if they cause stream flow reduction. The Department may check that the existing use is legal and may check the quantity of the use on a regular basis. Water users who do not register their water use risk losing their existing water entitlements.

Three different types of water use authorisations exist of which dairy farmers need to be aware of in terms of the NWA. These different types of authorisations determine the water use activities which require a licence and those that do not require a licence. The type of authorisation will become more strict and necessary as the activity runs an increased risk of impacting a water resource or uses more water, as illustrated in Figure 2.8.

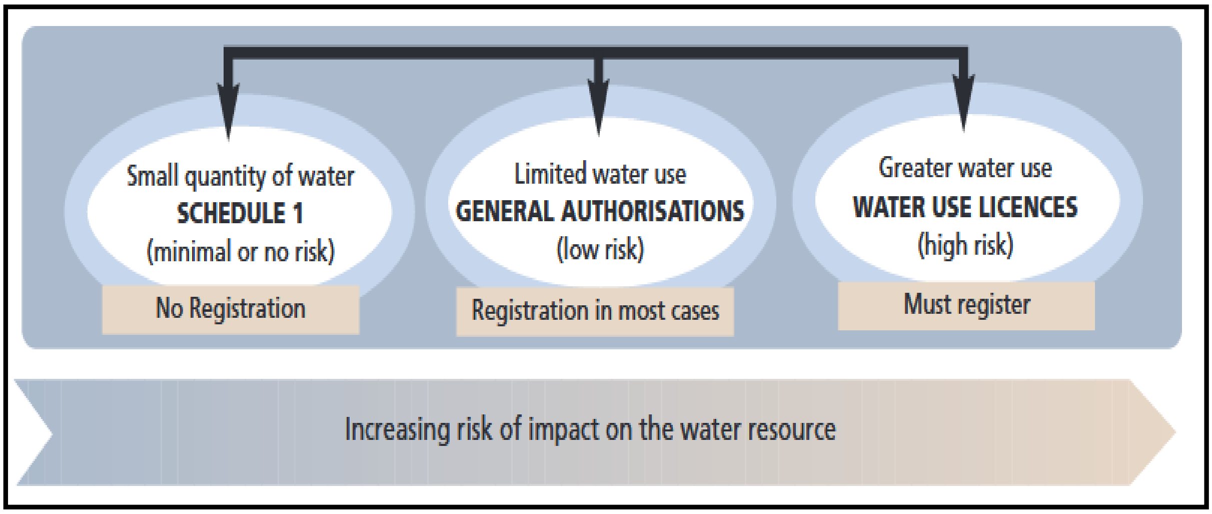

Figure 2.8: Types of water use authorisations
Source: Guide to National Water Act

The three types of water use authorisations include schedule 1, general authorisations and water use licences. Schedule 1 is the only water use which is excluded from compulsory registration and outlines permissible use of water where a licence is not required. The types of activities outlined in Schedule 1 are those that have a low volume and very small impact on the water resource.

General permission has been granted by the Minister for other slightly larger uses from certain less-stressed sources. This permission has been given by means of general authorisations published in the Government Gazette. These authorisations will allow dairy farmers to use water without a licence provided the water use lies within the conditions of the general authorisation. Examples of general authorisations applicable to dairy farmers is the storage and irrigation of waste water (GN 665); abstraction of surface water and ground water (GN 538); impeding or diverting flow within a watercourse or catchment area (GN 509); storage of a limited amount of clean water in dams (GN 538). The general authorisation replaces the need for dairy farmers to apply for a water licence in terms of the NWA.

Section 21 of NWA lists all water use activities that are subject to a water use licence application process, excluding water use under schedule 1, existing lawful use and general authorisation. The activities that generally occur on a dairy farm and require a water use licence are summarized in annexure 1. Water licences are used to control water use that exceeds the limits outlined in

Schedule 1 and allowed for under general authorisations. Water use licences give existing or new water users formal authorisation to use water for productive and beneficial purposes and specify the conditions under which the water can be used. Only a 'responsible authority' in the form of Department of Water Affairs or a catchment management agency can issue a licence to use water. Before the competent authority proceeds to grant or refuse the licence, the circumstances and possible detriment to the water resource must be considered carefully. The water use licence application process includes a public participation process, Broad-Based Black Economic Empowerment (B-BBEE) motivation of application and specialist studies in order to determine the sustainability of the proposed water usage. This comprehensive report must be submitted to the Department of Water Affairs for approval. A successful application will grant the farmer a legal right to water use in the form of a Water Use Licence.

It is not surprising that the majority of activities listed in Section 21 of NWA are focused on the disposal or reuse of waste water. As previously discussed the mismanagement of dairy waste water will lead to severe environmental impacts. A permit to discharge waste effluent into a water resource is required as well as compliance with the applicable prescribed discharge standards. In order for the owner, manager or operator of a dairy farm to legally discharge effluent, such as wastewater, a water licence must be obtained. The water licence must specifically give them permission to discharge effluent into a water resource, such as a river, and the discharge must be limited and kept within the legal requirements to prevent water pollution or to maintain it at an acceptable level. Alternatively, the waste licence must give them permission to manage a waste storage facility into which the waste can be contained and reused in the form of irrigation to pastures (GN 665). The competent authority may apply certain conditions to the water licence, for example, a specific water resource can be named for disposal purposes, treatment before disposal may be specified and the volume of wastewater disposed of on a daily basis may be limited. The water services provider of the area in which a dairy farm discharges effluent has the power to approve and then prescribe a certain manner in which the effluent must be discharged or disposed of, for example through pipelines directly into the specified water resource. The prescribed manner of disposal must be implemented from commencement of the activity which discharges effluent.

In terms of sections 151(i) and 151(j) of NWA no person may unlawfully and intentionally or negligently commit any act or omission which pollutes or is likely to pollute a water resource or have a detrimental effect on a water resource (Kidd, 2011). If dairy farms are not managed properly and leakage of wastewater occurs and subsequently leads to water pollution, the owner or manager may be convicted for non-compliance with section 151(1) and found guilty of an offence (Kanamugire, 2010). In terms of section 151(2) the penalties involved are that the person or persons can be held liable for payment of a fine of R5,000 or R10,000 or to be imprisoned not exceeding five or ten years, depending on the conviction, if found guilty of an offence in terms of the NWA (Kidd, 2011). 206 Dairy farms can avoid these penalties solely by complying with the directive (Kidd, 2011; Kanamugire, 2010).

The National Water Act is important because it provides a framework to protect water resources against over exploitation and to ensure that there is water for social and economic development and water for the future. Against the background of the above, the owners and/or managers of a dairy farm must ensure that the farm is in possession of a legal water use licence, issued under the competent authority of the relevant province. If a dairy farm operates without the required licence the owner, operator or manager can be found guilty of an offence for contravention of the NWA.

Water is a very essential and significant resource and should be protected and conserved as far as possible. Section 19 of the NWA places a duty on a dairy farm owner or manager to prevent, minimise and remediate degradation of a water resource and also provides certain sanctions and directives to realise the aforementioned. However, the prescribed penalties are not always adequate and may be quite vague. With reference to the above it is evident that without proper and regular monitoring methods, directives and penalties may prove to be useless. Compliance may for example be monitored by means of regular and proper on-site investigations conducted by an environmental officer. It is vital that the water resources surrounding a dairy farm be tested on a periodical basis with a view to determine whether slurry or effluent has leaked into the water resources. It is clear that a need for regulations exists which demand and permit that environmental officers regularly visit, as well as perform water-quality tests on dairy farms, and if not complied with the offices also run the risk of being held liable for pollution of water source. It is also essential that the proper investigation methods and procedures be implemented, especially where there is reason to believe that the activities on a dairy farm may lead to water pollution. Compliance and enforcement may prove to be problematic without adequate guidelines regarding preventative methods.

2.5.4. National Environmental Management: Air Quality Act 39 of 2004

The NEM:AQA is relevant to the dairy farming industry, since dairy farms emit various harmful gases such as methane and nitrogen. The Act regulates the emission of harmful gases and lays down requirements for the necessary facilities, which will be discussed in detail. The following provisions of the Act are relevant and must be complied with:

The general duty of care in NWA is relevant to all dairy farmers and is listed in annexure 1. Section 2 resorts under general duty of care and makes provision for Applicability of the Notice and states that minimum emission standards are applicable under normal working conditions. Section 29 resorts under the duty of care hierarchy and makes provision for a pollution prevention plan which must be compiled and submitted to the Minister or MEC for approval. This plan must entail the possible pollution that may be caused by the emissions and also the measures that will be taken to prevent or minimize the pollution. Farmers must have a pollution prevention plan for managing landfill sites on farms, especially when the burning of waste is their only option. This plan is solely necessary when the gas in question is declared a priority air pollutant. The gases released by the waste produced on dairy farms have been declared priority air pollutants in certain provinces such as the Western Cape, North-West, Gauteng and Mpumalanga, but not in the Eastern Cape where the study was conducted. Section 35(2) is also listed under duty of care and states the following with regard to air pollution and the odours caused by it:

> *The occupier of any premises must take all reasonable steps to prevent the emission of any offensive odour caused by any activity on such premises.*

As discussed above in section 2.4.2, dairy farms can emit offensive odours caused by the enormous amount of waste stored on the farms before disposal thereof. It is the responsibility of the owners, farmers or managers of these farms to prevent offensive odours which may disturb or cause discomfort to residents within the surrounding areas of the farm. There is a "duty of care" on the person responsible for the air pollution to manage, contain or remediate it and if the person in question cannot fulfil this duty they need to be punished appropriately. If the owner, manager or operator is not able to prevent or minimize the offensive odours it is regarded as an offence and the responsible party may receive a warning or penalty under section 51 of the Act.

Environmental Authorisation is stipulated in the NEM:AQA and is also relevant to dairy farmers. In terms of section 37 of NEM:AQA a person must apply for an atmospheric emissions licence by lodging an application with the competent authority in the area where the listed activity will take place. When considering the application, the licensing authority must take certain factors into account. These factors are set out in section 39 and include: the applicable minimum standards set for ambient air and point source emissions, the possible pollution that may be caused by the activity and the impact of that pollution on the environment, including health, social conditions, economic conditions, cultural heritage and ambient air quality. After consideration of the aforementioned factors, the licensing authority may grant or refuse the application and provide the applicant with reasons, if necessary (Kidd, 2011). If the activity is listed or it is determined that the gases or odours emitted by the activities on a dairy farm may be harmful, the dairy farm owner has a statutory obligation to obtain an atmospheric emissions licence. Without the aforementioned licence a dairy farm is not legally allowed to proceed with the activities which emit harmful gases into the atmosphere. If the owner ignores this fact, he may be found guilty of an offence.

Section 21 of NEM:AQA 214 authorises the Minister to list certain activities which may be harmful to human health or well-being and the environment. Category 10 is “Animal matter processing” and includes tanning, animal slaughter, rendering plants, animal carcasses or waste disposal or recycling (GN R 248, 2010). These activities may at some stage occur on dairy farms when the farmer slaughters the cull cows, but in general not on a large scale. The listed activity is only relevant when handling more than 1 ton of raw materials per day.

In light of Section 21 of NEM:AQA as mentioned above, it is still not clear whether NEM:AQA requires an atmospheric emission licence for the processing of animal matter and disposal of waste on dairy farms. The waste storage facilities may release certain harmful gases into the atmosphere and lead to damaging human health and cause environmental impacts. These harmful gases produced on a dairy farm, specifically by manure and decomposing animal carcasses (discussed in section 2.4.2) includes carbon dioxide, methane, nitrous oxide, nitric oxide and ammonia. Without the necessary licence it is not permissible to release the aforementioned gases into the air (DEA, 2005). However, it is not evident to what extent the released emission of these harmful gasses on a dairy farm is; therefore Kidd (2011) states that an Air Quality Environmental Officer first needs to establish the nature of the gases and report what impact they may have on the surrounding environment with regard to the damage these gases may cause to the surrounding environment and human health (Kidd, 2011).

Section 51 of the NEM:AQA makes provision for offences and penalties in the event of non-compliance or contravention of NEM:AQA. The applicable offences include failure to submit or implement a pollution prevention plan; failure to submit an atmospheric impact report required in terms of section 30; failure to notify the Minister as required by section 33; contravention of or failure to comply with a condition or requirement of an atmospheric emission licence; submission of false or misleading information on an application for an atmospheric emission licence or for the transfer, variation or renewal of such a licence; providing an air quality officer with false or misleading information; and lastly, the contravention of or failure to comply with a condition subject to which exemption from a provision of this Act was granted in terms of section 59. In terms of section 51(2) a person who operates a controlled emitter is guilty of an offence in the event that the emissions from that controlled emitter do not comply with the prescribed standards. In terms of section 23(1) of NEM:AQA a machine or activity can be declared a controlled emitter if it :

…results in atmospheric emissions which through ambient concentrations, bioaccumulation, deposition or in any other way, present a threat to health or the environment.

Some of the gases released by the waste on factory farms have been declared priority air pollutants in some Provinces of South Africa (DEA, 2005). These gases are harmful to the environment and human health, which makes it clear that dairy farms in those areas fall within the ambit of section 23(1). Furthermore, if the air pollutant emitted by a listed activity is at a concentration above the emission limits, as specified in the emission licence, the person who performs or manages the said activity may be found guilty of an offence (GN R 248, 2010).

The outline above suggests that dairy farms must ensure that they strictly comply with NEM:AQA so as to ensure that they do not commit an offence in terms of the abovementioned provision. The toxic gases released by the waste, specifically the manure, have to be controlled and regulated by the person in charge thereof. If these harmful emissions exceed the legal limit and pose a threat to the environment and/or human health, the dairy farm owner will be found guilty of an offence. If the owner is found guilty of an offence in terms of section 51, he may be held liable for payment of a fine or imprisoned. The penalties may also vary with regard to the specific circumstances involved.

The main concern of NEM:AQA is the monitoring and enforcement of the standards and limitations of the emissions released by dairy farms. It is essential that regular investigations and air quality tests be conducted in order to determine whether these conditions have been breached. An environmental officer has an obligation to ensure that the pollution prevention plan drafted by the owner or manager of the farm is sufficient and includes methods to prevent, minimise or remediate any potential pollution caused by waste generated on the dairy farm. In addition to the aforementioned methods, it must also include precautionary methods such as a basic assessment, to ensure that the reasonable measures are taken to prevent pollution. An example of the aforementioned is that the manager or operator must, as far as possible, ensure that the emissions released by the dairy farm are kept at a minimum level; otherwise the emission must be restricted as far as possible.

2.5.5 National Environmental Management: Biodiversity Act 10 of 2004

The National Environmental Management: Biodiversity Act (NEMBA) provides a framework for protecting biodiversity, sustainable use of indigenous biodiversity, equity in sharing benefits arising from use of biodiversity and the establishment of institutions for biodiversity management (Republic of South Africa, 2004). The aim and purpose of NEMBA is to provide for the management of biodiversity within the framework of NEMA. It also provides for the sustainable use of indigenous biological resources and their fair and equitable sharing of benefits arising from bio prospecting that involve indigenous biological resources.

The NEMBA currently has negligible influence over environmental assessment and management. However, it has potentially major significance in terms of introducing mandatory biodiversity considerations for scale to planning and authorisation processes relating to land use. Besides giving effect to the Convention on Biological Diversity and other ratified international agreements relating to biodiversity, NEMBA closely dovetails with the Integrated Environmental Management (IEM) aspects of NEMA by providing for the regulation of restricted activities in areas defined by threats to ecosystems or species (Naidu & Arendse, 2004). The NEMBA provides for a form of ‘tailor-made’ environmental impact assessment dispensation in certain geographical areas.

The Department of Environmental Affairs and Tourism requested the South African National Biodiversity Institute (SANBI) to assist in the process of listing threatened or protected ecosystems. SANBI has developed a National Biodiversity Monitoring and Reporting Framework, together with headline indicators, to provide an effective mechanism for reporting on the state of South Africa's biodiversity, including co-ordinating and aligning the biodiversity monitoring and reporting efforts of many organisations and individuals. In terms of Chapter 2 of the Biodiversity Act, the South African National Biodiversity Institute (SANBI) can assist the minister with the identification of bioregions and contents of any bioregional plan and other aspects of bioregional planning.

NEMBA’s chapter 4 deals with the protection of threatened or protected ecosystems.
According to section 52(1) (b) the MEC for environmental affairs in a Province may, in the Provincial Gazette, publish a list of ecosystems in the province that are threatened and that need serious protection.

Reference needs to be made to chapter 5 of NEMA in order to illustrate the implications of the NEMBA for the regulation of agricultural land-use change. The most directly-applicable provisions of chapter 5 of NEMA are those that relate to the identification of activities which may not be commenced without environmental authorisation, and the identification of geographical areas in which specified activities may not be commenced without prior authorisation (Gold, 2004). In the latter instance, the trigger for environmental investigation is a spatially explicit environmental attribute rather than an activity in its own right. The act also provides that information and maps can be compiled which detail the attributes of the environment in particular geographical areas (Hoffman & Ashwell, 2001). The sensitivity of such attributes must be taken into account by every competent authority (Glazewsk, 2005).

The dairy farmers need to be aware of sensitive biodiversity areas on their farms and as soon as critical biodiversity areas are identified on the farms, they must comply with the requirements set out in the NEMBA.

2.5.6 Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act 36 of 1947

This Act is aimed firstly and primarily at the registration of fertilizers and the various products as mentioned in the title of the Act so as to regulate the sale, importation, acquisition and use or disposal of them. This Act is relevant to the regulation of land-based sources and activities by virtue of the fact that dairy farming is a land-based activity that uses pesticides, insecticides, herbicides and fertilizers of which the compositions contain persistent organic pollutants (POPs) and are capable of negatively impacting the environment and human health. The act is necessary to regulate fertilizer practices within the borders of South Africa, and according to Torr (2009:29) advisers and regulators are in place to ensure that the generation and use of fertilizer is done in the most environmentally friendly manner.

