Effectiveness of the house-to-house rabies vaccination programme – a case study of Magabheni Township

By

Michael Mtshali

Submitted in fulfilment of the academic requirements for the degree of
Master of Agriculture (Agricultural Extension and Rural Resource Management) in the
School of Agricultural, Earth and Environmental Sciences,
University of KwaZulu-Natal
Pietermaritzburg

November 2013

DEDICATION

This study is dedicated to the memory of my late parents, Mr Kula Elias and Mrs Dolly Natalia Mtshali, who were both illiterate, but gave me an opportunity of pursuing education.

DECLARATION

I, Mduduzi Michael Mtshali declare that:

1. The research reported in this thesis, except where otherwise indicated, is my original research.

2. This thesis has not been submitted for any degree or examination at any other university.

3. This thesis does not contain other person's data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.

4. This thesis does not contain other person's writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:

    (a) Their words have been re-written but the general information attributed to them has been referenced.

    (b) Where their exact words have been used, then their writing has been placed inside quotation marks, and referenced.

5. This thesis does not contain text, graphics or tables copied and pasted from the Internet, unless specifically acknowledged and the source being detailed in the thesis and in the Reference section.

Signature Date

As the candidate's supervisor I have approved this thesis/dissertation for submission.

Dr. Steven Worth

Name Signature Date

ABSTRACT

Rabies is a zoonotic disease that is caused by a virus. Rabies infects domestic and wild animals, and is spread to people through close contact with infected saliva trough bites or scratches. The disease is present on nearly every continent of the world but most human deaths occur in Asia and Africa. Dogs continue to be the main carrier of rabies in Africa and Asia and are responsible for the human rabies deaths worldwide.People most at risk of rabies live in rural areas. The economic burden of rabies in the developing world takes large toll by means pre and post exposure prophylaxis treatments, cost of vaccine and other hidden costs.

The study is set out to investigate the effectiveness of house-to-house rabies vaccination in Magabheni Township in KwaZulu-Natal province, a region that has experienced rabies outbreaks since 1976s. It is well-known that control of rabies at the animal source is a key to control of the disease in humans. However the main problem faced in the control of this zoonotic disease is that vaccination of dogs is not sustained, as a large percentage of dogs are not accessible. Due to some hiccups in existing strategies, there is always a significant percentage of the dog population that is not accessible. The strategy proposed and investigated is indeed labour intensive but result is a much higher percentage of dogs being accessed. In brief the observation and questionnaires as tools to generate data. The data obtained will be useful and can be considered as a strategy for rabies control in the country and probably the region

ACKNOWLEDGEMENTS

It gives me great pleasure in acknowledging the support and help of my supervisor, Dr. Steve Worth, for his great insights, perspective, guidance and sense of humour. I am heartily thankful to him whose encouragement, guidance and support from the initial to the final level enabled me to develop an understanding of the subject.

My sincere thanks go to the officers in High Degrees Office, Faculty of Science and Agriculture, for helping me in various ways to clarify things related to my academic works in time with excellent cooperation and guidance.

This dissertation would not have been possible unless my supervisors Dr Shavitha Dahnillal and Ms Joey Peens did not help me in granting special leave to attend academic sessions.

I dedicate this research to my wife Khanyisile Constance, son Siboniso Clarence and daughter Dumile Carol for being patient and supportive of me during my period of study. I extend my dedication to my siblings; Boniwe, Felenzani, Zami, Busisiwe, Sgwili, and Sakhephi for supporting me morally and financially during my initial years of studies. They have been my pillar of strength and source of inspiration during hectic times and enabled me to complete this research.

Lastly, I am indebted to many individuals; friends and colleagues who have not been mentioned here personally, in making this educational process a success. I could not have made it without your support.

I give thanks to Almighty God for giving me the grace, the strength, the wisdom and the means to undertake this Master's programme. Thank you Lord and I give you all the glory.

TABLE OF CONTENTS

ABBREVIATIONS

AHT	Animal Health Technician
BC	Before Christ
CE	Common Era
CEPI	Childhood Expanded Programme of Immunisation
CP	Central Point rabies vaccination strategy
CP-CAHW	Combination of Central Point and the use of Community Animal Health Workers
CP-HH	Combination of Central Point and House-to-House
DALY	Disability-Adjusted Life Year
GPS	Global Positioning System
HH	House-to-House rabies vaccination strategy
PAS	Public Address System
PEP	Pre-Exposure Prophylaxis
RIG	Rabies Immunoglobulin
SAICCOR	South African Industrial Cellulose Corporation
SEARG	South East Africa Rabies Group
SMCRE	Sender-Message-Channel-Receiver-Effect
SS	Street-to-Street rabies vaccination strategy
WHO	World Health Organisation

LIST OF TABLES

LIST OF FIGURES **PAGE**

CHAPTER 1

1. INTRODUCTION

1.1 Background

Rabies kills approximately 55 000 people annually worldwide and between approximately 15 and 30 people in South Africa annually (World Health Organisation (WHO), 2005). This disease has survived whilst other diseases such as bourbon, plague, small-pox, and rinderpest, to mention a few, that had a high mortality rate, were eradicated. Its mortality is low compared to other diseases but there is no other disease that can equal rabies in "the terror it inspires in the minds of those who are cognizant of its effects and who chance to be exposed to the risk of its attack, as well as the uniform 100% fatality which terminates the distressing and hideous symptoms that characterize the disorder" (Jackson, 2013: 35).

The global numbers of person killed are always underreported and are greatly underestimated. Reliable statistics indicative of the accurate prevalence of individual rabies deaths are inadequate or fictional in number of countries (Jekel *et. al.,* 2007). In addition, it is the marginal majority who are always at danger of contact and demise from rabies and this section of the social order is frequently disregarded by policy-makers (Pitcairn and Pitcairn, 2005).

Rabies is a disease which can affect all warm-blooded animals but frequently the effect is measured in terms of human morbidity and mortality. Regardless of this, universally, where rabies is prevalent, there is habitually a lack of communication between the veterinary line of work and the communities they are working with, to the degree that the virus continues to flourish and prospective sufferers are not treated (WHO, 2010). The dilemma is partly exacerbated by lack of awareness and knowledge of the infection and what to do when confronted by a suspected rabid animal.

Regarding the transmission of rabies, dogs make up approximately 95% of all human rabies cases reported internationally (natural world cases most probably are under-reported) and are accountable for over 90% of all human cases (Schwartz, 2008). However, the total number of cases of rabies in domestic animals in United States has steadily declined; dog rabies has been controlled or eliminated throughout Western Europe, and in a number of countries by means of parenteral immunization and the management of stray dogs (MacLauchlan and Dubovi, 2011). Spread of disease by dogs in the rest of the world is due to a variety of factors, including a lack of rabies contingency plan and records of unimmunized stray dogs.