Sections 2, 3 and 7(1) provides that only persons registered under the Act are allowed to sell fertilizer, farm feed, agricultural or stock remedies, and the Minister must designate a registrar of patents in the Department who will be responsible for registering pest control operators and pesticides. Kanamugire (2010) states that section 23 further grants the Minister the powers to make regulations on a wide range of matters relating to fertilizers, farm feeds, agricultural and stock remedies. Application for the registration of any remedy including pesticides must be made to the registrar before being sold (Beech, 2013). The registrar must also take into consideration certain criteria prior to registering any remedy or pesticide (Beech, 2013; Kanamugire, 2010).

As discussed in section 2.4 of this dissertation, the use of fertilizer in the agricultural sector can pose a serious threat to various natural resources in the surrounding environment and cause a dangerous hazard to humans in the area (Davis & Abbott, 2006). Dairy farmers must make sure that they buy fertilizers from responsible persons with the necessary registration forms. If dairy farmers decide to make their owns fertiliser in the form of organic compost, they must also comply with this Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act for the necessary registration process. This act is developed to regulate the use of all fertilizers, agricultural stock remedies and farm feeds to assist the consumer, farmer and most importantly, the natural environment.

2.5.7 Conservation of Agricultural Resources Act, 43 of 1983

The Conservation of Agricultural Resources Act (CARA) is the principle Act tasked with the regulation of the agricultural sector in South Africa. The Act has a strong environmental focus, as it's known objective is to provide for the conservation of South Africa's natural agricultural resources, to regulate and control the utilisation of natural agricultural resources and promote the conservation of soil, water sources and vegetation and to combat weeds and invader plants and other related matters. CARA is enforced by the Department of Agriculture, Forestry and Fisheries: it supports the conservation of natural agricultural resources by maintaining the production potential of the land and preventing erosion; for example, by controlling or eliminating invader plants.

Section 1 of CAR refers to "large stock units" and can be compared with cows on a dairy farm and is defined as follows:

> *A unit which consists of the prescribed number of animals of a prescribed kind, type, breed, age or sex, or which is in a prescribed phase of production or is of a prescribed approximate live mass.267.*

The CARA is further applicable to the dairy farming industry as the activities conducted on these farms fall within the ambit of the CARA. Section 6(1)(n) of the CARA makes provision for control measures and states that control measures may be prescribed for the protection of water resources against pollution resulting from farming activities. The control measures may prohibit or obligate a person or persons where pollution is concerned. Section 6(5) of CARA stipulates that if the farm owner, manager or operator refuses or neglects to comply with these measures, the person can be found guilty of an offence. In terms of section 7 of the CARA a person or persons may also be directed to comply with the measures.

In terms of section 18 of the CARA an executive officer, any other officer of the department, a member of a soil conservation committee or an authorised person may at any reasonable time enter upon any land in order to determine whether and to what extent water pollution has occurred resulting from the activities on the farm. If water pollution originates on or near a farm, any authorised person can enter the farm to investigate the pollution and determine the extent thereof. They may further direct them to remediate the pollution or take the reasonable measures to prevent it.

Section 23 of the CARA makes provision for penalties in the event of contravention of the Act. The responsible party may be found guilty of an offence and will be held liable for payment of a fine or face imprisonment. Section 25 of the CARA makes provision for the liability of the employer or principle and states that the employer or principal shall be held liable for the act or omission of the employees, agents or managers and may be convicted and sentenced. Section 25 also states that in the event that the owner of the farm can prove that the act or omission was not permitted by him/her and all reasonable measures were taken to prevent it, or the act or omission did not fall within the course of the employment or the scope of the authority of the person concerned, vicarious liability may be excluded.

The CARA is applicable to certain aspects of the dairy farming industry and makes provision for the exclusion of vicarious liability, subject to certain circumstances. The aforementioned may prove to be of significant importance, since the owner of a dairy farm may not always be held responsible for the actions or omissions of his/her employees.

2.5.8 National Health Act 63 of 1977

The purpose of the National Health Act (HA) with regard to dairy farming is generally to ensure the prevention of nuisances and offensive conditions, to promote frequent monitoring of water quality, to manage harmful waste and to control environmental pollution. This HA defines a dairy farm as an "intensive animal feeding system," which refers to a farm constructed for purposes of breeding animals to produce meat, milk, eggs, fur or any other product of animal origin. The animals are kept in a confined space to accomplish intensive feeding or maximum control of maximum food conversion in the animal.

In terms of section 36(d) of the HA the Minister may, after consultation with the Minister of Agriculture, Forestry and Fisheries, draft regulations relating to the regulation, control, restriction or prohibition of intensive animal-feeding systems, and to the registration of such systems, the requirements in regard to the manner of application for such registration, the submission of terrain, building and site plans for such systems, the materials to be used in the construction of such systems, the construction and ventilation of such systems, the provision of sewerage and drainage systems and water and washing and sanitary conveniences for workers at such systems, the prevention of overcrowding of such systems, or any other matter deemed necessary, with which any such feeding system shall comply for purposes of registration, and the circumstances under which any such registration may be cancelled or suspended.

Section 20 of the HA makes provision for the duties and powers of the local authorities and obligates them to take the necessary and reasonable measures to prevent, minimise or remediate pollution. The local authorities have a duty to prevent or manage any threat to human health and well-being – this can be done by providing proper regulations. Dairy farmers must comply with these reasonable measures to minimise pollution caused by farming operations.

In terms of section 38, the Minister may draft regulations regarding the disposal and treatment of hazardous waste which may be dangerous or detrimental to health, removal or remediation of pollution or a nuisance and lastly regarding the reporting of existing pollution, a nuisance or any other threatening condition (Kidd, 2011).

The National norms and standards relating to environmental health in terms of National health act are set out in the Governmental Notice (GN R 943). These norms and standards for environmental health will assist in setting a benchmark of quality against which delivery of environmental health services can be monitored. The main purpose of the norms and standards is to provide a national approach in ensuring standardization of functions and activities in the delivery of environmental health services and establish a level against which environmental health service delivery can be assessed and gaps be identified. Dairy farmers must be aware of these norms and standards, especially section 17 of GN R 943, where the norms and standards are listed for keeping animals on premises (annexure 1). This shall refer to agricultural holdings and to any premises where animals are being kept for breeding, agriculture or selling. Dairy farmers must comply with the requirements for keeping cattle, hygiene standards for keeping cattle and removal of dead animals on all premises where animals are being kept.

Section 57 of the HA makes provision for offences and penalties, stating that any person who fails to comply with any provision of the HA shall be found guilty of an offence and be held liable to pay a fine not exceeding five hundred rand or be imprisoned for a period not exceeding six months or both on a first conviction. On a second conviction the person will be held liable and must pay a fine not exceeding one thousand rand or be imprisoned for a period not exceeding one year or both the aforementioned. On a third conviction the person will be held liable to pay a fine not exceeding five thousand rand or be imprisoned for a period not exceeding two years or both the aforementioned.

In the event of non-compliance with the provisions of the HA a farm owner, manager or operator whoever is in charge, can be held liable for the abovementioned fines or imprisonment. These laws are created to protect the environment and human health and well-being. Their ultimate purpose is to fulfil the constitutional right provided for by section 24 of the Constitution.

2.6 Conclusion

The main purpose of the literature review was to address the sub research aims of this dissertation. The sub research aims are:

To conceptualize the life cycle of a dairy farm in South Africa to determine the main potential environmental impacts; and

To identify and describe existing environmental regulatory requirements for a dairy farm in South Africa.

These sub research aims furthermore provided a link between chapters two and three of this dissertation. The results gathered in the literature review from chapter two were used to create the questions posed during the interviews with the farmers which are reported on in chapter three of the methodology. The literature review on previous studies identified the main environmental issues that occur along the life cycle of a dairy farm. The literature review also allowed the researcher to gather the existing and relevant environmental regulatory requirements for dairy farming in South Africa. The data collected around these sub research aims allowed the researcher, during the interviews and site visits, to ask the selected farmers the relevant questions regarding the management of environmental aspects pertaining to the farm and environmental requirements regarding it.

The answers and data gathered from the created questionnaires and site visits allowed the researcher to address the main research aim of this dissertation, namely:

To critically reflect on the implications of the environmental regulatory requirements for dairy farming in South Africa.

CHAPTER 3 METHODOLOGY

This Chapter describes the research methodology which is applied to attend to the main research aim, namely:

To critically reflect on the implications of the environmental regulatory requirements for dairy farming in South Africa.

The outline of this chapter is as follows:

Section 3.1 summarizes the case study approach, followed by the case study design (section 3.2). The identification of case studies is outlined in section 3.3. The research methods through interviews and farm visits are highlighted in section 3.4. Finally, the cross-case design and limitations to the research are included in sections 3.6 and 3.7

3.1 Case study approach

Eisenhardt (1989:534) defines a case study approach as being a research strategy which focuses on the understanding of the dynamics that are present in a single setting. Eisenhardt (1989:534) further states that case studies typically are a combination of data collection approaches such as interviews, archives, observations and a questionnaire, and the information can also be quantitative or qualitative in nature. Anderson (2009:54) reflects that a case study research approach is very valuable when the research is difficult to separate from its setting or when it refers to a new study area which is being addressed.

According to Eisenhardt (1989:549) compelling case studies are those that present interesting or ground-breaking theories which can be tested against good theory which are grounded in credible facts. This study aimed at providing convincing evidence for further concept developments in the dairy industry. Kelly (2006a:287) confirms the aforementioned and includes that when a researcher enters into the research setting, it must be done with utmost care and engagement with participants must take place in an open and empathetic manner. Kelly (2006a:317) furthermore suggests that a qualitative researcher is required to develop good interpersonal skills, tolerate disagreements and vagueness, hone the ability to build and maintain relationship and is not confused by clear disorganisation. Furthermore, the researcher needs to be conscious of the dynamics of the situation throughout the entire period (Nieuwenhuis, 2010:75).

A case study research approach was adopted for this dissertation. The case study approach is the ideal methodology when a holistic and in-depth investigation is required (Brannen, 2005). The case study approach is generally used as a way of doing social science research and the preferred strategy when questions of “how” or “why” are being posed (Yin, 2003:1). This case study will assist in contributing knowledge and in gaining the points of view of five dairy farmers and allow the researcher to retain meaningful characteristics of real-life events such as life cycles of dairy farming within the Tsitsikamma region, management practises of the different environmental aspects, knowledge and awareness of environmental law and national relations with local authorities. A multiple-case design in the form of a “five-case” design was selected for the case study approach, because the design is more likely to be stronger and more objective worthy than singe-case designs.

3.2 Case study design

According to Yin (2003, 19) the design of the case study is a fundamental part of the case study, because it is the logic that links the collected data and conclusions drawn to the initial questions of the study. The case study design used for this dissertation is a multiple-case replication design. The first initial step in designing the study consists of the theory development and shows the importance of case selection and specific measures. Each one of the case studies consists of a “complete” study on its own, in which evidence is required regarding the facts and conclusions of the case. Each case’s conclusions are considered to be the visual case. The method of the case study was conducted in three different phases: Phase 1 - Define and Design; Phase 2 - Prepare, collect and analyse and Phase 3 – Analyse and conclude (Yin 2003:46-51). Each of the five case studies will be analysed individually, which will be followed by a cross-case analysis and conclusions as illustrated in Figure 3.1.

The design of the case study is open-ended semi-structured interviews with key role-players for purposes of gathering empirical data.

Case evaluation took place through semi-structured open-ended interviews with key stakeholders in the form of a multiple-case replication design. Interviews and farm visits will take place on five different farms. The five case study areas will be selected from one of the main dairy farming Provinces in South Africa, namely the Eastern Cape: Tsitsikamma and Alexandria area (DOA, 2008b).

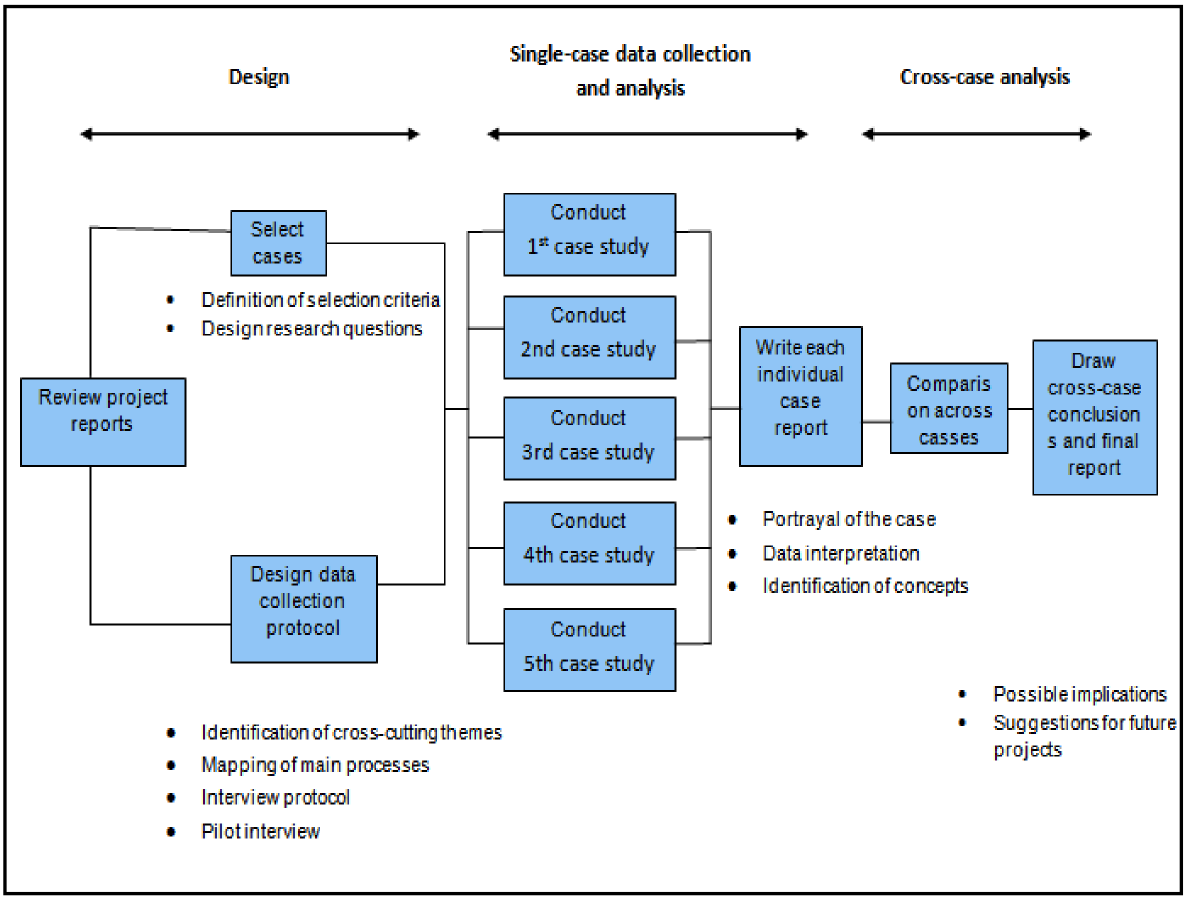

Figure 3.1: Layout of case study design

Source: Yin (2003)

3.3 Identification of case studies

A pilot study was conducted and contributed valuable information and assisted the researcher with the study. The pilot study provided the researcher with the opportunity to develop and to enhance the required skills before commencing with the larger study so as to obtain preliminary data and evaluate the data-analysis methods. The pilot study was conducted on a farm close to Potchefstroom in the North West Province of South Africa. The reason for using this farm as the pilot study, mostly was that the farm is in close proximity to the University where the researcher registered the dissertation, and that this said farm provided the much-needed skills to successfully complete this study.

The outcome of the pilot study was that the research protocol is realistic and workable and there are no logistical problems with proposed methods.

The primary research area, in which this study was conducted, is the Tsitsikamma area, situated in the Eastern Cape Province, South Africa (Figure 3.2). Visits to these farms enabled the researcher to conduct interviews with five large-scale commercial farmers within the dairy industry and allowed to identify the different management practices in use within these dairy farms. The reasons for choosing this region specifically include accessibility, seasonal and climatic variations, herd management and pasture management. Regarding the accessibility of the study, the researcher is based in Potchefstroom in the North West Province but lives in Jeffreys Bay in the Eastern Cape Province and is in close proximity to all five selected farms. The selected farms were also to a substantial extent more accessible with assistance and recommendations from the Woodlands Dairy sustainability department in Humansdorp. Woodlands Dairy is a milk manufacturing company and has implemented the Woodlands Dairy Sustainability Project in partnership with Trace & Save, an independent agricultural sustainability company. The project aims to assist all of Woodlands Dairy's milk producers to become more sustainable, reduce the environmental impacts of their farming practices and to make sure that responsible practices are implemented on their farms. The Woodlands Dairy Sustainability department arranged permission to let the researcher access the selected farms to gain valuable information through farm visits and interviews with the farmers.

The dairy farms in the Eastern Cape are accustomed to the seasonal and climatic variations – cold, wet winters and dry summers, with a relatively high average rainfall of 1200mm per annum. The climate plays a very important role in the management of dairy farming. Rainfall plays a significant role in the availability of grazing and fodder for intensive livestock production, the amount of rainfall will determine whether the feeding system will be pasture-based or full feed-based. The Department of Agriculture has listed the coastal areas as favoured for dairy farming due to their mild temperatures and good rainfall. The Tsitsikamma region falls within the favoured coastal agricultural areas of South Africa and has large scale farming operations in the area. The farmers in the area make use of the most advanced farming technologies, form part of an independent agricultural sustainability company and form part of various study groups to exchange techniques and information amongst one another. The region is most suitable and therefore selected for this dissertation.

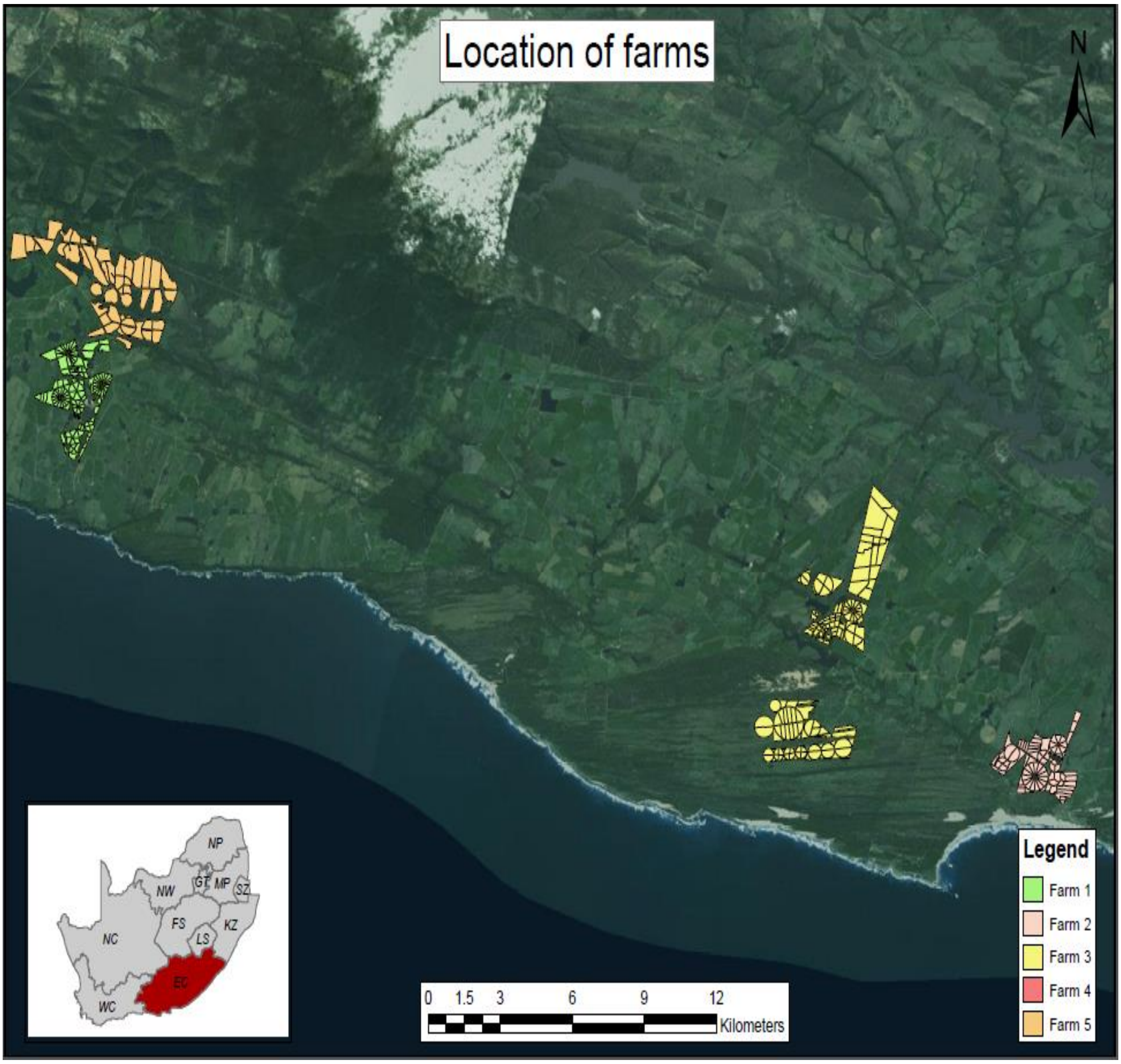

Figure 3.2: Location of selected dairy farms in the Eastern Cape Province

3.4 Research methods: Interviews and site visits

According to Marsick and Watkins (1997:143) case study researchers can use a variety of data collection methods. The data collected must assist in building a broader picture of knowledge. In this dissertation the researcher aspired to use as many data collection methods as possible, to represent a comprehensive picture of the dairy industry from the farmer's point of view.

The data collecting methods used by the researcher for this dissertation include interviews and site visits at the five selected dairy farms.

Interviewing is a more natural form of data collection than questionnaires. Interviews fit well with the interpretive approach to research as followed in this dissertation. By conducting interviews, the researcher is afforded the opportunity of becoming personally familiar with the participants. This helps in understanding how the participants experience and reflect on the phenomenon being researched. The researcher who follows an interpretive approach to research attempts to create a setting of openness and trust which enables the participants to convey their thoughts and feelings in a safe environment (Kelly, 2006a:297).

The interviews were conducted in an informal, face-to-face, open-ended manner during the farm visits. The open-ended questions posed allowed the participants to engage in discussion with the researcher on the various topics. The interviews were conducted using a snowball effect of question construction, for instance: the answerers of the farmers directly determined the line of questioning. The questions were specifically directed at the management of environmental aspects on their farms. Each farmer was asked a similar set of questions concerning their management practices on the farm. The researcher not only utilised individual interviews for data gathering; general observations and field notes were also used during the visits to the farms.

The researcher could not conduct a comprehensive case study if the surroundings were not experienced by the researcher personally. The information gathered by means of the interviews and site visits was used to compile the case studies regarding the various farms. The researcher made use of experiences when visiting each farm, and field notes were taken during the interviews with the participants and during the site visits. During the visit to each research farm the researcher made notes about the management of the different environmental aspects on the farms and the farmer's general perspective regarding environmental law. The perspectives of the owners of the various farms were also included in the data as they are the closest to the phenomenon. Interactions, relationships, verbal language and attitudes were the main focus of the field notes taken by the researcher. The owners of the farms each have several years of experience within the dairy industry, and the researcher aimed at tapping in on this wealth of knowledge. The interviews and farm visits allowed the researcher to gain valuable insight into the different environmental aspects such as water, waste, biodiversity, soil, air and energy on a dairy farm.

All the aforesaid data were collected between 18 August 2016 and 24 August 2016. The researcher implemented research rigour throughout the research process, and five different engagements with the various participants took place during the abovementioned dates. All primary research activities are documented and summarised in Chapter 4 of this dissertation.

3.5 Cross-case approach

Nieuwenhuis (2010:80) argues that the reliability and validity of research instruments are crucial in qualitative research, which means that the researcher who is the data gathering instrument needs to generate trustworthiness in order to ensure validity. The aforementioned author (2010:80) continues by stating that if the researcher engages in multiple methods of data collection it would lead to trustworthiness. Nieuwenhuis (2010:75) further states that case studies can offer a multiple perspective study in which the researcher reflects not only on the voice and perspectives of one participant in a situation, but also multiple participants in relevant groups of actors and the interaction between them. This multi-layered perspective forms a critical part of the process followed by the researcher of this dissertation creating the possibility of giving a voice to the voiceless dairy farmers in this situation.

This multi-layered perspective is also known as a cross-case analysis and extends the researchers expertise beyond the single case. It provokes the researcher's imagination, prompts new questions, reveals new dimensions, produces alternatives, generates models, and constructs ideals and utopias (Stretton, 1969). Cross-case analysis enables the case study researcher to define the combination of factors that can contribute to the outcomes of the case, seek or construct an explanation as to why one case is different from or similar to others and make sense of unique or puzzling findings. The cross-case analysis helps to improve the researcher’s capacities to understand how relationships can exist among separate cases, refine and develop concepts, accumulate knowledge from the original case (Ragin, 1997) and build or test theory (Eckstein, 2002). Furthermore, cross-case analysis allows the researcher to compare cases from one or more settings, communities, or groups. This provides opportunities to learn from different cases and gather important data.

A multiple-case design in the form of a cross-case analysis was selected and used for this dissertation, because the design is more likely to be stronger and more objective worthy than single-case designs.

3.6 Limitations to the research

Several limitations were experienced during the research process. These limitations will be discussed in this section of the methodology chapter.

Anderson (2009:188) and Swanson *et al*. (1997:97) identified some problem areas when making use of interviews as a data gathering method. Interviews can be seen as a time- consuming form of data collection, as the availability of time is essential for comprehensive interviews to take place (Anderson, 2009; Swanson *et al*., 1997). The available time that the researcher and interviewees had was limited due to work obligations, and more time on each research farm could have delivered more insight into the phenomenon being studied by the researcher. Had there been more available time, the researcher would have opted to select another research area in a different milking region of South Africa, to gain an even broader perspective on the different styles of environment management aspects pertaining to dairy farms.

The audio recording is seen as a form of data collection; however, according to Anderson (2009:188), the audio recording of an entire interview can inhibit the interviewee’s personal opinion regarding the phenomenal investigated. The inhibition of the participants was experienced first-hand by the researcher. During the first interview the conversation was audio recorded with a cellular phone. However, the participant felt uncomfortable when the device was used during the early phase of the interview. The researcher had to reconsider the use of audio recordings during the remainder of the interviews. The researcher opted to only make use of notes from the conversation during the site visits, due to the nature of the interview. The participants felt more relaxed without the audio recording device and the interviews occurred without restraint.

A large commercial dairy farm can also be seen as a well-designed business; therefore, all site visits had to be coordinated in advance, as the researcher did not wish to inconvenience the farm owners or the farm workers in any way. Access to participating farms was also limited, which allowed only a limited amount of cases to choose from in a limited stretch of time. Accesses to the selected farms came from assistance from Woodlands Dairy Sustainability Department. The farms that were willing to participate in the research formed part of Woodlands Dairy’s sustainability project. The farms that form part of the sustainability project can be seen as the best farms in the region regarding the sustainable management of environmental aspects. The researcher only made use of the views and perspectives of farmers that agreed to participate, and this can make the data gathered to be seen as biased to only the views of best practice dairy farms in the region. The researcher also only made use of the views and perspectives of dairy farmers and not of any other relevant party, such as the surrounding landowners, farm workers or competent authorities. The results can therefore also be seen as biased, since the views and perspectives of the farm owners only, were used.

The data gathered in the methodology of this dissertation is only focused on the questions posed by the researcher regarding the farmers’ views and perspectives of the management of environmental aspects and legal requirements on the selected dairy farms. The researcher also did not check whether that which the farmer had said during the interview complied with what actually was taking place across the entire farm - the results can thus not be seen as a legal audit.

Figure 3-1: Layout of case study design

Figure 3.2: Location of selected dairy farms in the Eastern Cape Province

CHAPTER 4: RESULTS & DISCUSSION

In this chapter, the data analysis and results are described in relation to the main research aim:

Main research aim:

To critically reflect on the implications of the environmental regulatory requirements for dairy farming in South Africa.

The outline of this chapter is as follows:

Section 4.1 to 4.5 provides a review of each single case analysis performed. The overall performance of the selected farms is summarised in section 4.6 and the cross-case analysis is described in section 4.7.

A single-case analysis was performed on each of the selected farms individually. The single case studies consisted of a complete study on its own, in which data is gathered regarding the management of the different environmental aspects on the selected farms, together with the farmers perspective on relevant environmental laws within the dairy industry.

At the closing stage of each single case analysis, conclusions were drawn regarding the management of the environmental aspects on each farm, together with the farmer's perspective on relevant environmental laws. These conclusions are summarised in a single case table, where the key issues are raised on the management of each environmental aspect on the selected farm. It is important to note that the issues raised are focused on positive and negative outcomes regarding the management of environmental aspects.

4.1 Farm 1

The farmer responsible for the management of farm 1 (F1) worked on the family farm from 1986 and is the official landowner from 1998 up to date. The ownership of the farm is divided between three brothers; each manages their own farm separately. The farm makes use of a free-range pasture-base feeding system and the cows are rotated on a daily basis, to ensure that overgrazing does not take place and cows get enough feed from pastures to produce more milk. The total herd size is 1000 milking cows, 500 dry cows, 400 heifers and 400 calves. The cows are concentrated in a confined space (dairy parlour) for approximately six hours a day. Future expansions on F1 are difficult, because available lands are scares and expensive, therefore F1 are considering a different expansion plan. The future expansion plan is to build concentrated cow housing and work on a full feed-based system. The full feed system will ensure more cows on the farm where the space is limited. The farmer wants to improve the quality of current livestock and rather work with a better genetic cow.

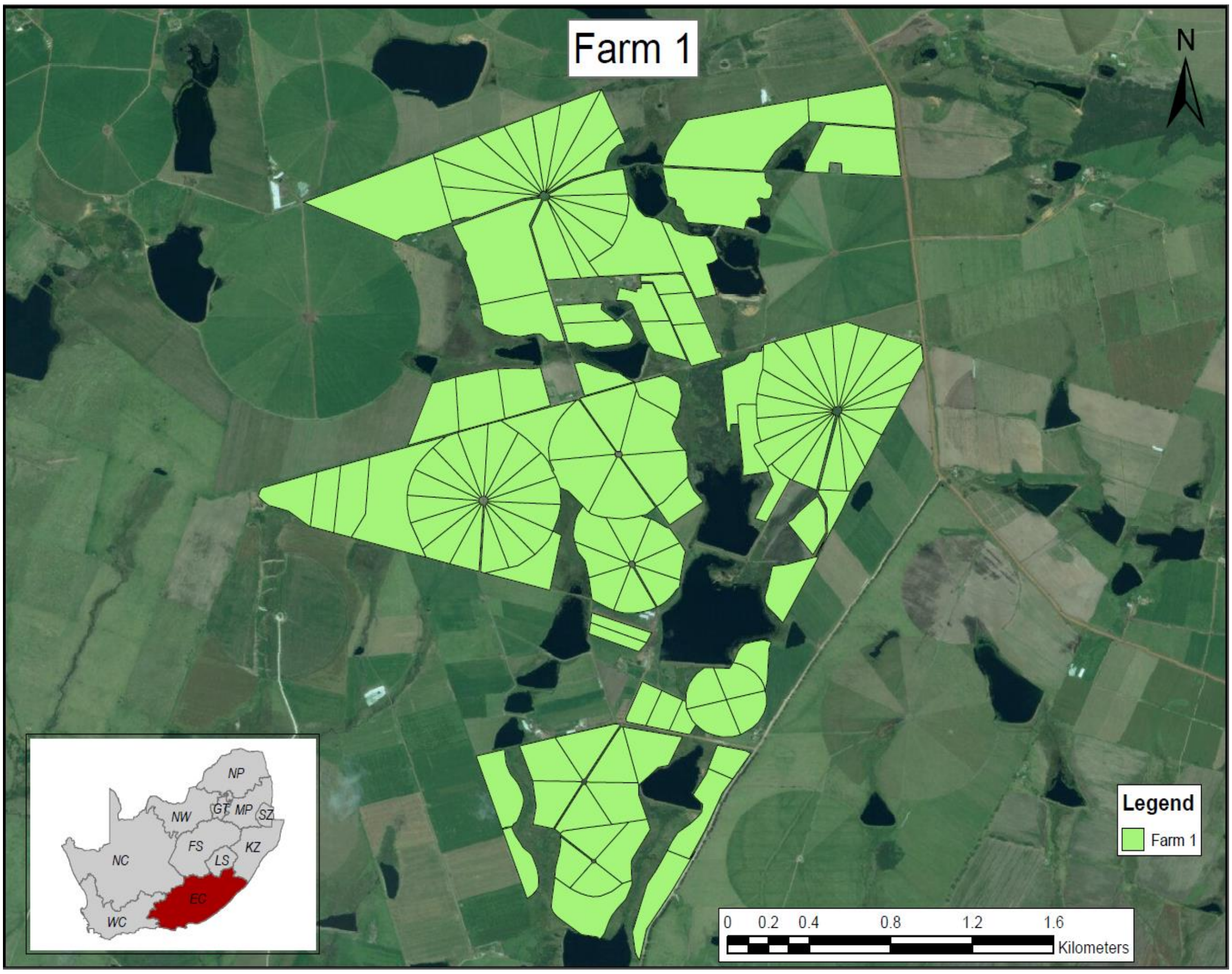

Figure 4.1: Map layout of Farm 1

4.1.1 Water

The main source of water is from four natural boreholes and five rainwater dams located on the F1. The five natural rainwater dams can store a combined water capacity of 138 000m³, first dam is 25 00m³, second dam is 19 000m³, third dam is 30 000m³, fourth dam is 21 000m³ and fifth dam is 43 000m³. When the water levels in the dams are low, water from the boreholes will be pumped into the dams. All boreholes are registered by the Department of water affairs and all the dams are under the threshold for storing capacity. The Department of Water Affairs had a farm visit in 2009 and was satisfied with all water use applications on F1. No waste or water containing waste is discharge into natural water resources on F1. Waste water generated in the milking parlour is reused and irrigated on 200ha of pastures. The irrigation area is not close to any wetlands or natural rainwater dams but is on a slight gradient and can lead to water run-off if not efficiently managed. No application for a general authorisation for the irrigation of waste or water containing waste is done as requested in the NWA GNR 665. Although no general authorisation is done for the irrigation of waste water, Woodlands dairy's sustainability department takes samples of the waste water and monitors the water quality on a monthly basis. The future plans around water on F1 is mainly focused to drill more boreholes in order to make use of natural ground water and to use the current water more efficient, through better irrigation systems.