Beside dog rabies, in the United States of America, wildlife is responsible for approximately 90% of confirmed rabies cases. Raccoons are the most commonly reported infected group, followed by bats, skunks, foxes and coyotes (Corn *et. al.,* 2003, Warren, 2002, Auth and Kesrtein, 2002). In Africa, rabies can have a major impact when infection spills over into fragmented populations of endangered social carnivores such as the wild dog and Ethiopian wolf. In sub-Saharan Africa the vectors include kudu and jackals species i.e. both side stripped *Canis adustus* and black-backed jackals *Canis mesomelas* as other vectors species in Namibia and the yellow mongoose *Cynictis penicillata* in Free State, South Africa (Biggs, 2003).

Domestic animals are in danger of acquiring rabies. The concern with pets is twofold. First, the wellbeing of the pet; if a pet develops clinical symptoms of rabies, treatment is almost never effective, and death occurs (Friis, 2012), Second, the wellbeing of humans, because pets are more likely to contact with humans than with wildlife. Pets are more likely to be the vector that brings rabies to their human counterparts.

Although primarily a disease of animals, humans may also be infected. Thus, rabies is a zoonotic infection, a zoonosis being a communicable ailment that can be transmitted between animals and humans. The widespread means of infection of the rabies virus is a bite by a rabid animal; however, less common non-bite routes of transmission, though rare, are known (WHO, 2005). With the exception of rare cases following organ or corneal transplants originating from an undiagnosed donor who died of rabies, there have

been no confirmed reports of man-to-man transmission of the rabies disease (WHO, 2005). Nevertheless, the possibility remains an important consideration in dealing with friends, family, and health-care workers who may have been in close contact with a rabies victim and perhaps exposed to potentially infectious bodily fluids (e.g., to saliva through shared drinks or eating utensils). Such concerns extend to mortuary personnel (WHO, 2005).

Children are predominantly at risk from rabies. Due to children's close relationships with dogs, they are more prone than adults to experience bites and scratches to the face and skull, both of which hold an imminent danger of contracting rabies. Children are often ignorant of the risk that dogs may pass on rabies and may not inform their parents when a bite has occurred from an infected animal (WHO, 2005). Regardless of contemporary medication, there is no treatment for rabies. Giese, a teenager from Wisconsin, became the first of only seven patients known to have survived symptomatic rabies without receiving the rabies vaccine. The Milwaukee protocol is sometimes referred to as the Wisconsin protocol. The Milwaukee protocol is an experimental course of treatment of an infection of rabies in a human being. The treatment involves putting the patient into a chemically induced coma and administering antiviral drugs. It was developed and named by Rodney Willoughby, Jr., M.D., following the successful treatment of Jeanna Giese in 2004 (Willoughby *et. al.*, 2005 and Jackson, 2013). Medical experts disagree about the effectiveness of the Milwaukee treatment, pointing out that a certain body type appears in all survivors. This suggests that it is perhaps genetics, not the Milwaukee protocol, that was key to the survival of Giese and others. That is why the theory still stands that once symptoms of rabies appear, death is inevitable (Corn *et. al.* 2003). Rabies is a continuing threat and therefore studying how to control and eradicate it is important.

This study was conducted at Magabheni, KwaZulu-Natal, South Africa. It investigated the relation of different rabies vaccination strategies and focused specially on the house-to-house (HH) vaccination programme. The history of rabies in Africa is not well recorded, but it is well accepted that the disease must have been present in in northern Africa for hundreds of years. Rabies became epizootic in many countries of sub-Saharan

Africa only during the nineteenth and twentieth centuries; in this region, the disease became well-established in dogs and involved wildlife species over large areas (Nel, 2013 and Oldstone, 2010). Therefore, rabies is a recent addition to the sub-Saharan Africa region, having been introduced from canine prevalent regions which had existed in Angola since the 1940s (Coetzee 2006; Swanepoel, *et. al.* 1993). It has since spread throughout southern and east Africa, and has established infectious cycles among multitude species, including the bat eared fox, black backed jackal and domestic dog. Canid rabies was introduced into southern regions of Zimbabwe from Botswana and the northern Limpopo province of South Africa in 1947. From here it is hypothesized that the disease moved eastwards into the Mozambique district of Maputo, and then spread southwards into Swaziland and the northern regions of KwaZulu-Natal (Coetzee, 2006). Two outbreaks believed to have been introduced from the southern Mozambique district of Maputo have since broken out among dogs in the KwaZulu-Natal province. The earliest of these epidemics began in 1964 and put under control by 1968, while the second epidemic which started in 1976 still manages to endure, regardless of hard work to bring it under control (Bishop *et. al.,* 2003). According to Coetzee (2006), reasons for this are diverse and incorporate a number of social and political changes which occurred in South Africa which has resulted in the increased urbanization of human populations, the development of informal settlements and an associated parallel growth in domestic dog populations. This situation appears to be compounded by the AIDS pandemic, political unrest and subsequent rise in crime. Deaths from AIDS pandemic led to the emergence of orphans and households which were headed by children, which has resulted in the development of feral dog packs that were neglected and, in turn, contributed to the spread of the disease (Brown, 2011). Rabies continued to cause a significant risk to communities in KwaZulu-Natal, with the majority of individual rabies cases diagnosed each year in South Africa being the result of bite exposure from infected dogs from KwaZulu-Natal province (Coetzee, 2006). Lately, there is an apprehension surrounding the more unusual types of rabies related viruses that circulate in South Africa. These include the Duvenage Virus, named after the first recorded victim in 1970, as well as the Lagos Bat and Mokola Viruses. Scientists have isolated Mokola virus from a number of cats in Eastern Cape and KwaZulu-Natal (Brown, 2011). Therefore the imminent

introduction of an effective rabies control strategy is a prerequisite for containing this horrific disease.

As a technical subject much of the research that has been undertaken is about the pathogenesis of rabies. A study that was almost similar in nature to this one was conducted by Kaare *et. al. (*2007*)* in Kenya's pastoral and it appears, however, that little research has been conducted where rabies vaccination is juxtaposed with the social aspect of communities that the animal health technicians (AHTs) are working within eThekwini Metro. Earlier studies led to difficulty in finding text books and other sources that deals with the topic effectively. That is why much of the work has been accessed through the Internet, and International Rabies Association has drafted some points on community-based rabies control and eradication. Notwithstanding the above, it was anticipated that the study was feasible.

1.2 Objectives

The overarching aim of the study was to identify the effective strategy to control or eliminate rabies in eThekwini Metro. The objectives of the study were to:

1. To provide a theoretical framework for the study grounded in discussion of rabies, its effect on humans and how it can be controlled.
2. Identify and discuss the different vaccination strategies used in South Africa.
3. Establish a context for the study, including a description of Magabheni communities and identification of the classes of dog population found there.
4. Discuss the expectation, amid of high rabies outbreak incidences of the KwaZulu-Natal Department of Agriculture and Environmental Affairs, and its subordinate, the Veterinary Section regarding the House-to-house (HH) or door-to-door vaccination programme, particularly in the context of high rabies outbreak incidences in the EThekwini Metro.