4.1.2 Air

The farmer responsible for F1 believes that methane generated from livestock on the farm is a natural waste product generated by concentrated livestock and the Earth struggles to process the gas and can rather be used as something more valuable, like energy. The farmer states that all livestock farmers have a responsibility to ensure that the concentration of methane gas should be distributed gradually all over the farm through more open pastures for livestock. No reasonable measures are taken in order to control offensive odours on F1, as no complaints from surrounding landowners in known. The protection of workers from odours in the milking shed is in place through face masks and gloves.

4.1.3 Soil

F1 has a sandy top soil and the farmer does his best to minimise cultivation on to the soil in order to keep the natural nutrients and organisms. Open pastures are well managed to ensure that overgrazing on the pastures are limited. The pastures are managed through a weekly measurement of pastures (pasture walk). The grazing on the pastures is worked out to ensure that the cows don't graze on the same camp in 21 days.

4.1.4 Biodiversity

When considering the biodiversity on F1, there are no natural areas on the farm left, which means that all available land is utilised for agricultural purposes. All of the development on the farm was done on already disturbed or old cultivated lands. The farmer believes that natural ecosystem is essential when it comes to sustainable farming, but that it won't have a direct impact on production of the farm. The farmer is unaware of South African National Biodiversity Institute (SANBI) and the role that SANBI plays in the agricultural sector.

4.1.5 Waste generation

The generation of waste on F1 is not seen as a problem, but rather as an opportunity to optimally reuse and utilise wastes as a by-product. The total amount of effluent generated by livestock in the milking parlour daily is 125m³. The effluent is managed in a responsible way. F1 has a system in place to separate the liquid slurry from the solid manure. The solids manure goes to an on-farm compost facility where it goes through a process to form compost. The composting process is seen as open-windrow composting and consists of placing a mixture of raw organic materials in long narrow piles called open wind-rows composting (Figure 4.2). These windrows are turned on a regular basis to mix the composting materials and to enhance passive aeration. The solid compost is sprayed on to the pastured as a form of organic fertiliser and the liquid is pumped through irrigation systems on to the pastures. There is a landfill site on the farm for household wastes, fertilizer bags and empty plastic containers. All the waste in the landfill will be burned as soon as the hole fills up. The animal carcasses go to a nearby wolf farm and if the carcass is contaminated the carcass will be dumped into landfill site and burned. The farmer on F1 takes reasonable measures when it comes to waste management, by ensuring that the effluent generated in the parlour is manage reasonably and makes sure the medical waste goes to a separate bin, where the involved vet safely disposes it. The farmer states that there are allot of recyclable materials that end up in the landfill and the local municipality must make an effort to accommodate farmers and advise them were they can take the recyclable materials.

Figure 4.2: Open wind-row composting

Source: researchers own photograph

4.1.6 Energy and non-renewable resources

The farmer responsible for F1 believes that there is a market for renewable energy, but the market is full of “fly by night” products and that he will make use of solar or wind power in the near future as concerns over the availability of energy grows. The farmer already makes use of wind and solar energy to pump water (Figure 4.3) but want to investigate the waste to energy systems produced by compost.

Figure 4.3: Wind energy for water pumps

Source: researchers own photograph

Table 4.1: Key environmental issues on farm 1

Farm 1	
Water	
Reference to Annexure 2	Summary of key environmental issues raised
2.5)	Application of general water use licence is approved and submitted to Water Affairs.
2.5)	Registered boreholes to the Department of Water Affairs and dams fall under the threshold for storing water (50 000m^3).
2.6)	Untreated liquid slurry generated from the dairy parlour, is pumped on to the pastured as a form of organic fertiliser.
2.8)	The facilities for the treatment of effluent generated by livestock are not efficient and the storage of effluent is not managed by best practice.
2.9)	No application for a general authorisation for the irrigation of waste or water containing waste is done as requested in the NWA GNR 665.
2.10)	Monitor and keep record of the effluent quality on a monthly basis.
2.11)	The general location, were irrigation of wastewater takes place not close to any wetlands or rainwater dams.
Air	

Reference to Annexure 2	Summary of key environmental issues raised
1.3)	Concentrated methane emissions from livestock in dairy parlour four to six hours per day.
1.4)	Free-range pasture-based system.
3.3)	No reasonable steps to control offensive odours.
Soil	
Reference to Annexure 2	Summary of key environmental issues raised
1.4) 4.2)	The grazing on the pastures is worked out to ensure that overgrazing does not take.
4.3) 4.7)	Use of fertilizer on a responsible way.
Biodiversity	
Reference to Annexure 2	Summary of key environmental issues raised

5.2) 5.6)	No large natural habitat areas left on farm, only wetlands.
5.4)	All developments on the farm are done on already disturbed land and no virgin soil areas transformed.
5.7)	Disruption of natural ecosystems
5.7)	Not aware of indigenous vegetation listed in SANBI.
Waste generation	
Reference to Annexure 2	Summary of key environmental issues raised
6.4)	Solid manure generated in dairy parlour is treated as compost for reuse.
6.7)	Landfill site not managed accordingly.
6.8) 6.9)	Effective disposal and management of hazardous waste
Energy and non-renewable resources	
Reference to Annexure 2	Summary of key environmental issues raised

7.2)	Makes use of wind and solar energy to pump water.
7.5)	Effective storage of diesel.
7.6)	Effective storage area for hazardous chemicals and fertilizers.

4.2 Farm 2

The farmer responsible for the management of Farm 2 (F2) is the official landowner from 2004 up to date. F2 is 600ha and consist out of a combination of pastures with irrigation and without irrigational systems. The herd is managed on a free-range pasture-based system and the cows are rotated on a daily basis, to ensure that overgrazing does not take place and cows get enough feed from pastures to produce more milk. The farm is located close to the sea and has a sandy soil type. The total herd size is 1200 milking cows and 800 dry cows. The cows are concentrated in the dairy parlour for approximately four hours a day. Extra crops are planted on F2 for an extra additional feed and protein source in the dry seasons. Future expansions are difficult and expensive, as F2 planned to construct a large rainwater dam for irrigational purposes. The Department of Water Affairs requested an Environmental Impact Assessment, as the project went over the threshold for the construction of dams as listed in NEMA list 2 (GNR984) section16. The expansion plans are currently on hold as the farmer rather plans to drill for more boreholes.

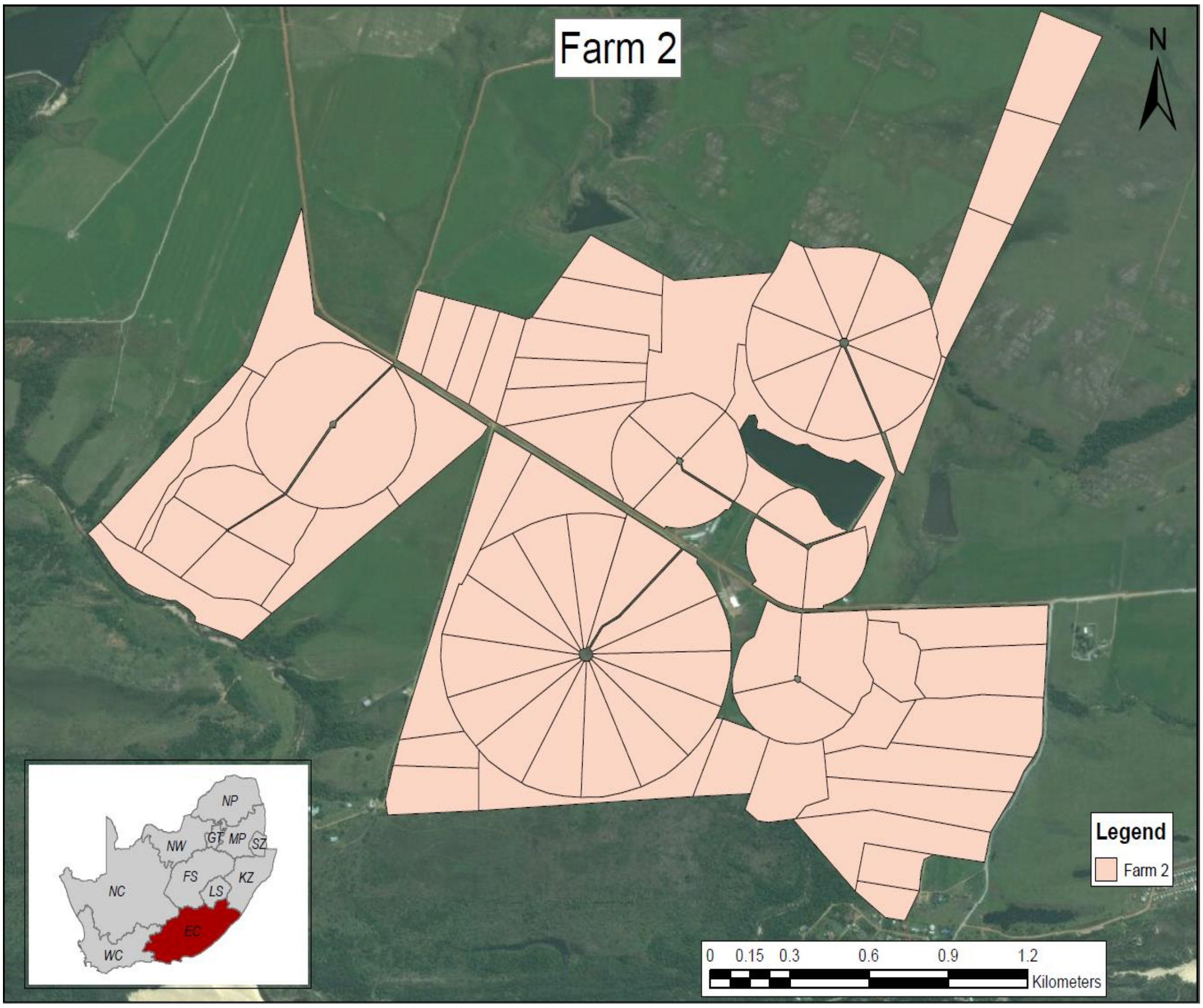

Figure 4.4: Map layout of farm 2

4.2.1 Water

The main water resource is from natural boreholes and rainwater dams located on the farm, F2 also makes use of a communal river and is seen as n water scheme (Slang River). The two rain water dams can store a shared water capacity of 55 000m³, first dam is 30 00m³, and the second dam is 25 000m³. Water from five boreholes is used to pump groundwater into the two dams as needed. All boreholes are registered by the Department of water affairs and water rights are in order to use waster on F2. No waste or wastewater is discharge into natural water resources; the waste water is stored in holding dams, specially build to store the effluent until further treated. The Waste water generated in the milking parlour is reused and irrigated on 300ha of pastures. The use of waste water for irrigational purposes require a general authorisation as listed in GNR 665, but no application for a general authorisation is done. Although there are no general authorisations done for the irrigational activities, the sustainability department of Woodlands dairy takes samples of the waste water and monitors the water quality on a monthly basis. F2 uses a combined total of 30 000 litres water and 5 000 litre of waste water for irrigational purposes per day in dry summer seasons and les in the rainy winter seasons. The farmer on F2 states that a dairy farm needs an enormous amount of water per day and in the dry seasons it is challenging. He wants to ensure that drinking water for the livestock is enough and that the water is of a high quality. The farmer wants to construct a new rain water dam as mentioned above but feels like he does not get the necessary required tools and information on what path to follow.

4.2.2 Air

The farmer accountable for F2 feels that he is not educated enough around the topic of methane generated from livestock but sates that livestock methane can't be compared with air pollution generated by large industrial factories. No reasonable measures are taken in order to control offensive odours on F2, although complaints have surfaced in holiday seasons from the surrounding holidaymakers. F2 made plans to minimise the noise of the dairy parlour, by placing the compression pumps in a closed off soundproof room. The workers in the dairy parlour make use of gloves and facemasks for protection from odours.

4.2.3 Soil

In order to ensure soil fertility on F2 the farmer makes use of chemical and organic fertilizer to help the sandy soil secure all the needed components for a fruitful soil type. Grazing is well managed and weekly measurement of pastures (pasture walk) is done to calculate where the cows must grace next. The herd gets a 12-hour period per camp for grazing, to ensure that overgrazing does not take place. Grazing on the pastures is worked out on a 21days system to ensure that a routine grazing system is in place for optimal use of pastures. The farmer wants to make more use of organic fertiliser in the future, using cow and chicken manure.

4.2.4 Biodiversity

When the farmer became the official landowner of F2, there were no natural areas left and the farm consisted out of old cultivated land. There are also no areas where it is difficult to develop, because the farm is located on a gradual gradient. The farmer believes that moles, bugs and earthworms is essential when it comes to the natural flow of the ecosystem and to be more sustainable in farming activities it is vital to protect the natural ecosystem. The farmer is aware of South African National Biodiversity Institute (SANBI), but he does not know the role that SANBI plays in the agricultural sector or whether his farming operation complies with it.

4.2.5 Waste generation

The management of dairy waste on F2 is done in a modern technology way as generally used on dairy farm in New Zealand. F2 has a system in place to mechanically separate the liquid slurry from the solid manure generated by livestock in the milking parlour (Figure 4.5). The system is known as the horizontal screw press process. The solid material produced is dry and easy to handle and store for future use. The solid material is used as an organic fertilizer on pastures and is more cost effective and sustainable than chemical fertilizers. The liquid slurry is pumped into two separated dams where it is stored and treated with oxygen before it is pumped on to the pastures as irrigation. The total effluent generated in the milking parlour daily is approximately 175m^3. There is a landfill site on the farm where household waste, empty plastic bags and plastic containers are disposed. All the wastes in the landfill are burned on a weekly basis and when the landfill is to full a new one landfill is constructed. The animal carcasses will go to a nearby wolf farm or if the meat is not contaminated, the workers have the option the take the meat. If the carcass is contaminated the carcass is burned on the farm. The farmer takes reasonable measures when it comes to waste management by making sure the medical waste goes to a separate bin and is marked as hazardous waste, as illustrated in Figure 4.6. The farmer also effectively manages the dairy effluent to ensure that no natural areas gets polluted by waste water run-off.

Figure 4.5: Mechanical manure separator

Source: researchers own photograph

Figure 4.6: Hazardous waste bins

Source: researchers own photograph

4.2.6 Energy and non-renewable resources

The farmer sees the consumption of energy as a problem in the near future and is uncertain about the availability of energy, because it’s restricted and dependent on Eskom, therefore the farmer believes there is a market for renewable energy and want to make use of solar power in the future. The farmer does not believe that there is enough feedstock on a dairy farm to successfully operate a waste to energy plant and that the waste has a better use as an organic fertiliser. The farmer states that energy is a major necessity on any dairy farm and F2 makes use of a standby generator, because the milk must be cooled at all time.

Table 4.2: Key environmental issues on farm 2

Farm 2	
Water	
Reference to Annexure 2	Summary of key environmental issues raised
2.3	Extracts water from a natural stream and has water rights to use the water.
2.5)	Application of general water use licence is approved and submitted to Water Affairs.
2.5)	Registered boreholes to the Department of Water Affairs and dams fall under the threshold for storing water (50 000m³).
2.6)	Separates the liquid slurry from the solid manure. The solids generated from the dairy are used as organic fertiliser. The liquid slurry is treated before used as irrigation on the pastures.
2.8)	The facilities for the treatment of effluent generated by livestock are efficient and the storage of effluent is managed by best practice.
2.9)	No application for a general authorisation for the irrigation of waste or water containing waste is done as requested in the NWA GNR 665.
2.10)	Monitor and keep record of the effluent quality on a monthly basis.
2.11)	The general location, were irrigation of wastewater takes place all over the farm and can include wetlands or rainwater dams.

Air	
Reference to Annexure 2	Summary of key environmental issues raised
1.3)	Concentrated methane emissions from livestock in dairy parlour four to six hours per day.
1.4)	Free range pasture-based system.
3.3)	No reasonable steps to control offensive odours.
Soil	
Reference to Annexure 2	Summary of key environmental issues raised
1.4) ;(4.2)	The grazing on the pastures is worked out to ensure that overgrazing does not take.
4.3) ;(4.7)	Use of fertilizer in a responsible way.
Biodiversity	
Reference to Annexure 2	Summary of key environmental issues raised
5.2) ;(5.6)	No large natural habitat areas left on farm.

5.4)	All developments on the farm are done on already disturbed land and no virgin soil areas transformed.
5.7)	Disruption of natural ecosystems
5.7)	Not aware of indigenous vegetation listed in SANBI.
Waste generation	
Reference to Annexure 2	Summary of key environmental issues raised
6.4)	Solid manure generated in dairy parlour is treated as compost for reuse.
6.4) ;(6.9)	Separation of solid and liquid manure from the dairy and responsible use as irrigation and fertilizer.
6.7)	All the general waste generated on the farm gets burned in landfill.
6.8) ;(6.9)	Effective disposal and management of hazardous waste.
Energy and non-renewable resources	
Reference to Annexure 2	Summary of key environmental issues raised
7.5)	Effective storage of diesel.
7.6)	Effective storage area for hazardous chemicals and fertilizers.

4.3 Farm 3

The farmer in charge of Farm3 (F3) is the official landowner from 1991 up to date. The total area of F3 is 782 ha, from the total area there are 380ha pasture under irrigation and 400ha pasture without irrigational systems. The herd is managed on a free-range pasture-based system and the cows are rotated on two times daily in order to ensure that overgrazing is minimised, and cows get a sufficient amount of feed from the pastures. The farm is located on a sandy soil type and is close to the sea. The total milking herd size is 1650 cows and 400 dry cows. The cows spend approximately three hours in morning and three hours in the evening in the dairy parlour. Gras seeds such as kikuyu, ryegrass, chickaree and clovers are planted for optimal food on pastures. Extra crops are also planted such as maize and soya for additional feed and a source of protein in the dry seasons. The farmer has no expansion plans for F3, as land is scares and expensive, he would rather spend more time and money on improving current irrigation systems.