1.3 Research questions

The research problem envisaged by this study was: How effective is the HH rabies vaccination programme? To answer this question, six sub-questions have been formulated:

- What is the pathogenesis (the origin and development) of rabies?
- How does rabies affect human beings?
- How is rabies controlled?
- How does the HH programme compare to CP rabies vaccination programmes, which has been widely used?
- What are the animal health technicians' perceptions regarding the practicability of the HH programme?
- How cost-effective is the HH programme in terms of numbers of dogs vaccinated and cost of the programme?

1.4. Significance of the study

This study is drawing from bodies of knowledge in the HH rabies vaccination programme. In line with the principles of rabies vaccination, the findings of the study will help the KwaZulu-Natal Veterinary Service to adopt HH as an effective rabies vaccination programme among the alternative strategies in rural and peri-urban areas. The other vaccination strategy is Central Point strategy that is still practiced in towns and cities around the country. The Cordon vaccination strategy is the strategy that is always there, but it is practiced sporadically after rabies outbreaks. Other strategies are impractical at eThekwini Metro. Furthermore the findings of this study are expected to assist policymakers in the formulation of sustainable strategies and policies aimed at making veterinary services more relevant to the needs of rural, peri-urban and township communities, to improve the quality and patterns of utilization and thus justify governmental investment in the rural veterinary services facilities. Political will to

implement effective ways to control the rabies will go a long way in eliminating rabies. The policymakers will be aware of the problem through reports. It is envisaged that adequate utilization of the HH rabies vaccination programme will enhance the status of rural communities and thus their disease-free status will be augmented with this attempt.

Dog rabies can be eliminated, as has been confirmed in North America, Western Europe, Japan and many areas in South America (Plotkin *et. al.*, 2012). During the last two decades, a considerable decrease in human rabies associated with dog rabies has been achieved in Mexico, South America and the Caribbean by the programme for the eradication of canine rabies initiated and coordinated by the Pan American Health Organization/WHO Regional Office for the Americas (WHO, 2005). In contrast, over the past two decades, rabies has been increasing in parts of sub-Saharan Africa and Asia, accredited to fast increasing dog populations and growing urbanization, and density and mobility of human populations (Ngoepe *et. al.*, 2010). However, dog rabies is still prevalent (Fig 1.1) and is taking place in over 80 countries, which are in the developing world (Webber, 2009). In more than 9% of all human rabies cases, the virus is transmitted from dogs; half of the worldwide human populace lives in canine rabies-endemic areas and is considered at risk of contracting rabies (WHO, 2005).

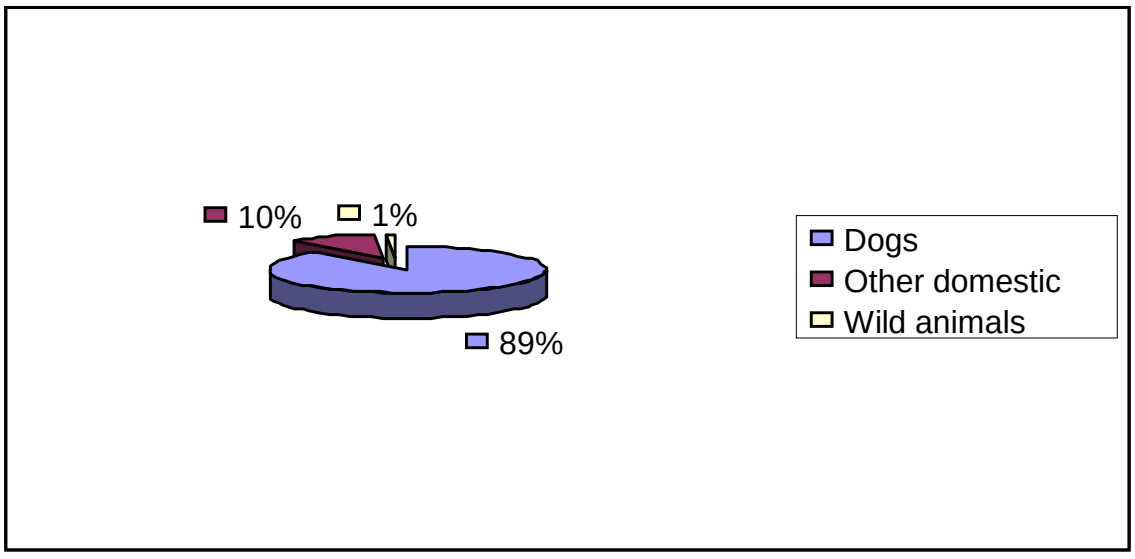


Fig 1.1 *Species distribution of animal rabies positive cases in KwaZulu-Natal, 1986-2010* (Vet Annual Report 2011/2012)

Efficient animal vaccines that provide a significant duration of protection have been developed and mass parenteral vaccination programmes remain the foundation of dog rabies control (WHO, 2012).

The most important challenge is efficient delivery of vaccines to ensure adequate vaccination coverage in the dog population. Studies coordinated by WHO on dog populations have shown that, in many regions in Africa, Latin America and Asia, a proportion (at least 60–75%) of the total dog population is accessible for parenteral immunization. In communities where dogs are less accessible for immunization (for example, in areas where large populations of stray dogs live), oral rabies vaccination may provide a possible supplementary strategy. Exact levels of coverage required is likely to fluctuate according to the demographic, behavioural and spatial characteristics of the dog population to vaccinate large proportion of dogs (Bishop *et. al.,* 2003).

To guarantee effective treatment, vaccination programmes should consider the local ecology of the dog inhabitants, involve organization of linked sectors and integrate ethnically suitable education efforts (Coker, 2008). Key to the success of vaccination campaigns in Latin America has been the role played by the public health sector as a lead agency and community participation and empowerment in rabies control activities (Bishop *et. al.,* 2003).

1.5 Broad Problems and Issues to be investigated

Regardless of being a vaccine-preventable disease through an inactivation procedure developed by Louis Pasteur in 1885, rabies is still a problem up to this day (Nadine-Davis, 2001). Therefore this study looked at the rabies disease holistically. It will start with the history of the rabies problem and look at international control of rabies specifically in those countries that have eradicated rabies. While much can be learned from work undertaken in other countries, rural settings in those countries differ from those in the third world such as South Africa. This study will attempt to shed light on

what should be carried out in the rural settings of eThekwini in South Africa to eradicate rabies. The moral context of this study is that …"despite the development of even safer and more successful treatments, better and more effective vaccines, rabies remains the most important and devastating viral zoonotic (which is transmitted from animals to people) disease worldwide" (Collinge and Ray, 2006: 149). Therefore the pathogenesis of rabies was the broad problem to be addressed and the milestones in its development. This investigation served as a response into the human attitudes regarding rabies and the steps that have been taken by the Department of Agriculture and Environmental Affairs to reach each and every pet that needs vaccination by means of adhering to the HH vaccination strategy.

The paradox of rabies is the method used in its eradication. In the past, the veterinary services technicians used to vaccinate against rabies using Central Point (CP) vaccination systems. These systems entailed the identification of venues where vaccination would be carried out. These venues included shopping centres, schools, clinics, churches or any places that were conspicuous in any given settlement. This process is still practiced in South African towns and cities where the population have higher income margins. In most cases, these animals are brought by cars, and they are trained and well-fed so their handling is not problematic. Most of the time there is cooperation between technicians and members of that community. Bishop *et. al.* (2003) further argues that vaccination clinics are usually held in lower-risk areas, such as formal urban areas where properties are usually strongly fenced thus lowering the risk of disease transmission. These clinics function at approved time and places.

When the CP system is practiced in townships, informal settlements and rural areas the technicians encounter problems. If the venue is more than 500 m from their homesteads, people are unable to send their animals for vaccination (Wasik and Murphy, 2012). The handling of animals is poor and the reason for keeping pets is solely to prevent criminal elements from invading their properties. In areas where people in high-income groups lives, there are different sizes of dogs and the reasons for keeping them vary, which may

include ornamental purposes only. Very few keep animals out of love of animals. In these areas the technicians vaccinate a low percentage of the dog population thereby exacerbating the prevalence of rabies (van Sittert et. al. 2010). That is why in 1996, the house-to-house rabies vaccination system was introduced, which was exactly 20 years after the second phase of rabies was introduced to KwaZulu-Natal. The first phase of rabies outbreaks in KwaZulu-Natal was between 1961 and 1976 and thereafter it was totally eliminated (Bishop *et. al.*, 2003).

1. 6 Observations of rabies in KwaZulu-Natal

Rabies is a serious problem in the province. Figure 1.2 shows that between 1986 and 2013, nearly 80% of all established human rabies cases are in South Africa and 80% in KwaZulu-Natal. Since the occurrence of the second rabies pandemic, the KwaZulu-Natal The preparations for these campaigns are of a high standard. Many technicians have been

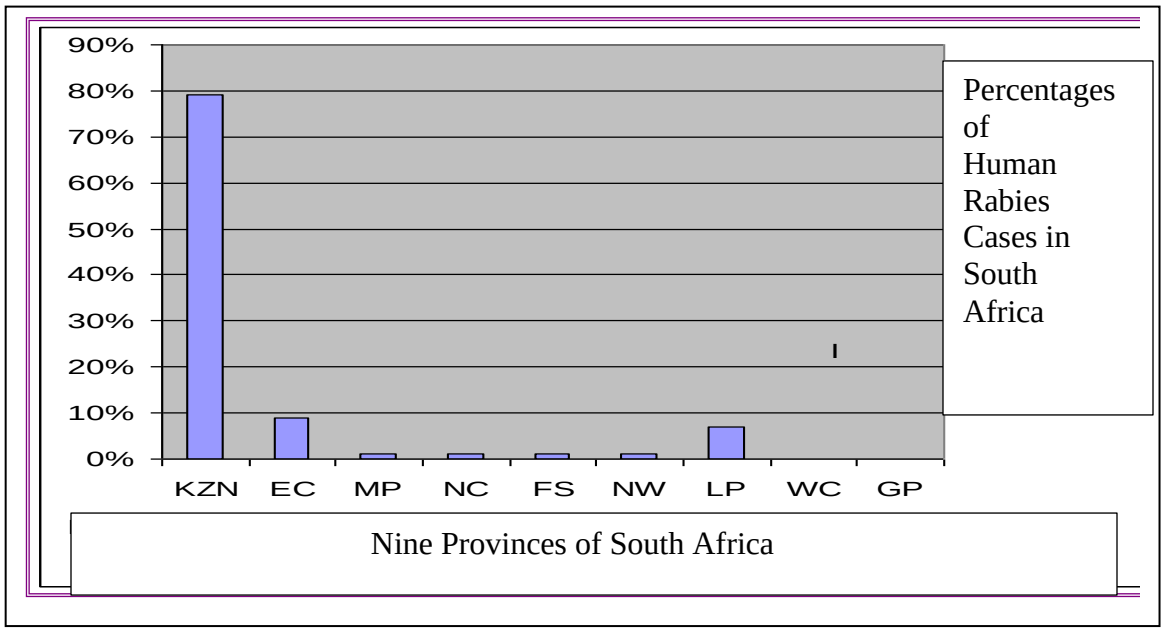


Fig 1.2 *Distribution of laboratory established human rabies cases for South Africa 1986 – 2013 (National Institute for Communicable Diseases. Special Pathogens Unit)*

involved in conducting these campaigns but the problem of rabies still persists. Total eradication depends, to some extent, on the geographical terrain of the country (Bishop *et. al.*, 2003). For example, some countries that have eliminated rabies are islands or peninsulas which help limit the spread of rabies from other countries. The difficulty of controlling rabies in KwaZulu-Natal is that, although it is not landlocked, it is connected by land to three other provinces and three neighbouring countries; Lesotho, Mozambique and Swaziland. If animal health services are of a low standard in those countries and provinces, KwaZulu-Natal is affected. This is illustrated in Fig 1.2. Furthermore, eThekwini is an economic hub of South Africa, which attracts people and pets from different areas. Therefore, it is imperative to review at different methods and strategies and assess their effectiveness to control or eliminate rabies in KwaZulu-Natal.

The KwaZulu-Natal Department of Agriculture and Environmental Affairs has approached rabies vaccination in a unique manner. A subdivision of which is solely responsible for rabies eradication and control has been formed. It is headed by the Provincial Rabies Project Manager who coordinates and organizes mass campaigns which are carried out jointly by all the state's veterinary areas under the auspices of different animal health control technicians. This has been a major step forward in the attempt to eradicate the rabies disease. Its milestone is that it ensures that vaccine and equipment are provided for the staff to carry out vaccinations. The rabies project did a sterling job in organizing mass rabies campaigns in rural and peri-urban areas of all municipalities of KwaZulu-Natal, South Africa. However, the programme is regional and international entity which did not mobilise the people by means of rendering extension that involves awareness campaigns and rabies education on how to prevent rabies in all levels of society. Therefore it lacks understanding of what are the real statistics on the ground. Animal rabies positive cases statistics are obtained from private vets, Society for the Prevention of Cruelty to Animals (SPCAs) and in rare cases AHTs euthanize dogs after diagnosis. The National Institute for Communicable Diseases reported that many cases of people dying of rabies went undetected (Child, 2013). Lastly, the shortcoming of Rabies Project is that it is built around personality rather than an identifiable organization. In the absence of the leader, there is no one who is a

mouthpiece of the entity to take the message to the public. The HH rabies control strategy is to be explored as the best for the rural and peri-urban areas.