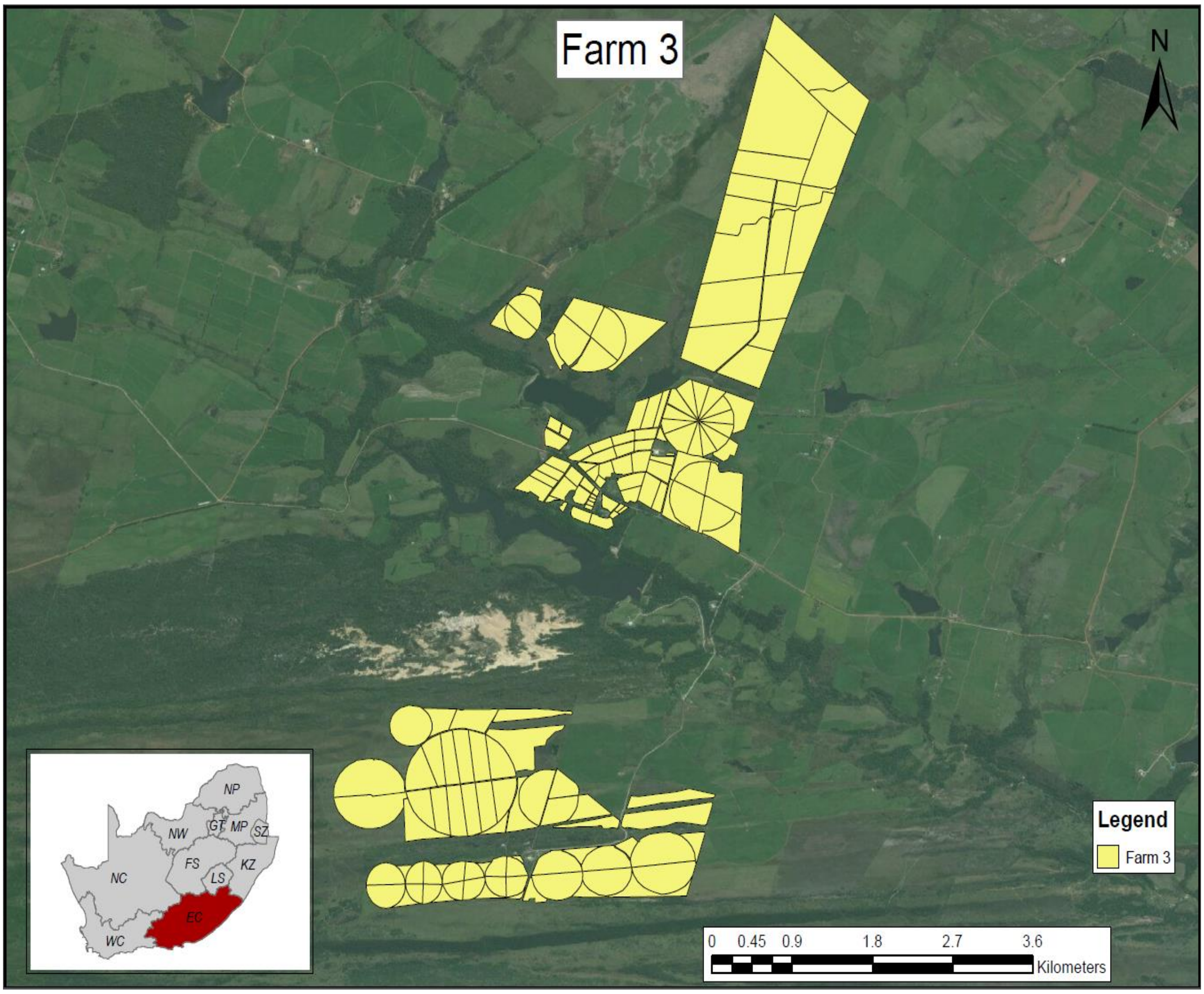

Figure 4.7: Map layout of farm 3.

4.3.1 Water

The main water resource is from natural rivers and fountains located on the F3, along with three rainwater dams, four boreholes and part of the Elandsjag dam water scheme. The farmer has water rights on the water scheme, to use a certain amount of water on a monthly basis. Located on F3 are three natural rainwater dams, the first dam is 35 00m³, second dam 14 000 and third dam is 10 000m³. When the water in the dam runs low, water from the four boreholes is pumped into the dams as needed. The farmer responsible for F3 has done all the necessary registration for boreholes and has water rights to use more water than currently using. No waste or waste water are discharged into a natural water source, the waste water generated from the dairy parlour flows into two ponds, specially build for the storage of effluent. The Waste water stored in the ponds is reused as irrigational water on 380ha of pastures. F3 uses approximately 2 000 litres of wastewater per day in rain scares seasons. The use of wastewater for irrigational purposes require a general authorisation as listed in GNR 665, but no application for a general authorisation is done up to date. The sustainability department of Woodlands dairy takes samples of the waste water and monitors the water quality on a monthly basis, in order to keep record of water quality. According to the farmer the core challenges around water management is the financial implications for new developments together with uncertainties around legal requirements for developments and water use. Water levies for the Government is also a concern, because the farmer states that the levies always stay the same and that it does not matter if the dam is empty or full. Future plans around water on the F3 are mainly based more irrigation systems and to use current water more efficient as possible, because if water moves past the farm it ends up in the sea.

4.3.2 Air

The farmer liable for F3 feels that South Africa needs food and without milk or meat from livestock it will be impossible to produce to the needs of the ever-growing population. No reasonable measures are in place to control offensive odours. The workers in the dairy parlour make use of gloves and facemasks for protection from odours. The farmer has not seen any dramatic changes in the climate up to date.

4.3.3 Soil

The soil on F3 is mainly sandy soil, which makes it difficult to get a fruitful soil type. A large amount of chemical and organic fertiliser is used on pastures, to make soil more fertile. Soil samples are taken to determine what type of nutrients is needed. The organic fertilizers are effluent water from the dairy and chicken manure, where the chemical fertilizers are different types of nitrogen. The grazing is well managed through a weekly measurement of pastures, in order to determine grow up of the pastures. The herd moves from one camp to another after the camp has no more food left. The future aim of soil fertility is to increase organic fertilizers and to decrease chemical fertilizers.

4.3.4 Biodiversity

There are about 700ha of natural areas located on F3 and is situated on sand dunes where development can't take place. The farmer believes that any form of natural ecosystem is crucial when it comes to production on farming activities, because micro-organism can make the carbon balance better in sandy soil areas. No virgin soil was transformed from the farmer's ownership and all of the developments were done on old cultivated and already disturbed lands. The farmer is unaware of South African National Biodiversity Institute (SANBI) and does not know the role that SANBI plays in the agricultural sector.

4.3.5 Waste generation

The management of dairy waste is done by the runoff of effluent from into two separate dams specially developed for the storage of effluent. The first dam has an outflow where the liquids surge out into the next dam. The liquid slurry from the second dam is used as irrigation and will be pumped on to the pastures. The solid manure of the first dam will be scrapped out every 18 months by a contractor and then used as a dry organic fertilizer on pastures. The total effluent generated in the milking parlour daily is approximately 206m^3. The management of such a vast amount of dairy waste can become a major problem when the dams overflow, which will result to water and ground pollution. There is a landfill site on F3 and is close to the workers lodging. The landfill is used for household waste, animal carcasses, empty fertilizer plastic bags, paper and empty plastic containers. All the waste is burned and when the landfill gets to full, a new one is prepared. The farmer believes that he takes reasonable measures for the management of waste on F3, by taking medical waste to the responsible vet, managing dairy effluent effectively and implementing best practices when it comes to pollution of natural areas.

4.3.6 Energy and non-renewable resources

The farmer sees energy availability as a major problem and has a backup generator at the dairy. The farmer also believes that there is a market for renewable energy and that the potential are enormous. The farmer makes use of solar and wind power and wants to expand on the use of solar power in the future. The farmer does not believe that there is enough feedstock on one dairy farm to operate a waste to energy plant but feels that a combination of dairy farms will be more than enough.

Table 4.3: Key environmental issues on farm 3

Farm 3	
Water	
Reference to Annexure 2	Summary of key environmental issues raised
2.3)	Extracts water from a natural stream and has water rights to use the water.
2.5)	Application of general water use licence is approved and submitted to Water Affairs.
2.5)	Registered boreholes to the Department of Water Affairs and dams fall under the threshold for storing water (50 000m^3).
2.6)	Untreated liquid slurry generated from the dairy parlour, is pumped on to the pastured as a form of organic fertiliser.
2.8)	The facilities for the treatment of effluent generated by livestock are not efficient and the storage of effluent is not managed by best practice.
2.9)	No application for a general authorisation for the irrigation of waste or water containing waste is done as requested in the NWA GNR 665.
2.10)	Monitor and keep record of the effluent quality on a monthly basis.
2.11)	Irrigation of wastewater normally takes place on all pastures, through pivot irrigation.

Air	
Reference to Annexure 2	Summary of key environmental issues raised
1.3)	Concentrated methane emissions from livestock in dairy parlour are four to six hours per day.
1.4)	Free range pasture-based system.
3.3)	No reasonable steps to control offensive odours.
Soil	
Reference to Annexure 2	Summary of key environmental issues raised
1.4) ;(4.2)	The grazing on the pastures is worked out to ensure that overgrazing does not take place.
4.3) ;(4.7)	Use of fertilizer on a responsible way.
Biodiversity	
Reference to Annexure 2	Summary of key environmental issues raised
5.2) ;(5.6)	Large natural habitat areas left on farm and located on sand dunes

5.4)	All developments on the farm are done on already disturbed land and no virgin soil areas transformed.
5.7)	Not aware of indigenous vegetation listed in SANBI.
Waste generation	
Reference to Annexure 2	Summary of key environmental issues raised
6.1)	Solid manure generated in dairy parlour is stored in holding ponds for 18 months.
6.4) ;(6.5)	Storage facility of solid manure is not sufficient for the daily amount generated.
6.7)	All the general waste generated on the farm gets burned in landfill.
6.7)	Landfill site not managed accordingly.
6.8) ;(6.9)	Effective disposal and management of hazardous waste.
6.8)	Medical waste is transported to the responsible vet.
6.10)	A private recycling company comes and collects the recyclable materials generated on the farm.
Energy and non-renewable resources	
Reference to Annexure 2	Summary of key environmental issues raised

7.1)	Makes use of wind and solar energy to pump water.
7.5)	Effective storage of diesel.
7.6)	Effective storage area for hazardous chemicals and fertilizers.

4.4 Farm 4

Farm 4 (F4) is a family farm from 1987 and the farmer is the official landowner from 2007 up to date. The total farm area is 350 ha, from the total area there are 180ha pasture with irrigation and 170ha pasture without irrigational systems. The farm is located next to the sea and on a sandy soil type. The overall gradient of the farm is moderate, but in some areas sharp as it borders the coastal sea line. The herd is managed on a free-range pasture-based system where the cows are rotated on a daily basis and will graze on pastures with the most feed available. This system is done to ensure that overgrazing is minimised, and cows get as much as necessary feed from the pastures. Gras seeds such as kikuyu, ryegrass, chickaree and clovers are planted under irrigation systems. Extra crops such as maize are planted for an additional protein source in the dry seasons. The total herd size is 2000, 1400 milking cows and 600 dry cows. The cows spend roughly thirteen hours in the milking parlour per day and are milked two times a day. The future expansion plans for the F4 is to construct a new dairy and the farmer wants to do everything according to the relevant legislation from the beginning. The farmer has communicated with the regional authorities but did not get a speedy return. The farmer is still waiting on their response up to date (22 Aug 2016). The farmer would also like to buy more land, but it is difficult, because available land are scares and expensive in the region.

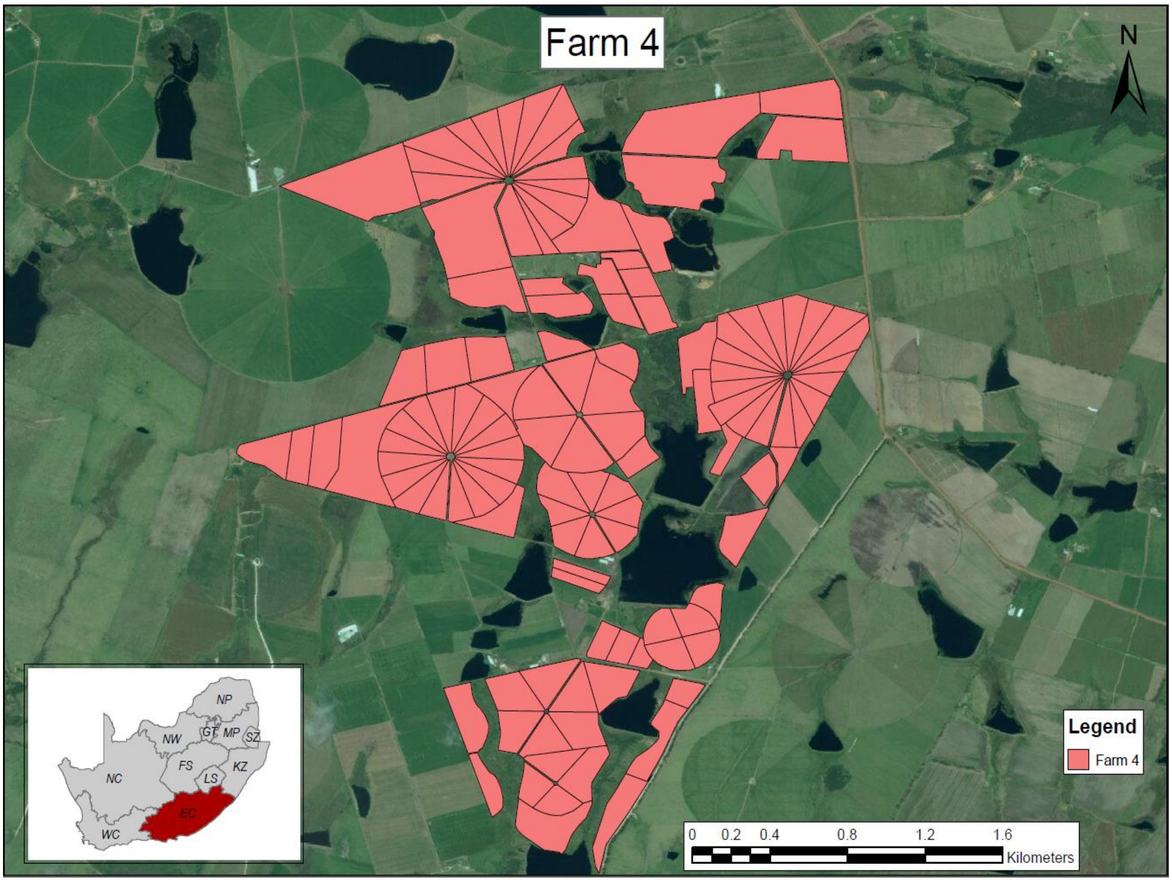

Figure 4.8: Map layout of farm 4

4.4.1 Water

The main water resources used on F4 are three boreholes and four rainwater dams. The boreholes are used for household and livestock drinking purposes, where the rainwater dams are used for irrigational purposes. The four rainwater dams can store a combined capacity of 75 000m³, the first dam is 15 000m³, the second dam is 14 000, the third dam is 22 000m³ and the fourth dam is 24 000m³. The farmer liable for F4 has done all the necessary registration for all three boreholes and the dams did not require any authorisation, because the farmer carefully planned and construct the dams in order not to trigger an Environmental Assessment. No wastewater is discharged into a natural water source, only the effluent generated from the dairy parlour gradually flows into ponds, particularly build for the storage of effluent. The Waste water stored in the ponds will be reused as irrigational water on 180ha of pastures. The wastewater will be combined with the rainwater dams and irrigate up to 1 200mm per ha per year and 3.3mm per ha per day, when it is not raining. The use of wastewater for irrigational purposes require a general authorisation as listed in GNR 665, but no application for a general authorisation is done up to date. The sustainability department of Woodlands dairy takes samples of the waste water and monitors the water quality on a monthly basis, in order to keep record of water quality. Future plans around water on the F4 are to use current water more efficient and optimally make use of effluent water. The major challenges around water management on F4 is drinking water for the livestock, as the farmer as lost cows to contaminated water caused by access fertilizer runoff in dams.

4.4.2 Air

The farmer feels that dairy farms in the specific area is all well managed according to odours and methane, because the livestock is not as concentrated as full-feed farming systems and will result in less concentrated methane emissions. No reasonable measures are in place to control offensive odours, because no complains has arisen in the area and all the surrounding landowners are dairy farmers. The workers in the dairy parlour have the option to make use of facemasks and rubber gloves for protection against odours.

4.4.3 Soil

There are some problems regarding soil fertility on F4, because of the sandy topsoil. Extra fertiliser is needed to ensure that pastures grow up is better. The management of grazing is done in a responsible and efficient way to ensure that overgrazing is minimised, and pastures grow up is maximised. Weekly measurement of pastures is done to determine were the cows must feed throughout the week. The pastures will never be overgrazed and is well monitored to ensure full capacity food produced for livestock. Chemical fertilizers are used to get more nitrogen turnover on the pastures together with organic fertilizers in the form of chicken manure and effluent from the dairy to produce more natural ground composition. The future regarding soil fertility is to increase organic fertilizers in order to save money and decrease carbon footprint.

4.4.4 Biodiversity

There are about 30ha of natural habitat areas located on F4 and are identified as wetlands where no farming activities may take place. The farmer believes that any form of natural ecosystem is important and that it is always an indicator of a high quality of water when fish and bird species are active. No virgin soil was transformed from the farmer's ownership and all recent developments were done on old cultivated lands. The farmer did clear five ha of invasive plant species in order to make way for more pastures. The farmer heard off the South African National Biodiversity Institute (SANBI) but he does not know the role that SANBI plays in the agricultural sector.