CHAPTER 2

2. LITERATURE REVIEW

2. 1 Introduction

Rabies control has been practised time immemorial. During the ancient times rabies control was to prevent dog bites since, there was no rabies vaccine. The gradual development and understanding of the rabies virus through centuries has enabled the practitioners, namely, Louis Pasteur and associates to discover rabies vaccine in 1885. After the discovery of rabies vaccine, mass vaccination started in Europe and spread rapidly throughout the world. Their original vaccine was harvested from infected rabbits, from which the virus in the nerve tissue was weakened by allowing it to dry for five to 10 days. Similar nerve tissue-derived vaccines are still used in some countries, as they are much cheaper than modern cell culture vaccines (Jackson, 2013). Although, these mass vaccinations resulted in elimination of rabies in a few European countries, it succumbed to a dismal failure in other continents, especially India and Africa. Secondly, the success of mass parenteral rabies vaccination was measured by the total elimination of mass outbreaks that were experienced in Europe in the nineteenth century. At present there are sporadic outbreaks of rabies, which results in people underestimating the dangers of rabies.

This literature review will explore three broad themes: the pathogenesis of rabies; rabies in the human context; and controlling and eradicating rabies. Under the pathogenesis of rabies the origination and development of a disease will be discussed in details. The section on human rabies in the human context will discuss how rabies has evolved as a zoonosis, the particular concern regarding rabies and children, high risk occupational groups and finally rabies epidemiology in South Africa.

The section on controlling and eradicating rabies discusses controlling the disease from an international perspective and the role of the State in rabies control. It will discuss the

World Health Organization's (WHO) concern regarding the lack of progress in the control of rabies. This is followed by a review of the strategies for controlling rabies including issues faced by developing countries.

2.2 The pathogenesis of rabies

The disease is zoonotic, meaning that it can be transmitted from one species to another, such as from dogs to humans, commonly by a bite from an infected animal. Rabies is a rapidly progressive and lethal viral infection of the central nervous system (Parija, 2009). The causative agent is a bullet-shaped virus belonging to the genius *Lyssavirus* (from the Greek word *lyssa*, meaning fury or madness) of the family *Rhabdoviridae* (from the Greek word *rhab-dos*, meaning rod) (Brass, 2009). The word 'rabies' comes from the Latin word '*rabere'*, whose origin may be derived from an old Sanskrit word '*rhabdas*', which means violence (Barrett *et. al.*, 2009; Coetzee, 2006). It is usually transmitted to human beings through a bite from a wild or domestic animal. The viruses affect the central nervous system of an affected animal or human being. Lyssa viruses are responsible for causing fatal encephalitis, which result in the death of thousands of people each year (WHO, 2004). The virus is maintained in two overlapping epidemiological cycles, one that is limited to domestic dogs, and the other that occurs in wildlife has its own epidemiological cycle.

The most familiar means of transmission of the rabies virus is the bite of a rabid animal; however, less common non-bite routes of transmission, though rare, are also known. With the exception of rare cases following organ or corneal transplants originating from misdiagnosed donors who had died of rabies, there have been no confirmed reports of human-to-human transmission of the rabies virus (Brass, 2009; Clarke and Jay, 1992).

Coetzer *et. al.* (2004) warns that rapid and occasionally unpredicted onsets of disease, along with the aggressive actions that are manifested in the course of its development and

the prognosis after onset of symptoms, all make rabies a horrifying disease for humankind. Coetzer *et. al.* (1994) further argues that attempts should be made to avert or even eliminate rabies before it can cause fatalities. Understanding the biological foundation for the transmission of rabies and its pathological implications have allowed for the development of suitable management and treatment programmes. Coetzer *et. al.* (1994) concludes by stating that strict vaccination procedures for domestic animals have led to a decrease in animal rabies cases in many developed countries, signifying that prevention (and possibly even elimination) is feasible.

Since the ancient period, an infected animal will have neurological symptoms after one or two days after the development of symptoms. Rabies has three phases of progress, but one may observe only one or two. Stage one lasts one to three days when the animal has a change in behaviour. An aggressive animal may become friendly, and wild one may lose his fear of humans. Stage two brings on the excitability often referred to as 'furious' rabies. The animal is easily agitated and bites at anything that comes near, and the muscles that controls swallowing are paralysed. Stage Three is the final phase which involves loss of muscle control (Thomas, 2009). After that, the animal becomes comatose and this is followed by death. These symptoms may at the onset be inconspicuous, but advance over a week until the animal dies after more or less 10 days. The symptoms includes aggression or belligerence, staggering, seizures, trouble in swallowing, drooling, despair, self-mutilation or photosensitivity. Cattle may show choking gestures. Cats often become aggressive. Dogs may be violent or even attack themselves. These animals are infectious just before noticeable clinical signs emerge. This is when the virus is in the saliva. Bite contact from an infected animal is the general means of infection. Others include contact with infected saliva into wounds or mucous membranes such as eyes, mouth or nose. However, if this animal dies in one's garden, it may take days before the body is no longer contagious (Fleming and Hunt, 2000).

2.3 Rabies in the human context

The problem with rabies is partially exacerbated by a lack of awareness and knowledge of the disease and of what to do when confronted by suspect cases. Coetzer *et. al.* (1994) argues that rabies is maintained by either dogs (canine rabies) or in wildlife species (sylvatic rabies). South Africa is one of only a small number of countries where both forms of the disease occur. South Africa does have the sylvatic form of the disease which is present in canids such as jackals, bat-eared foxes, *viverridae* (yellow mongooses and genets), and in bats (Coetzer *et. al.*, 1994). Swanepoel *et. al.*, (1993) further describes that when compared with other virulent human diseases, such as bubonic epidemic and smallpox, and other animal diseases such as rinderpest and anthrax, rabies has most likely never caused comparably high fatality rate s in humans and animals. However, the severe mode in which rabies manifests itself in its victims continues to catch the attention of scientists, health and veterinary workers. The precise situation of rabies in South Africa remains unclear; it is masked by the fact that many thousands of people may each year receive treatment from a doctor or clinic; the records of such human rabies cases are not reflected in official data (Coetzer *et. al.*, 1994). Five hundred and fifteen cases of rabies have been identified in humans in SA since 1928; 344 (88%) from dog contact, 29 (6%) from Yellow mongooses, 11 (2%) from genets and other wild cats, 15 (3%) from domestic cats, 2 (0.2%) from bats, and one each from a jackal, an ox, a caracal, a honey badger and a Chacma baboon; 108 from unknown sources (Barrett *et. al.*, 2009). While the number of human cases is low the death of one individual is too high for the state not to respond. The Animal Disease Act of 1984 (Wilson and Obiola, 2003) and other preceding animal health enactments such as the Animal Diseases Act 49 of 1947 were promulgated for the control of schedule and controlled diseases such as the rabies in South Africa. Animal Health Technicians (AHTs) under the auspices of veterinarians are tasked by the government to stop at nothing in controlling rabies diseases. Furthermore, they educate the public about rabies.

It is crucial for the population to be knowledgeable of rabies and its symptoms. For a human, rabies is almost invariably fatal if post exposure prophylaxis is not administered

prior to the onset of severe symptoms. The rabies virus infects the central nervous system, ultimately causing disease in the brain and death. Once the rabies virus enters the body, it moves to the brain through the central nervous system. The rabies virus travels to the brain by following the peripheral nerves. This may possibly take weeks or months. The incubation period of the disease is usually a few months in humans, depending on the distance the virus must travel to reach the central nervous system (Cotrans *et. al.*, 2005). The infected human being will appear absolutely normal throughout this incubation period. The rabies virus manifests itself in the part of brain which is known as the hippocampus. Once the rabies virus reaches the central nervous system and symptoms begin to show, the infection is effectively untreatable and usually fatal within days (Cotrans *et. al.*, 2005; Jackson, 2013).

Early-stage symptoms of rabies in humans are malaise, headache and fever, progressing to acute pain, violent movements, uncontrolled excitement, depression, and hydrophobia (Drew, 2004). Finally, the patient may experience periods of mania and lethargy, eventually leading to a coma. The primary cause of death from rabies is usually respiratory insufficiency (Cotrans *et. al.* 2005).

The period between infection and the first flu-like symptoms is normally two to 12 weeks, but can be as long as two years. Soon after incubation period, the symptoms expand to slight or partial paralysis, cerebral dysfunction, anxiety, insomnia, confusion, agitation, abnormal behaviour, paranoia, terror, hallucinations, progressing to delirium. The production of large quantities of saliva and tears coupled with an inability to speak or swallow are typical during the later stages of the disease; this can result in hydrophobia, in which the patient has difficulty swallowing as the throat and jaw become slowly paralysed, shows fear when presented with liquids to drink, and cannot quench his or her thirst (Schoenstadt, 2008).

Death almost invariably results within two to 10 days after the first symptoms. The few humans who are known to have survived rabies were all left with severe brain damage (Willoughby, 2009).

When a human being is exposed to rabies, infection can be halted if treatment is sought without delay. In these cases, post-exposure prophylaxis is administered as a sequence of injections over a period of five to seven weeks or four injections in succession. These are intramuscular injections much like the flu vaccine. Of paramount significance is that this treatment be administered within hours of contacting rabies, before the commencement of irreversible signs. Once the virus reaches the brain and medical signs appear, there is no cure, and death is unavoidable (Brown, 2011).

While rabies in humans can be prevented through rabies vaccine, preventing the spread of rabies from animals to humans is the preferred method of ensuring humans are not affected by rabies. The South African government have stringent regulations pertaining to rabies inoculation of pets because of the terrible consequences of rabies in people. All dogs and cats must be vaccinated at three months of age. These animals should be vaccinated again by six months, at least within that year, which is known as a booster vaccination. The vaccination is then given in subsequent year, then every three years afterwards, depending on the government's inoculation programme. Although stray cats are at greater risk, even domestic cats can be exposed through bites from infected animals in particular bats. While international and national standards dictate animal vaccinations every three years, KwaZulu-Natal conducts rabies vaccination yearly due to the prevalence of rabies outbreaks and the high number of human deaths (Bishop *et. al.*, 2003).

2.3.1 How rabies have evolved and spread?

Rabies has existed for centuries, but has a short recorded history of vaccination. Although there are contrasting views regarding the history of rabies, it is generally agreed that it is an ancient disease that was first diagnosed more than 3 000 years ago (Bishop *et. al.*, 2003). According to Baer *et. al.*, (1996), rabies has a long and interesting history that is long lost. Attesting further to its antiquity, Baer *et. al.*, (1996) notes that rabies occurred in Greek mythology where rabid dogs were the cause of the death of a fabled hunter. Further underscoring the history of rabies, the Greeks had the god Aristaeus who could

counteract the effect of rabies, and he was the son of Apollo. Further, Artemis was represented as the healer of rabies (Baer *et. al.*, 1996).

Baer, (1991), Coetzee (2006), and Bishop *et. al.* (2004) all report that rabies is an ancient disease but they differ about its first diagnosis and people's awareness of the disease. Baer, (1996) argues that by the Twenty-third Century B.C. people of Mesopotamia already had the Eshnunna Code, that precedes the code of Hammurabi, which has a clause whereby the owner of the dog that had bitten someone and that person died, should be penalized and pay the authority two-thirds of mina (40 shekels of silver) (Baer *et. al.* 1996). The code of Hammurabi is a well-preserved Babylonian law code, dating to circa 1780 B.C. (Bryant, 2005). The presence of rabies was documented in Egyptian, Chinese, Greek and Roman texts, with characteristic symptoms and the inevitable outcome of the disease, ensuring its notoriety, even among the major epidemics that plagued the citizens of the ancient world (Coetzee, 2006). Bishop *et. al.*, (2003) referred to the rabies as a disease that was diagnosed 5000 years ago. Coetzer *et. al.* (2004) traces rabies to 3000 B.C. Wound cauterization was the usual treatment for bites from the 1st – 19th Century AD (Bleck and Rupprecht, 2005). It was not until the late nineteenth century, however, that biological basis became observable. A strong logical grasp on the transmission and advancement of the disease has permitted many states to instigate public health campaigns that have wiped out the frequency of human rabies all over the first world countries (Kisterman, 2008).

The perceptions of rabies among many ancient cultures were grounded on animism. This is the view that spirits, gods or supernatural powers control people and the world (Louw and Edwards, 1995). Demonology, or the belief that those who show abnormal behaviour are controlled by demons, was and is still believed. The treatment of abnormal behaviour during ancient times was very drastic in nature. It may have consisted of the person being beaten, burnt, starved or otherwise persecuted to force the evil spirit to leave the body (Louw and Edwards, 1995). In the case of rabies, Celsus, who was one of the compilers of facts, a natural philosopher, a physician and a professional writer, recommended that hot and cold baths could be used to cure the disease. He stated that when the disease

appears, "the only remedy is to throw the patient unexpectedly into a pond, if he has no knowledge of swimming, to allow him to sink, in order that he may drink, and to raise and again depress him, so that though unwillingly, he may be satisfied with water; for thus at the same time both the thirst and dread of water is removed" (Baer *et. al.*, 1996. 32). Such historical accounts of the disease point out that they were often accurate in their clinical depiction, predominantly of archetypal hydrophobia (fear of water) and encephalitic delusion, even if injudicious in contribution conventional methods of a 'cure', such as suggested eating of the tongue, tail or liver of the biting animal by the person who was bitten (IRC, 2002).

In the first century, Common Era (CE)[1], the Roman writer Cardamus believed that the poison (virus) responsible for rabies was present in an infected dog's saliva. This observation was a cornerstone of the modern knowledge of the rabies disease. He recommended that a wound (i.e. dog bite) from a mad dog be treated with caustic and corrosive substances and burning with a hot iron - a practice that persisted for centuries in Europe (Koprowski, 1985).

With the fall of the early classical period of the Western Civilization and the rise of the Christian Church, new thinking patterns developed. The main point of departure was that everything that happened to human beings was by the will of God (Louw and Edwards, 1995). Rabies research suffered from this thinking and little or no research was done on rabies. In the 16th Century there was great faith in the miracles of St. Hubert which was practiced as late as the nineteenth century, even though it had been pointed out that many who went to the shrine near Liege, Belgium, died of madness (Baer, 1991).