4.4.5 Waste generation

The management of dairy waste is done in two different ways on F4. Management of dairy effluent in the first milking parlour is done by a mechanical system in place to separate the liquid slurry from the solid manure. The system is known as the horizontal screw press process. We then take the solids generated from the parlour and store it for future use on our pastures as an organic fertiliser. The liquid slurry is pumped into two separated dams where it is stored and treated before it gets pumped on to the pastures as irrigation. The second parlour on the farm is different, because it is a much older parlour. The effluent generated gradually runs off into one big effluent pond where it is stored until the wastewater is used as irrigation on pastures. The solid manure will be scrapped out every 18 months by a contractor and then used as a dry organic fertilizer on pastures. The farmer states that the old parlour is causing environmental and health problems and is not the ideal way to manage effluent on a dairy farm. The total effluent generated in the milking parlour daily is approximately 175m^3. There is a landfill site on the F4 and all household waste, dirty plastic bags, dirty silage plastic and medical waste end up in the landfill. As soon as the landfill is to full, all of the wastes are burned in order to make more space. The workers have the option to eat the dead cows, but if the carcass is contaminated the carcass will be burned and buried on the farm. The farmer takes reasonable steps to make sure that the landfill site is away from any households or natural wetlands on F4. The farmer reuses old tyres on dam walls and silage heaps. The farmer also has a contract with a regular recycling company to take clean recyclable material away in order to be reused.

4.4.6 Energy and non-renewable resources

The farmer sees the energy capacity as a major problem, because electricity is weak, and the voltages are too low, which results in power failure from time to time. The farmer also believes that there is a market for renewable energy on a dairy farm and it is the way to go in the near future, as dairy farmers can't go a minute without electricity. The farmer does not believe that a waste to energy plant will work on F4, because there is not enough organic, and the manure is better used as a fertilizer. The main challenges on energy consumption on F4 is the quality of energy which result in power failures, a standby generator is installed because the milk must be cooled at all time. The future plan regarding energy on F4 is to make use of wind power, but financial implications are slowing plans.

Table 4.4: Key environmental issues on farm 4

Farm 4	
Water	
Reference to Annexure 2	Summary of key environmental issues raised
2.5)	Application of general water use licence is approved and submitted to Water Affairs.
2.5)	Registered boreholes to the Department of Water Affairs and dams fall under the threshold for storing water (50 000m^3).
2.6)	Separates the liquid slurry from the solid manure. The solids generated from the dairy are used as organic fertiliser. The liquid slurry is treated before used as irrigation on the pastures.
2.8)	The facilities for the treatment of effluent generated by livestock are efficient and the storage of effluent is managed by best practice.
2.9)	No application for a general authorisation for the irrigation of waste or water containing waste is done as requested in the NWA GNR 665.
2.10)	Monitor and keep record of the effluent quality on a monthly basis.
2.11)	Irrigation of wastewater normally takes place on all of our pastures, through pivot irrigation.
Air	

Reference to Annexure 2	Summary of key environmental issues raised
1.3)	Concentrated methane emissions from livestock in dairy parlour are 13 hours per day.
1.4)	Free range pasture-based system.
3.3)	No reasonable steps to control offensive odours.
Soil	
Reference to Annexure 2	Summary of key environmental issues raised
1.4) ;(4.2)	The grazing on the pastures is worked out to ensure that overgrazing does not take.
4.3) ;(4.7)	Use of fertilizer on a responsible way.
Biodiversity	
Reference to Annexure 2	Summary of key environmental issues raised
5.2) ;(5.6)	No large natural habitat areas left on farm, only wetlands.
5.4)	All developments on the farm are done on already disturbed land and no virgin soil areas transformed.

5.7)	Not aware of indigenous vegetation listed in SANBI.
Waste generation	
Reference to Annexure 2	Summary of key environmental issues raised
6.1)	Solid manure generated in dairy parlour is treated as compost for reuse.
6.2)	Separation of solid and liquid manure from the dairy and responsible use as irrigation and fertilizer.
6.7)	All the general waste generated on the farm gets burned in landfill.
6.7)	Landfill site not managed accordingly.
6.8) ;(6.9)	Effective disposal and management of hazardous waste.
6.10)	Reuse old tyres on dam walls and silage heaps.
Energy and non-renewable resources	
Reference to Annexure 2	Summary of key environmental issues raised
7.5)	Effective storage of diesel.
7.6)	Effective storage area for hazardous chemicals and fertilizers.

4.5 Farm 5

The farmer responsible for the management of Farm 5 (F5) is the official landowner from 2005 up to date. The farm is pasture based and mostly consists of irrigational systems. An additional 160ha of maize is planted without irrigational systems and used as silage for extra feed in dry seasons. The total herd size is 1950, which are 1100 productive milking cows and 850 other cows. The herd is well managed on a free-range pasture-based system where the cows are rotated once a day in order to ensure that overgrazing does not take plays and to allow the herd a sufficient amount of feed from the pastures. The milking cows spend most of the day on the open pasture and approximately three hours in the morning and three hours in the evening in the milking parlour.

Figure 4.9: Map layout of farm 5

4.5.1 Water

The main water resource is from natural rainwater dams and boreholes located on the farm. The five rain water dams can store a shared water capacity of 1400 000m³, first dam is 45 0 00m³, the second dam is 32 000m³, third dam is 28 000m³, forth dam is15 000m³ and the fifth is 20 000m³. Water from four boreholes is used to pump the underground water into the five rainwater dams as needed. All boreholes are registered by the Department of water affairs and water rights are in order to use waster on F5. The wastewater generated from the dairy parlour is discharge and stored in holding ponds, specially build to store effluent. The Waste water generated in the milking parlour is reused as irrigational water on the pastures. The use of waste water for irrigational purposes require a general authorisation as listed in GNR 665, but no application for a general authorisation is done on F5. Although no general authorisations are done for irrigation of wastewater, the monitoring of wastewater are done on a monthly basis by the sustainability department of Woodlands dairy. The total daily amount of wastewater used on F5 is 150m³ and the farmer states that a dairy farm is in need of a vast amount of water per day and the wastewater helps with the high-water demand from pastures in the dry seasons. He wants to ensure that there is enough storage for the available water and improve the quality of livestock drinking water.

4.5.2 Air

The farmer feels that the carbon captures of pastures are more than compensates. He also states that surrounding dairy farms are well managed, because livestock are managed on open pastures and methane emissions will not be as concentrated as full-feeding systems. There are no reasonable measure in place to control offensive odours on F5 and no complains has been made in the area up to date. The workers in the dairy parlour have the option to make use of facemasks and rubber gloves for protection against odours.

4.5.3 Soil

There are some problems regarding soil fertility on F5, because of the sandy topsoil and soil potassium. Extra fertiliser is needed to ensure that pastures grow up is better. The management of grazing is done in a responsible and efficient way to ensure that pastures grow up is maximised. Weekly measurement of pastures is done to monitor and pasture growth and to calculate were the cows must feed throughout the week. Pastures are rotated on a daily basis and the longest growth in pastures will be fed to the cows first (Figure 4.10). The pastures will never be overgrazed to ensure full capacity food for livestock. Organic fertilizers in the form of chicken litter and dairy effluent are used to produce more natural composition in the soil. Chemical fertilizers are only used to get more nitrogen on the pastures as needed. The developments of road on F5 are done with large machinery and the roads are built up with gravel and are approximately eight meters wide. The future plan around soil fertility is to increase organic fertilizers in order to save money and to make use of lime for better C and Ca levels in soil composition.

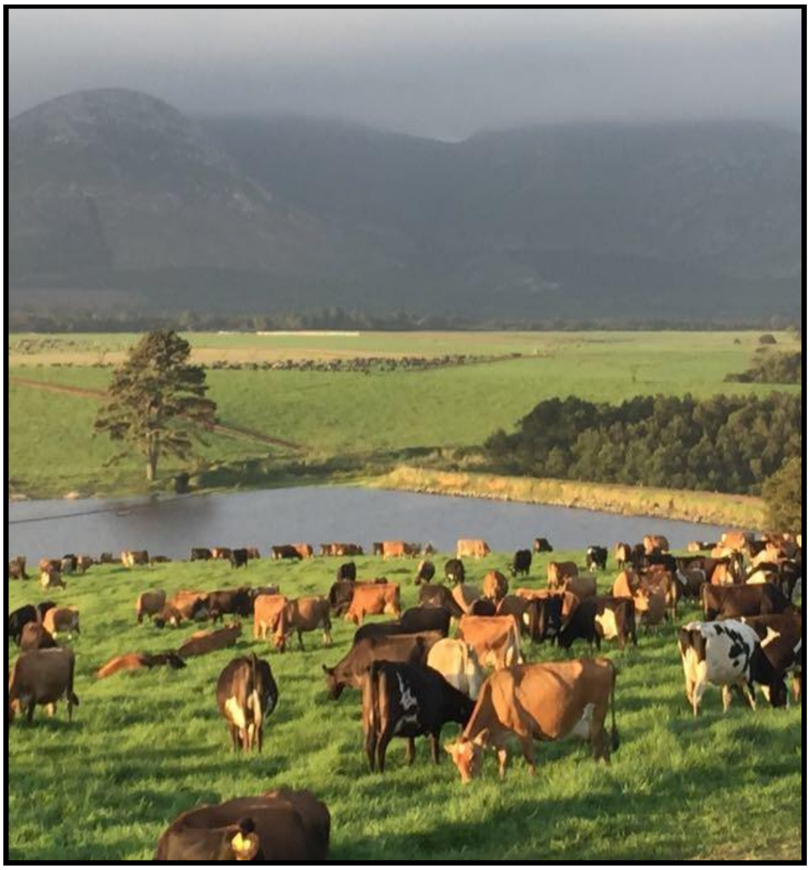

Figure 4.10: Cows grazing on open pastures

Source: researchers own photograph

4.5.4 Biodiversity

When the farmer became the official landowner of F5, there were a small amount of natural habitat areas left and the farm mostly consisted out of old cultivated land. The farmer cleared 80ha of invasive Blackwattle trees to make space for extra pastures. There are currently 5ha of natural areas on F5, these areas are also difficult to develop, because some areas are close to natural wetlands and the gradient is too steep. The farmer believes that earthworms and fungi are essential when it comes to the natural flow of the soil ecosystem. The farmer is aware of South African National Biodiversity Institute (SANBI) and believes that the wetland areas on F5 fall under the indigenous vegetation as listed in SANBI.

4.5.5 Waste generation

The management of dairy waste is done by effluent runoff from the milking parlour into three separate ponds; these ponds are specially built for the storage of dairy effluent. The first pond stores the solid manure and has an outflow where the liquid slurry flows out into the next pond. The second pond is built to filter the water on a natural process, were the lasting slurry sinks to the bottom of the pond and the top liquid flows out to the third pond. The liquid from the third pond is pumped to one of the larger rainwater dams where it will be used as irrigation on the pastures. The management of the third pond is a major problem, as the effluent runoff into natural wetlands and pollutes the natural wetland ecosystem. The solid manure of the first dam will be scrapped out every 12 months by a contractor and used as a dry organic fertilizer on pastures. The total effluent generated in the milking parlour daily is approximately 150m^3. There is a landfill site on F5 and is close to the workers temporary housing. No products on F5 are recycled or reused. The landfill is used for household waste, animal carcasses, medical waste empty fertilizer plastic bags, paper and empty plastic containers. All the waste in the pit is burned on a regular basis and a new pit is prepared as needed. The farmer believes that he takes reasonable measures for the management of waste, by managing dairy effluent effectively.

4.5.6 Energy and non-renewable resources

The farmer sees the consumption of energy as a major problem, because of power shortages and power failure from time to time. The farmer states that a dairy farm is in need of electricity 24hour a day to ensure that milk is stored at a cool temperature. The farmer also believes that there is a market for renewable energy and it is the way to go in the future. The farmer is not sure if a waste to energy plant can effectively work on a dairy farm. The farmer states that the available data hold opposing views where the figures differ from plant to plant and not enough research is done to know whether it can work on a dairy farm. The main challenges on energy consumption is the soaring prices from Eskom together with power failures, a standby generator is installed because of the uncertainty of available electricity. There are no future plans regarding energy on F5. The chemical fertiliser is stored in the shed and chemicals are locked inside a room in the shed.

Table 4.5: Key environmental issues on farm 5

Farm 5	
Water	
Reference to Annexure 2	Summary of key environmental issues raised
2.3)	Extracts water from a natural stream and has water rights to use the water.
2.4)	Discharges water containing waste into a natural water resource.
2.5)	Application of general water use licence is approved and submitted to Water Affairs.
2.5)	Registered boreholes to the Department of Water Affairs and dams fall under the threshold for storing water (50 000m^3).
2.6)	Untreated liquid slurry generated from the dairy parlour, is pumped on to the pastured as a form of organic fertiliser.
2.8)	The facilities for the treatment of effluent generated by livestock are not efficient and the storage of effluent is not managed by best practice.
2.9)	No application for a general authorisation for the irrigation of waste or water containing waste is done as requested in the NWA GNR 665.
2.10)	Monitor and keep record of the effluent quality on a monthly basis.

2.11)	Irrigation of wastewater normally takes place on all pastures, through pivot irrigation.
Air	
Reference to Annexure 2	Summary of key environmental issues raised
1.3)	Concentrated methane emissions from livestock in dairy parlour are four to six hours per day.
1.4)	Free range pasture-based system.
3.3)	No reasonable steps to control offensive odours.
Soil	
Reference to Annexure 2	Summary of key environmental issues raised
1.4) ;(4.2)	The grazing on the pastures is worked out to ensure that overgrazing does not take.
4.3) ;(4.7)	Use of fertilizer on a responsible way.
Biodiversity	
Reference to Annexure 2	Summary of key environmental issues raised

5.2) ;(5.6)	No large natural habitat areas left on farm, only wetlands.
5.4)	Cleared more than 80ha of invasive plant species (wattle trees).
5.4)	All developments on the farm are done on already disturbed land and no virgin soil areas transformed.
5.7)	Not aware of indigenous vegetation listed in SANBI.
Waste generation	
Reference to Annexure 2	Summary of key environmental issues raised
6.1)	Solid manure generated in dairy parlour is stored in holding ponds for 18 months.
6.2)	Storage facility of solid manure is not sufficient for the daily amount generated.
6.7)	All the general waste generated on the farm gets burned in landfill.
6.7)	Landfill site not managed accordingly.
6.8) ;(6.9)	Effective disposal and management of hazardous waste.
Energy and non-renewable resources	

Reference to Annexure 2	Summary of key environmental issues raised
7.5)	Effective storage of diesel.
7.6)	Effective storage area for hazardous chemicals and fertilizers.

4.6 Overall performance of selected farms

The main research aim of this research was to critically reflect on the environmental regulatory requirements for dairy farming in South Africa. The sub research aims assisted to give effect to the main research aim, by gathering data on the views of the selected farmers, regarding management of environmental aspects together with the relevant environmental legislation.

This chapter helped to evaluate the management of the different environmental aspect of five dairy farms. The research methods used in this chapter assisted to gain an overall view of the performance of the selected farms. The farm visits results discussed in this chapter, clearly indicates that the overall mindset of the farmers is positive towards sustainable farming, as they are all part of Woodlands Dairy Sustainability project, however there are numerous environmental impacts still occurring along the life cycle of dairy production on these farms. These impacts are summarised in the cross-case report and listed as environmental issues raised.

The management of the environmental aspects by all five-selected farmer will be discussed and summarized in a cross-case analysis in section 4.8.

4.7 Cross Case Analysis:

The cross-case research design used for this dissertation assisted the researcher with stronger and more objective worthy data, than data from single-case designs only. The cross-case also helped to accumulate knowledge from the original single cases and build or test it to the literature theory, by comparing the different cases to one another, to learn from the different cases and gather important data (Eckstein, 2002).

A symbol is provided on whether the selected farm effectively or ineffectively addressed the issue raised regarding the environmental aspects or environmental laws. To indicate that the management of aspects on the farm was done in the most responsible manner available, the symbol “x” is used and indicates that the environmental issues regarding the management of aspects is successfully addressed. To indicate that the management of the aspects on the farm was done ineffectively, the symbol “-“ is used and this indicates that the environmental issues on the management of aspects is not successfully addressed. To indicate that the management of the aspects on the farm was done in a neutral way the symbol “=” is used and indicates that the environmental issues on the management of the aspects is not effectively or ineffectively addressed, therefore still requires additional attention to the management of the environmental issue raised.

Table 4.1 illustrates the different symbols used to evaluate the selected farms in the cross-case analysis.

Table 4.6: Performance scorecard

Addressed	**x**
Not addressed	**-**
Partially addressed	**=**

The management of the different environmental aspects on farm level are summarised in table 4.2 below. This table also compares the five different dairy farms effectiveness regarding to the management of environmental aspects and legal compliances towards relevant environmental legislations.

Table 4.7: Cross-case analysis of the five dairy farms

Aspects	Environmental issues	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
Water	Extracts water from a natural stream and has water rights to use the water.	-	x	x	-	x
	Discharges water containing waste into a natural water resource.	-	=	=	-	x
	Application of general water use licence is approved and submitted to Water Affairs.	x	x	x	x	x
	Registered boreholes to the Department of Water Affairs and dams fall under the threshold for storing water (50 000m³).	x	x	x	x	x
	Untreated liquid slurry generated from the dairy parlour, is pumped on to the pastured as a form of organic fertiliser.	x	-	x	-	x
	Separates the liquid slurry from the solid manure. The solids generated from the dairy are used as organic fertiliser. The liquid slurry is treated before used as irrigation on the pastures.	-	x	=	x	=
	The facilities for the treatment of effluent generated by livestock are not efficient and the storage of effluent is not managed by best practice.	x	-	x	-	x
	The facilities for the treatment of effluent generated by livestock are efficient and the storage of effluent is managed by best practice.	-	x	=	x	-
	No application for a general authorisation for the irrigation of waste or water containing waste is done as requested in the NWA GNR 665.	x	x	x	x	x

	Monitor and keep record of the effluent quality on a monthly basis.	x	x	x	x	x
	The general location, were irrigation of wastewater takes place not close to any wetlands or rainwater dams.	x	x			
	Irrigation of wastewater normally takes place on all pastures, through pivot irrigation.	-	-	x	x	x
Air	Concentrated methane emissions from livestock in dairy parlour are four to six hours per day.	x	x	x		x
	Concentrated methane emissions from livestock in dairy parlour are 13 hours per day.	-	-	-	x	-
	Free range pasture-based system.	x	x	x	x	x
	No reasonable steps to control offensive odours.	x	x	x	x	x
Soil:	The grazing on the pastures is worked out to ensure that overgrazing does not take.	x	x	x	x	x
	Use of fertilizer in a responsible way.	x	x	x	x	x
Biodiversity:	Large natural habitat areas left on farm and located on sand dunes	-	-	x	-	-
	No large natural habitat areas left on farm.	-	x	-	=	-
	No large natural habitat areas left on farm, only wetlands.	x	-	-	x	x

	Cleared more than 80ha of invasive plant species (wattle trees).	-	-	-	-	x
	All developments on the farm are done on already disturbed land and no virgin soil areas transformed.	x	x	x	x	x
	Not aware of indigenous vegetation listed in SANBI.	x	x	x	x	x
	Disruption of natural ecosystems	x	x	-	=	x
Waste generation:	Solid manure generated in dairy parlour is stored in holding ponds for 18 months.	=	=	x	=	x
	Storage facility of solid manure is not sufficient for the daily amount generated.	=	=	x	=	x
	Solid manure generated in dairy parlour is treated as compost for reuse.	x	x	=	x	-
	Separation of solid and liquid manure from the dairy and responsible use as irrigation and fertilizer.	-	x	-	x	-
	All the general waste generated on the farm gets burned in landfill.		x	x	x	x
	Landfill site not managed accordingly.	x	x	x	x	x
	Effective disposal and management of hazardous waste	x	x	x	x	x
	Medical waste is transported to the responsible vet.	-	-	x	-	-
	Reuse old tyres on dam walls and silage heaps.	-	-	-	x	-
	A private recycling company comes and collects the recyclable materials generated on the farm.	-	-	x	-	x
Energy and non-	Makes use of wind and solar energy to pump water.	x	-	x	-	-

renewable resources:						
	Effective storage of diesel.	x	x	x	x	x
	Effective storage area for hazardous chemicals and fertilizers.	x	x	x	x	x

The cross-case analysis of the five selected dairy farms indicates positive and negative outcomes, regarding the management of the different environmental aspect and the farmers' knowledge of environmental laws. There is an overall positive mindset from the farmers towards taking more reasonable measures in some of the farming practices, however there is still various environmental impacts which result from the mismanagement of environmental aspects on these farms.

The management of water had a positive outcome in some respects, since all of the selected farms complied with the requirements from the Department of Water Affairs and done the necessary registrations of boreholes and applications of general water use licences. All of the selected farms form part of the Woodlands Dairy Sustainability project, where they monitor and keep record of the effluent quality generated on the farms. This can be seen as a step in the right direction, as the quality monitoring of effluent can result in improved control over the quality and volume of effluent discharge on to the pastures. However, the overall effectiveness of the management of irrigation with waste water can be seen as ineffective, because not one of the farms has done the required authorisation for the irrigation of waste water. There was also visual evidence on some of the farms, where ineffective management practices of the discharge of waste water took place and resulted to water pollution of natural water resources, such as wetlands. The facilities for the treatment and storage of effluent generated by livestock in the dairy parlour can be seen as not fully addressed, since leakages and spills on the farms occur. However, one farm makes use of highly advanced technology to separate the solid manure from the water, in order to get a better-quality effluent and reuse the water irrigation and the solid material as fertiliser for the pastures.

The overall management regarding the aspects of air quality on the farms, can be seen as positive, because farmers manage their herds on a free range and open pasture grazing method. This method helps to prevent the concentration of animals in a confined space, which will also assist to reduce air emissions from methane produced by livestock. The cows are however restricted to a confined space when entering the milking parlour and the time spend inside the milking parlour will have a direct impact on amount of methane emission produced. Not one of the farms take reasonable measures to control offensive odours, since there have not been any complaints from the surrounding land owners. Furthermore, no pollution prevention plan have been submitted by the selected farms as a duty of care under NEM:AQA, because the gases released by waste on dairy farms have not yet been declared as priority air pollutants in the Eastern Cape province.

The management of the aspect regarding soil is overall positive and managed effectively on all five farms. All of the farms have a sandy top soil and the farmers do their best to minimise cultivation, in order to keep the natural nutrients and organisms. A large amount of chemical and organic fertiliser is also used on pastures, for additional nutrients to the soil. The grazing is also well managed and monitored through weekly measurement of pastures (pasture walk). The open pastures are well managed on all five farms to ensure that overgrazing on the pastures is limited.

The management of biodiversity on the farms had some positive outcomes, since there are still natural areas on some of the farms left, where no development can take place and natural ecosystems can thrive. It was also evident that all the new developments of the farms were done on old cultivated lands and no virgin soil was transformed. The farmers are unaware of indigenous vegetation listed South African National Biodiversity Institute (SANBI), which can lead to degradation of protected biodiversity's. The management of aspect around waste on the selected farms is in general only partly addressed; however, there is one farmer who almost fully addressed all the aspects. The overall management of the landfill sites on the farms are not reasonably managed, since all the waste inside the landfill is burned throughout the year. The farmers do however take some reasonable measures to reuse waste and dispose hazardous waste.

The management of aspects around energy and non-renewable resources is overall positive, as the selected farmers store diesel, fertilizers and chemicals in a reasonable way. All of the farmers have a positive mindset around the use of renewable energy resources and believes that it is the way to go for further developments. They all want to make use, or already make use of solar or wind power, as concerns over the availability of energy grows.

CHAPTER 5 CONCLUSIONS & RECOMMENDATION

This chapter provides the overall outcome of the dissertations results and will be discussed in relation to the main research aim and sub-research aims.

The outline of this chapter is as follow:

Section 5.1 provides an evaluation critical perspective on the environmental regulatory requirements for dairy farms in South Africa, followed by a summary of the main challenges for dairy farmers (section 5.2). The final conclusions and recommendations are included in section 5.3.

5.1 A critical perspective on the environmental regulatory requirements for dairy farms

Environmental legislation is essential for promoting environmental sustainability, both as a source of guidance and as a source of enforcement. The success of legislation and policies primarily depends on 'policing' and action at all levels in society, from governmental organisations through to civic engagement and environmental activist groups.

In terms of all the chapters above, this dissertation sought to critically reflect on the implications of the environmental regulatory requirements for dairy farming in South Africa and forthwith to determine whether the current environmental legislation is relative and can be used as an effective management tool within the dairy industry of South Africa. In conclusion it can be said that there is a comprehensive framework for environmental legislation and an existence of well documented regulations connected to environmental protection, however the implementation and enforcement of theses environmental laws on dairy farms is not successful or well investigated.

The results of this dissertation agree with the study of (Grobler, 2011) and can also state that there is a need for specific environmental laws and regulations to regulate the severe environmental impacts related to dairy farming activities in South Africa. The dissertation found that there is currently no specific environmental legislation or guided regulations, related to the dairy farming industry and the management thereof. It is evident that the relevant South African environmental legislation only regulates the dairy farming industry to an extent. Most of the legislation as discussed in section 2.5 is only applicable on a general level and not specifically to the dairy farming industry. The legislation discussed in this dissertation has a general application on the dairy farming industry, which can prove to be insufficient and vague in the near future. The legal framework currently available for prevention, minimisation together with remediation of the various environmental impacts linking to the dairy farming industry is still limited. It is crucial that the national government recognise the ever-growing industry and the severe impacts which it can have on the receiving environment. The health and well-being of South African citizens, together with the protection of the natural environment are very important and must be prioritized. Legislation, specifically linked to intensive farming industries, like dairy farms, must be created to regulate each aspect which can result in an impact within the industry. This must also include specific guidelines and sufficient enforcement methods.

Further established through this dissertation, is the lack of the implementation of environmental legislations for the containment of effluent from dairy run-off, as well as the use of waste water for irrigation on the selected farms. These aspects are both related to severe environmental impacts and better enforcement measures must be implemented from the relevant authorities. Implementation of the relevant legislation regarding environmental care at farm level needs to be improved and better implemented, in line with the international norms and standards because South Africa has a significant commercial dairy farming sector, therefore South African authorities need to improve pollution and waste management to be fully included into the global community.

The lack of enforcement measures is also found throughout the interviews and farms visits of this dissertation and can agree with the previous studies of (Hoogervorst et al., 1999; Grobler 2011; Torr, 2009), that the relevant environmental laws are unsuccessfully enforced in the agricultural sector and more awareness is needed, especially within the dairy sector.

5.2 Challenges for dairy farmers

The management of the environmental aspect according to the relevant environmental regulations and guidelines are still a challenge for the selected farm owners. The regulations and guidelines specifically for dairy farming are currently deprived and the farmers are not aware of all the relevant environmental regulations, which they must comply with. This will then lead to the mismanagement of environmental aspects of the farm and use inefficient farming methods which could cause significant pollution to the receiving environment and natural resources.

During the interviews and farm visits, it was evident that the farmers are not always aware of the relevant environmental laws and regulations. The selected farm owners do not know what all of the relevant environmental laws are, and they are not up to date on what the role of these laws are, within their farming practices. It was also found that the farmers are willing to cooperate with these laws, however they need to be provided with the necessary information on how they can become more compliant to the relevant legislations. The compliance towards environmental laws remains a challenge to dairy farmers, as failure to comply with relevant laws can have severe implications and result in either stern financial fines or penalties.

5.3 Final conclusions and recommendations

Certain conclusions regarding the research process of this dissertation has been made and can contribute to the literature of South Africa environmental regulations for dairy farming, which is currently to a great deal absent and vague.

Dairy farming in the form of large commercial factory farming is still relative new in South Africa, but because of production speed and cost-effectiveness the industry is growing at a rapid pace. Even though there are less dairy farmers in South Africa than before, they are still producing an efficient amount of milk to the growing population, because of enlarged dairy herds and use of the most advanced technology. The dairy farmers in South Africa understand that dairy farming is a business and must be operated with significant business skills, necessary agricultural knowledge and management of dairy cattle by providing enough nutrition that will allow the cows to produce the optimum amount of quality milk.

As the global population grows, so does the demand for any form of food security. This demand has resulted to the increase of global livestock production systems and has thus resulted to an increase in environmental impacts. The potential environmental impacts were identified during the evaluation of the life cycle of dairy farming in South African. The increase of dairy production observed within South Africa, linked to the growing demand for dairy products has resulted to the increase use of natural resources, like water and soil than ever before. The management of environmental aspects within the dairy farms can result in severe environmental impacts if not managed accordingly. The significance of these impacts will depend on the farming practices and management techniques used on the farms. To ensure that sustainable agriculture takes place in the long term, it is essential that farmers become more aware of the environmental impacts associated with intensive agricultural practices used dairy farms. These environmental impacts can be controlled and mitigated, through the farmers' successful interaction with key stakeholders, together with the implementation and management of environmental legislation.

Regarding the environmental law framework discussed in this study, it is important to note that farmers need to be aware of the significance of sustainable agricultural practices and incorporate the relevant environmental legislation into their farming activities. This dissertation provides several recommendations which could assist farmers or future farmers to make use of the relevant environmental framework when expanding or developing new dairy farms. The environmental framework provides the farmers with the relevant norms and standards, guidelines, regulations and environmental authorisation, which are required from the authorities. However, there is no effective use of a legal framework system, if there is no formal implementation or enforcement methods of the relevant policies and regulations in place.

The recommendation of the researcher is that governmental authorities involved in regulating the environmental sector of South Africa, must be stricter in the implementation of the relevant legislations and policies pertaining to agricultural activities. The authorities focus must rather be on preventing environmental impacts, rather than curing future impacts from the agricultural sector. The stricter approach to policy and legislation is a necessity for the symbiotic coexistence of the environmental and agricultural sectors of South Africa. The South African government must also involve as many as possible key stakeholders in the promotion of environmental sustainability in the agricultural sector, as this approach is crucial if a positive relationship is to exist, between the agricultural sectors and the receiving environment.

As mentioned throughout the above conclusions and recommendations there is a definite need for specific regulations regarding dairy farming to ensure that there is a set of guidelines to assist farmers in managing the farm in an environmentally sustainable manner. Because of the industrial nature of the selected dairy farms, the researcher recommend that these farms should also be obligated to implement an environmental management system into the business. An environmental management system, such as the *International Organisation for Standardisation*'s management system 14001 (ISO 14001), will force the farmers to comply with the necessary environmental laws. If the laws applicable to dairy farming activities are strict and the penalties are enforced adequately, the farmers will have no other choice but to manage the farms in accordance with the applicable laws and regulations. It is also fundamental that the farm owner provide the necessary facilities, develop effective procedures, conduct risk assessments before each activity and train their employees to conduct their duty without posing any risk to the environment.

To acknowledge that farms pollute and degrade the environment should neither accuse farming as a way of life nor denigrate the ideals farmers hold. Farming in South Africa is a deeply-rooted cultural institution with many noble qualities and important economic and social benefits, but it is also an industry with much in common with other industries, their owners, and their workers. Recognizing that industries cause environmental damage has not generally been regarded as an attack on the people or the institutions involved, nor should it be so for dairy farms. The basic reality is that dairy farms pollute and deplete natural resources such as water, air and soils; the farms eliminates open spaces for wild life habitat, erode and contaminate soils and contribute to sedimentation of lakes and rivers. These effects are and always have been consequences of dairy farming in general. What is remarkable is that these consequences have escaped serious regulatory attention even through the recent decades of environmental awakening. It is now more important than ever for the relevant authorities to step in and make sure that farms comply with the relevant environmental legislation, to decrease the devastating impacts that mismanagement of environmental aspect has on the environment.

The researcher recommends that more farms must be selected for future case studies. The researcher also recommend that different farming areas must be selected, in order to gain more information from the different management and agricultural practices used in the different climatic regions. The different dairy farming regions can then be compared to one another and conclusions can be made on whether environmental impacts will differ for the two different farming regions.

These findings, conclusions and recommendations could lead to future research in the South African context, which will increase the knowledge pool on dairy farming in this country. Further research could include an environmental audit to evaluate whether the collected interview data agrees with the actual management of environmental aspects on the farm.

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List of Interviews

Farm.1 Personal Interview. 22 August 2016

Farm 2 Personal Interview. 23 August 2016

Farm 3 Personal Interview. 24 August 2016

Farm 4 Personal Interview. 24 August 2016

Farm 5 Personal Interview. 24 August 2016

ANNEXURE 1 (SUMMARY OF ENVIRONMENTAL LEGISLATION)

General duty of care:

Relevant legislation					
National Environmental Management Act 107 of 1998	**National Water Act 36 of 1998**	**National Environmental Management: Air Quality Act 39 of 2004**	**National Environmental Management: Waste Act 59 of 2008**	**National Environmental Management: Integrated Coastal Management Act**	**Conservation of Agricultural Resources Act, 1983**
Section 2 - Principles	Section 19 - Prevention & remedying effects of pollution; Reasonable measures	Section 2 - Applicability of the Notice	Section 16 - Take all reasonable measure, General duty in respect of waste management	Section 58 - Duty to avoid causing adverse effects on coastal environment	Section 6 - Control measures
Section 24 - investigate, assess and evaluate the impact on the environment	Section 20 – Control of emergency incidents		Section 17 - Reduction, re-use, recycling & recovery of waste		Section 12 - Maintenance of soil conservation works and maintenance of certain states of affairs

Section 28 - Duty of Care; Reasonable Measures	Section 22- Permissible water use	Section 29 – Pollution prevention plans	Section 21 – General requirements for storage of waste	Section 69 - Discharge of effluent into coastal waters	
Section 30 - Control of emergency incidents	GNR 665 – Precautionary practices	Section 35 - Control of offensive odours.	Section 22 – Storage of general waste		

Norms and standards:

Relevant legislation				
National Water Act 36 of 1998	**National Environmental Management: Air Quality Act 39 of 2004**	**National Environmental Management: Waste Act 59 of 2008**	**National Health Act 61 of 2003**	**National Environmental Management Biodiversity Act 10 of 2004**

Norms and standards set by the Minister in terms of section 10(1) of the Water Services Act, 1997 is a precondition for a free raw water allocation.	GNR 163 Part 1: National framework Establishment 7. (c) national norms and standards for the control of emissions from point source; (d) national norms and standards for air quality monitoring; (e) national norms and standards for air quality management planning (f) national norms and standards for air quality information management;	GNR 635 National norms and standards for the assessment of waste for landfill disposal GNR 233 Draft National norms and standards for the remediation of contaminated land and soil quality NEM:WA Category C. GNR 921: 5 (a) Norms and Standards for Storage of Waste GNR 926 National norms and standards for the storage of waste	GNR 943 National norms and standards relating to environmental health in terms of National health act. Section 17 – Keeping of animals on premises 1. Norms 2. Environmental health monitoring standards 3. Standards for keeping of animals: 3.1 Requirements for keeping of cattle 3.2 Hygiene standards for keeping of cattle	GNR 214: Norms and standards for biodiversity management plans for species

Environmental Authorisation:

Relevant legislation			
National Environmental Management Act 107 of 1998	**National Water Act 36 of 1998**	**National Environmental Management: Waste Act 59 of 2008**	**National Environmental Management: Air Quality Act 39 of 2004**
Section 24 G: Consequences of unlawful commencement of activity (1) On application by a person who— (a) has commenced with a listed or specified activity without an environmental authorisation in contravention of section 24F(1); (b) has commenced, undertaken or conducted a waste management activity without a waste management licence in terms of section 20(b) of the National	GNR 704: 21. Water use For the purpose of this Act, water use includes – (a) taking water from a water resource; (b) storing water; (c) impeding or diverting the flow of water in a watercourse;	Category A: GNR 921 1. The storage of general waste in lagoons 5. The recovery of waste in excess of 10 tons but less than 100tons of general waste per day	Application for atmospheric emission licences: 37. (1) A person must apply for an atmospheric emission licence by lodging with the licensing authority of the area in which the listed activity is or is to be carried out. An application in the form required by the licensing authority. (2) An application for an atmospheric emission licence must be accompanied by-

Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), <u>List 1 GNR 983:</u> 4: the construction of or : the expansion of facilities or infrastructure for the concentration of animals for the purpose of commercial production in densities that exceed— (i) 20 square metres per large stock unit and more than 500 units, per facility;" 8: The construction of- agri-industrial infrastructure outside industrial complexes where the development footprint covers an area of 2 000 square metres or more. 12. The development of- (i) canals exceeding 100 square metres in size; (ii) channels exceeding 100 square metres in size;	(d) engaging in a stream flow reduction activity contemplated in section 36; (e) engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1); (f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit; (g) disposing of waste in a manner which may detrimentally impact on a water resource; (h) disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process; "26(1): (h) prescribing waste standards which specify the quantity, quality and temperature of waste which may be discharged or deposited into or allowed to enter a water resource; (i) prescribing the outcome or effect which must be achieved through management practices for the treatment of waste, or any class of waste, before it is discharged or	6. The treatment of general waste using any form of treatment at a facility that has the capacity to process in excess of 10 tons but less than 100 tons. 9. The disposal of inert waste to land in excess of 25 tons but not exceeding 25 000 tons 10. The disposal of general waste to land covering an area of more than 50m² but less than 200m² and with a total capacity not exceeding 25 000tons. 12. The construction of a facility for a waste management activity listed in Category A of this Schedule	(a) the prescribed processing fee; and (b) such documentation and information as may be required by the licensing authority.?