Up until the middle ages, epizootics were infrequent. Most common were singular incidents of bites from rabid dogs, and intermittently from wolves, badgers, foxes, and bears. The first recorded rabies outbreak was in the year 900 CE when a rabid bear bit 20 people who attempted to kill it. Six people developed madness and were smothered to death in the next 27 days (Baer, 1991). Baer, (1991) further mentions the first large

[1] Previously referred to as the Christian Era (BC/AD)

outbreak, which occurred in Franconia in 1271 when rabid wolves invaded towns and villages attacking herds and flocks, and that no fewer than 30 persons died following the bites inflicted on them. In 1500, Spain was said to be devastated by canine rabies. By 1586 there were epizootics of rabies amongst dogs in Flanders, Austria, Hungary, and Turkey. In 1684, canine rabies was prevalent in Paris and caused great panic. In 1700s rabies appeared in many parts of Europe. From 1719 until 1721 rabies was common, especially in France and Silesia (now part of Poland). It continued to be a problem in Central Europe where it erupted among the wolves and foxes. In England the disease appeared in 1734-1735 and many rabid dogs were seen in the late summer (Baer, 1991).

By the mid-1700s, the whole of Europe was engulfed by rabies. France was the epicentre of serious outbreaks. The horror of rabies disease among people was such that frequently people even suspected of rabies, were killed like feral animals. They were shot, poisoned, throttled, or asphyxiated (Baer, 1991). Koprowski (1985: 85) and Belotto (1987: 6) both noted that in 1810 in France, legislation was promulgated in the following terms: "It is forbidden under pain or death, to strangle, suffocate, bleed to death, or in any other way murder individuals suffering from rabies, hydrophobia, or any disease causing fits, convulsion, furious and dangerous madness".

In 1852, the French government offered a reward to anyone who could come up with a cure or a remedy for rabies. That was the first time that the pathogenesis of rabies was brought to the fore. The tried cures and remedies were revisited, however, the conclusion was that cauterization of the wound was the only prophylactic treatment for rabies as proposed by Celsus, a physician, in the first century (Koprowski, 1985). Zinke, a German scientist, had already proved in 1804 that rabies was transmitted through the saliva of the rabid dog. Although that was far from the desired cure, he had proved in 1826 that rabies was without doubt a disease of the nervous system (Baer, 1991). This paved the way for the historic work of Pasteur and his associates (Coetzer *et. al.*, 2004). The offer of the reward was not followed by desired results. Some 20 years later in 1879, Victoria Galtier, a professor of Veterinary Science in Lyon, France, used intravenous injections of rabid material to immunize sheep and goats. This laid the foundation for Pasteur's historic

invention that would change medicine regarding the control of the rabies disease (Koprowski, 1985; Coetzer *et. al.*, 2004).

Pasteur's interest in rabies was a natural extension of his previous work in developing vaccines. As stated earlier, Europe was in the midst of severe rabies epidemics which had never been experienced before. Hundreds of rabid dogs were seen in Paris and human rabies cases were numerous. One of Pasteur's childhood recollections was of the terror in his native Jura in eastern France evoked by a rabid wolf. He had witnessed the cauterization of a young girl with a red hot iron in close proximity to his father's residence (Koprowski, 1985; Dubos, 2007).

Obviously, much of the acknowledgement for rabies research belongs to Pasteur, but one should acknowledge the contributions of his collaborators, Roux, Chamberland, and Thullier. These three investigators carried out most of his laboratory operations, since Pasteur was partially disabled by a stroke in 1868 (Dubos, 2007).

Pasteur proved Zinke's theory that the clinical type of rabies produced depended upon the dose of infective material (Coetzer *et. al.*, 2004). He successfully vaccinated dogs and other animals such as monkeys and rabbits for the first time. The successful prophylactic treatment of a human being marked an invention in fighting rabies. This was performed on a boy of nine years from Alsace by the name of Joseph Meister. Pasteur (1885) (cited by Baer, 1991: 36) stated,

"The death of this child seemed inevitable, and I decided, not without lively and cruel doubts, as one can believe, to try in Joseph Meister, the method which has been successful in dogs. Consequently on July 6 at 8 o' clock in the evening, 60 hours after the bites, in the presence of Doctors Vulpian and Grancher, were inoculated under a skin fold in the right hypochondrium of the little Meister a half syringe of the cord of a rabid rabbit preserved in a flask of dry air for 15 days".

According to Robbins, (2001) the boy recovered within a short period and the technique found widespread application. This event had a lasting impact on rabies immunization practices. The survival of Meister opened a new chapter in the treatment of rabies disease, leading to new discoveries. While Louis Pasteur remains the champion in the treatment of rabies, it was Aldechi Negri who discovered round oval bodies that are found in the cytoplasm of neurons, especially in the hippocampus of the midbrain. These were named after Negri. Seventy-five percent of dogs develop Negri bodies when they are rabid. Therefore to this day in laboratories, Negri bodies are reliable indicators of rabies disease (Robbins, 2001).

Through the 20th century, the impact of rabies vaccines is seen not only in the post-exposure immunotherapy of humans but also in the indirect but crucial protection afforded by the vaccination of dogs and other domestic animals. The immunization of wildlife by oral route provides the most recent example of the use of rabies vaccines by which humans and animals are protected from this ancient disease (Baer *et. al.* 1996). Despite all these described historical milestones, humans are still dying of rabies – including in Asia and Africa.

Until 1950, dog rabies elimination was limited to countries in central and northern Europe. In the 20th century and the beginning of this century large areas of central, western and northern Europe became free of rabies. Scandinavian countries had already successfully brought the disease under control in the 20th century by destroying stray dogs and placing domesticated dogs in quarantine. The veterinary services of Hungary showed, first by field trials in 1937 and a nationwide campaign from 1939 to 1944, that canine rabies can be eliminated in a well-planned programme based on the mass vaccination of dogs, in addition to the classical measures of movement and contact restriction of stray dogs. Since then, mass vaccination of dogs, has led to considerable success in many countries, although after sometimes those areas became reinfected from time to time and had to be freed of the disease with enormous efforts again (WHO, 1987).

2.3.2 Children in rabies epidemic areas

Exposure of young children or the elderly to a potentially rabid animal can be of great concern since a significant exposure history (especially following an interaction with a bat) may never come to the attention of an adult or caregiver. The consequences, of course, can be disastrous. In view of the fact that children from five to nine years old represent 5% of population which are prevalent to human rabies cases, and being most common recipients of post-exposure prophylaxis (Warren, 2002). It is particularly important that they be educated regarding the potential dangers of handling any wild animal—especially small and seemingly harmless mammals such as bats. Misconceptions regarding the epidemiology of rabies persist and often people are not aware that post-exposure prophylaxis, if deemed necessary, should be initiated as soon as possible, as once clinical manifestations develop, the disease is almost invariably fatal . Therefore, understanding the dangers of handling wildlife, maintaining current rabies vaccinations of pets and greater awareness about treatment of rabies remain the most important safeguards against the threat of this disease (Brass, 1994).