(iii) bridges exceeding 100 square metres in size; (iv) dams, where the dam, including infrastructure and water surface area, exceeds 100 square metres in size; (v) weirs, where the weir, including infrastructure and water surface area, exceeds 100 square metres in size; (vi) bulk storm water outlet structures exceeding 100 square metres in size; (x) buildings exceeding 100 square metres in size; xii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs- (a) within a watercourse; (b) in front of a development setback; or	deposited into or allowed to enter a water resource; (j) requiring that waste discharged or deposited into or allowed to enter a water resource be monitored and analysed, and prescribing methods for such monitoring and analysis "Controlled activity" 37. (1) The following are controlled activities: (a) irrigation of any land with waste or water containing waste generated through any industrial activity or by a ''waterwork;" "Compulsory licence applications 43. (1) If it is desirable that water use in respect of one or more water resources within a specific geographic area be licenced - (a) to achieve a fair allocation of water from a water resource in accordance with section 45 - (i) which is under water stress; or (ii) when it is necessary to review prevailing water use to achieve equity in allocations;	13. The expansion of a waste management activity listed in Category A or B of this Schedule which does not trigger an additional waste management activity in terms of this Schedule 14. The decommissioning of a facility for a waste management activity listed in Category A or B of this Schedule	

(c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse; 13. The development of facilities or infrastructure for the off-stream storage of water, including dams and reservoirs, with a combined capacity of 50000 cubic metres or more, unless such storage falls within the ambit of activity 16 of Notice 2 of 2014; 19: The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 cubic metres from- (i) a watercourse; (ii) the seashore; or (iii) the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater but	(b) to promote beneficial use of water in the public interest; (c) to facilitate efficient management of the water resource; or (d) to protect water resource quality, the responsible authority may issue a notice requiring persons to apply for licences for one or more types of water use contemplated in section 21." GNR 665: Department of Water Affairs – Revision of general authorisation in terms of section 39 of the NWA, 1998 (6 September 2013) Engaging in a controlled activity, identified as such in section 37(1)(a): irrigation of any land with waste or water containing waste generated through any industrial activity or by a waterwork. Purpose of authorisation- This general authorisation replaces the need for a water user to apply for a licence in terms of the Act, provided that the water use is within the limits and conditions as set out in this general authorisation.		

excluding where such infilling, depositing , dredging, excavation, removal or moving- (a) will occur behind a development setback; (b) is for maintenance purposes undertaken in accordance with a maintenance management plan; or (c) falls within the ambit of activity 21 in this Notice, in which case that activity applies. 22.The development of- (i) a road for which an environmental authorisation was obtained for the route	<u>Dam Safety Regulations GNR 193 of 2012</u> Every dam with a safety risk must be classified in accordance with this regulation 2 on the basis of its size and hazard potential to determine the level of control over the safety of the structure that is applicable in terms of these Regulations. (2) The size classification of a dam with a safety risk is based on the maximum wall height in accordance with Table 1 of the Annexure. Classification of dam with safety risk 2. (1) Every dam with a safety risk must be classified in accordance with this regulation 2 on the basis of its size and hazard potential to determine the level of control over the safety of the structure that is applicable in terms of these Regulations.		

determination in terms of activity 5 in Government Notice 387 of 2006 or activity 18 in Government Notice 545 of 2010; or (ii) a road with a reserve wider than 13,5 meters, or where no reserve exists where the road is wider than 8 metres; but excluding- (a) roads which are identified and included in activity 27 in Listing Notice 2 of 2014; or (b) roads where the entire road falls within an urban area. 26: Any process or activity identified in terms of section 53(1) of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004). (pertaining to the protection of threatened ecosystems which are prevalent in dairy farming areas) 25. The development and related operation of facilities or infrastructure for the treatment of effluent, wastewater or sewage with a daily throughput capacity of more than 2000			

cubic metres but less than 15000 cubic metres. 27. The clearance of an area of 1 hectares or more, but less than 20 hectares of indigenous vegetation, except where such clearance of indigenous vegetation is required for- (i) the undertaking of a linear activity; or (ii) maintenance purposes undertaken in accordance with a maintenance management plan. 29. The release of genetically modified organisms into the environment, where assessment for such release is required by the Genetically Modified Organisms Act, 1997 (Act No. 15 of 1997) or the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004). 34. The expansion or changes to existing facilities for any process or activity where such expansion or changes will result in the need for a permit or licence or an amended permit or licence in terms of national or			

provincial legislation governing the release of emissions or pollution, excluding- (i) where the facility, process or activity is included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case the National Environmental Management: Waste Act, 2008 applies; or (ii) the expansion of or changes to existing facilities for the treatment of effluent, wastewater or sewage where the capacity will be increased by less than 15 000 cubic metres per day. 36. The expansion of facilities or structures for the generation of electricity from a renewable resource where- (i) the electricity output will be increased by 10 megawatts or more, excluding where such expansion takes place on the original development footprint; or			

(ii) regardless the increased output of the facility, the development footprint will be expanded by 1 hectare or more; excluding where such expansion of facilities or structures is for photovoltaic installations and occurs within an urban area 43: The expansion and related operation of hatcheries or agri-industrial facilities outside industrial complexes, where the development footprint of the hatcheries or agri-industrial facilities will be increased by 2 000 square metres or more. 55: The expansion of a dam where: (i) the highest part of the dam wall, as measured from the outside toe of the wall to the highest part of the wall, was originally 5 metres or higher and where the height of the wall is increased by 2,5 metres or more; or (ii) where the high-water mark of the dam will be increased with 10 hectares or more.			

45. The expansion of infrastructure for the bulk transportation of water or storm water where the existing infrastructure- (i) has an internal diameter of 0,36 metres or more; or (ii) has a peak throughput of 120 litres per second or more; and (a) where the facility or infrastructure is expanded by more than 1000 metres in length; or (b) where the throughput capacity of the facility or infrastructure will be increased by 10% or more; excluding where such expansion- (aa) relates to transportation of water or storm water within a road reserve; or (bb) will occur within an urban area. 46. The expansion and related operation of infrastructure for the bulk transportation of sewage, effluent, process water, waste			

water, return water, industrial discharge or slimes where the existing infrastructure- (i) has an internal diameter of 0,36 metres or more; or (ii) has a peak throughput of 120 litres per second or more; and (a) where the facility or infrastructure is expanded by more than 1000 metres in length; or (b) where the throughput capacity of the facility or infrastructure will be increased by 10% or more; excluding where such expansion- (aa) relates to transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes within a road reserve; or (bb) will occur within an urban area. 48. The expansion of-.			

(i) canals where the canal is expanded by 100 square metres or more in size; (ii) channels where the channel is expanded by 100 square metres or more in size; (iii) bridges where the bridge is expanded by 100 square metres or more in size; (iv) dams, where the dam, including infrastructure and water surface area, is expanded by 100 square metres or more in size; v) weirs, where the weir, including infrastructure and water surface area, is expanded by 100 square metres or more in size; (vi) bulk storm water outlet structures where the bulk storm water outlet structure is expanded by 100 square metres or more in size; or (vii) marinas where the marina is expanded by 100 square metres or more in size; where such expansion or expansion and related operation occurs-			

(a) within a watercourse; (b) in front of a development setback; or (c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse; excluding- (aa) the expansion of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour; (bb) where such expansion activities are related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies; (cc) activities listed in activity 14 in Listing Notice 2 of 2014 or activity 14 in Listing Notice 3 of 2014, in which case that activity applies; (dd) where such expansion occurs within an urban area; or (ee) where such expansion occurs within existing roads or road reserves			

50. The expansion of facilities or infrastructure for the off-stream storage of water, including dams and reservoirs, where the combined capacity will be increased by 50000 cubic metres or more. 57. The expansion and related operation of facilities or infrastructure for the treatment of effluent, wastewater or sewage where the capacity will be increased by 15000 cubic metres or more per day and the development footprint will increase by 1000 square meters or more. 66. The expansion of a dam where- (i) the highest part of the dam wall, as measured from the outside toe of the wall to the highest part of the wall, was originally 5 metres or higher and where the height of the wall is increased by 2,5 metres or more; or (ii) where the high-water mark of the dam will be increased with 10 hectares or more. <u>List 2, GNR 984:</u>			

1. The development of facilities or infrastructure for the generation of electricity from a renewable resource where the electricity output is 20 megawatts or more, excluding where such development of facilities or infrastructure is for photovoltaic installations and occurs within an urban area. 2. The development and related operation of facilities or infrastructure for the generation of electricity from a non-renewable resource where the electricity output is 20 megawatts or more. 13. The physical alteration of virgin soil to agriculture, or forestation for the purposes of commercial tree, timber or wood production of 100 hectares or more. 15. The clearance of an area of 20 hectares or more of indigenous vegetation, excluding where such clearance of indigenous vegetation is required for- (i) the undertaking of a linear activity; or			

(ii) maintenance purposes undertaken in accordance with a maintenance management plan 16. The development of a dam where the highest part of the dam wall, as measured from the outside toe of the wall to the highest part of the wall, is 5 metres or higher or where the high-water mark of the dam covers an area of 10 hectares or more. 24. The extraction or removal of peat or peat soils, including the disturbance of vegetation or soils in anticipation of the extraction or removal of peat or peat soils, but excluding where such extraction or removal is for the rehabilitation of wetlands in accordance with a maintenance management plan. 25. The development and related operation of facilities or infrastructure for the treatment of effluent, wastewater or sewage with a daily throughput capacity of 15000 cubic metres or more. <u>List 3. GNR 985</u>			

2: The development of reservoirs for bulk water supply with a capacity of more than 250 cubic metres in specific geographic areas (b) In Eastern Cape 4. The development of a road wider than 4 metres with a reserve less than 13,5 metres. (b) In Eastern Cape 12: The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of ecosystem listed in terms of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan. (b) In Eastern Cape 16. The expansion of reservoirs for bulk water supply where the capacity will be increased by more than 250 cubic metres. (a) In Eastern Cape.			
Environmental Authorisation process			
24 G Rectification Application; Basic assessment; Full assessment (Scoping & EIA)	Water Use Licence	Basic assessment as part of Waste Management Licence.	Atmospheric emission licences

ANEXURE 2 (QUESTIONERS FOR DAIRY FARMERS)

Interview with farmer 1:

1.General		
Relevant Section	**Question**	**Comment**
1.1)	From what year are you the official land owner of the farm?	
1.2)	How would you describe your farm?	
1.2) NEMA, GNR 983: Section 4,	What is your total herd size (milking and dry cows)?	
1.3)	What length of time do the cows spend in the milking parlour per day?	
1.4)	Is your herd managed on an intensive full-feed system or free-range pasture-based system?	

1.5)	What other crops do you plant on the farm and what are their areas (ha)?	
1.6)	What are the main reasons for planting extra crops?	
1.7)	What are your future expansion plans for the farm?	

2.WATER		
Relevant Section	**Question**	**Comment**
2.1)	What is your main water resource on the farm?	
2.2) NWA, section 21,(b); NEMA,	How much water do you store on the farm?	

GNR 983 section 13		
2.3) NWA, section 21, (e)	Do you take water from a natural steam?	
2.4) NWA, section 21, (f)	Do you discharge waste or water containing waste into a water resource?	
2.5) NWA, section 21	Are you aware of any registration to Water Affairs? Have you applied for a water use licence and borehole registration within the last 18 years?	
2.6) NWA, Section 19	How do you store and manage liquid slurry, generated by livestock from the milking parlour	
2.7) NWA, section 37	Do you make use of wastewater for the irrigation of pastures and lands?	

2.8) NEMA GNR 983, section 25	Do you have facilities or infrastructures for the treatment of effluent and wastewater?	
2.9) GNR 665	Have you applied for a general authorisation for the irrigation of waste or water containing waste?	
2.10) GNR 665	Do you monitor and keep record of the effluent quality on a monthly basis?	
2.11) GNR 665	Describe the general location, where irrigation of wastewater takes place?	
2.12) GNR 665	How much cubic meter of wastewater do you irrigate per day/month?	
2.13)	What are your future plans regarding water on the farm?	
2.14)	What are your main challenges concerning water management on the farm?	

3. Air		
Relevant Section	**Question**	**Comment**
3.1)	What is your opinion on methane gas released from livestock?	
3.2) NEMAQA, section 29	Do you feel methane generated from dairy farms must be a priority waste?	
3.3) NEMAQA, section 35	What reasonable steps do you take to control offensive odours?	
3.4)	What protection from the odours do you have in place for the safety of the workers in the milking shed?	
3.5)	Would you say that climate change has influenced your farming operation to date?	

4. Soil

Relevant Section	Question	Comment
4.1)	Do you experience any problems regarding soil fertility and soil erosion?	
4.2)	How do you manage grazing of the farm?	
4.3)	What forms of fertilizer(s) do you use to produce pastures and crops and how do you apply the fertilizer to your lands?	
4.4)	During which period(s) of the year do you use more fertilizer?	
4.6) NEMA GNR 983, section 22	How do you develop roads on your farm and how wide are the roads?	
4.7)	What is your future aim regarding soil fertility on the farm?	

5. Biodiversity		
Relevant Section	**Question**	**Comment**
5.1)	Are you aware of the disruption of natural ecosystems on your farm?	
5.2)	How much natural habitat areas do you have on your farm (ha)?	
5.3)	Do you think biodiversity loss can have a negative impact on the overall production of your farm?	
5.4) NEMA GNR 984 section 13	How much virgin soil did you transform into cultivated land since your ownership of the farm?	
5.5)	Which organism is essential when it comes to the natural ecosystems of the farm?	
5.6)	Are there any areas on your farm where it is difficult to clear or develop?	

5.7) NEMA GNR 983 section 27	Are you aware of areas on your farm that fall under indigenous vegetation of SANBI?	

6. Waste		
Relevant Section	**Question**	**Comment**
6.1)	How do you currently manage dairy waste?	
6.2)	Is the management of dairy waste a problem on your farm?	
6.3) NEM:WA section 1	How much tons of effluent are generated and stored daily/ monthly?	

6.4) NEM:WA section 6	Do you make use of any treatment of effluent on the farm?	
6.5) NEM:WA section9,10	Do you consider using dairy waste (solids) as a form of fertilizer?	
6.6)	Do you have a combined sewer system on the farm?	
6.7) NEM:WA Section 16	Do you have a landfill site on the farm and what products end up in the landfill?	
6.8) NEM:WA Section 16	What happens to animal carcasses and medical waste on the farm?	
6.9) NEM:WA, section 16	How do you think a farmer can take reasonable measures when it comes to waste management on the farm?	
6.10)	What do you recycle, reuse or repurpose on the farm?	

7. Energy and non-renewable resources		
Relevant Section	**Question**	**Comment**
7.1)	Do you see the consumption of energy as a problem in the near future?	
7.2) NEMA GNR 984 section 1, 2	Do you see a marked for renewable energy on a dairy farm?	
7.3)	Do you know how waste-to-energy systems work?	
7.4)	Would you say there is enough animal waste on a dairy farm for a waste-to-energy plant?	
7.5)	How much diesel do you store on the farm?	

7.6)	Describe your storage areas, where fertilizers and chemicals are stored?	
7.7)	What are your major challenges regarding energy consumption?	
7.8)	Do you have a future plan concerning energy consumption?	