It is envisaged that routine vaccination of dogs and cats, together with children, might be valuable for children in countries where rabies is enzootic. As children are predominantly susceptible and experience a higher occurrence of bites to the head and neck as a result of their love to come within reach of animals, there are advocates who have long lobbied for addition of the rabies vaccine in the Childhood Expanded Programme on Immunisation (CEPI) in rabies-endemic areas (Kaplan, 1977 and Fooks, 2013). CEPI is proposed to be a worldwide programme to immunize children against common killer diseases, including diphtheria, tetanus and polio (India Annual report 2009/10). A small and secret vaccination programme on Vietnamese children illustrated that by bringing together untroubled rabies Vero cell vaccine with diphtheria, tetanus, whole-cell pertussis and inactivated poliomyelitis vaccine and managing these immunisations at two, three and four months, or alternatively at two and four months, resulted in all infants developing antibody concentrations against all five diseases with no severe undesirable events. A bigger experiment, also in Vietnamese kids, comparing intramuscular and intradermal

vaccine administration demonstrated that both methods offered acceptable immunisation (Kaplan *et. al.*, 1987).

Bishop *et. al.* (2003) indicated that in South Africa and other developing countries, the existing vaccine expenses hinder custom infancy vaccination against rabies. There is, however, a clear directive, at least in Africa, "for children to be formally educated on rabies transmission, the disease and prevention, particularly as educational interventions have proven effective in reducing the number of dog bites in children" (Bishop *et. al.* 2004: 35).

2.3.3 Rabies in South Africa

Details of the first case of rabies disease in South Africa are contradictory. Rolando (1990) states that the earliest case of rabies was reported in Cape Town in 1826. The case was reported by Drs Oorterzer Wehr and Heurtley of a girl of approximately 11 years who was bitten by a dog, presumably in Cape Town. No further description of that rabies case was provided and there is very little information regarding the development of the disease thereafter.

The first confirmed case in South Africa occurred in Port Elizabeth, Eastern Cape in 1892, following an outbreak believed to have been initiated by the importation of an infected dog from Britain one year prior (Bishop *et. al.* 2003; Coetzee 2006; Gummow *et. al.* 2010). It was brought under control by 1894, through muzzling and control of dog movement, and the destruction of strays, 90 affected dogs, seven cats and a bull. There was no reported spill-over to wildlife (Coetzee, 2006). An outbreak in dogs was confirmed in south-western Southern Rhodesia in 1902, following an introduction of the disease from western Northern Rhodesia, where it had been known to be rampant since 1901. It was brought under control in 1913, and apparently did not affect wildlife or extend southwards into South Africa (Cohen *et. al.*, 2007).

Animal rabies is widespread throughout South Africa and the disease is presently accountable for the laboratory confirmed deaths of between 10 and 30 people each year. With very few exceptions, those who succumbed to the disease over the past decade did not receive the post-exposure treatment and died following bites by rabid dogs. There have been numerous new and exciting developments in the comprehension of the disease and in procedures used to control rabies in South African animals. The whole country was affirmed rabies-endemic in 1999 and it is now obligatory for all dogs and cats to be vaccinated at least once every three years, with the exception of Kwazulu-Natal, which practice yearly vaccination procedure due to the high pervasiveness of rabies disease (Bishop *et. al.*, 2003*).*

Kaplan, (1977) argues that there is no evidence that canid (canine) rabies was prevalent in South Africa before the 1940s. Canine rabies became endemic in South Africa as a consequence of a dog-associated epizootic that started in the border region between South West Africa (Namibia) and Angola in 1947 (Coetzee, 2006). It spread through South West Africa and Bechuanaland, reaching the northern Limpopo province of South Africa in 1950 (Bishop *et. al.*, 2003). The sporadic dog infestations were thought to have been contracted in the course of contact with the mongoose rabies form of the disease. Veterinary establishment was, however, conscious of a more all-encompassing form of rabies that existed in South West Africa and Bechuanaland (Botswana) prior to 1950. Dog rabies was established in 1950 in the Limpopo Province and reached Southern Rhodesia later that year (Kaplan, 1977). By 1952 it had entered the densely populated southern Maputo district of Mozambique, where it became endemic in dogs, and from where it spread southwards down the eastern coastal belt of South Africa, entering Swaziland in 1954, and appearing in the northern districts of KwaZulu-Natal (KZN) in 1961 (Coetzee, 2006). Except for unconfirmed report of rabies in the province in the early nineteenth century, the KwaZulu-Natal Province, had up until then, been free of the disease (Coetzee, 2006). The Kruger National Park and game reserves in the KZN province have, with the exception of occasional intrusions of rabid domestic dogs from Mozambique, remained free of rabies (Cleaveland, 1998).

The discovery of rabies in the black-backed jackal population has resulted in the disease remaining endemic in the northern parts of South Africa. Reports indicated that the jackal rabies spill over into human species was however inevitable and the two are intimately linked . After spreading through Mozambique from 1952, the first cases of dog rabies in KwaZulu-Natal, which had previously been free of the disease, were diagnosed in 1961 (Oucho, 2006). There are conflicting reports that the disease had existed before in KwaZulu-Natal. It is either that the disease was in low scale and underreported or among the wildlife. Brown (2011. 35) argues that in 1857 the Natal Witness newspaper reported that "rabies disease was raging among African dogs in the Kaarkloof District (near Pietermaritzburg) and this has led to cases of hydrophobia among Africans". There is conflicting evidence of rabies outbreak in KwaZulu-Natal before 1961. There is a suggestion by Josia Mathews, who according to Brown (2011) practiced as a doctor in Verulam, North of Durban from 1865 to 1871, wrote that Asiatic Cholera and hydrophobia have never been known in Natal.

The introduction of rabies into the northern region of KZN initiated an epidemic of extraordinary intensity in dogs, with high population densities associated with rural areas providing favourable conditions for the spread of the disease (Coetzee, 2006; Jackson, 2013). It was brought under control in 1968 through vaccination and prohibition of transport of unvaccinated animals, even though the vaccination coverage achieved during this time period (1961-1968) in dogs never rose above 41% (Childs *et. al.*, 2007). Higher vaccination coverage was achieved by targeted vaccination campaigns in the most severely affected regions of the province (Coetzee, 2006). Rigorous control measures, including vaccination and euthanisation of stray dogs, were imposed by the local veterinary authorities who successfully eliminated the disease by the end of 1968 (Coetzee, 2006).

The re-emergence of rabies in KwaZulu-Natal in 1976, eight years after the first one, and its ensuing endemicity was coupled with the relocation of refugees from Mozambique following the country's independence from Portugal (Coetzee, 2006). Rabies incidence has been aggravated for the duration of political unrest and famine due to migration of

people abandoning pets. During the 1980s to 1990s and between the initial and the subsequent epidemic, there had been an increase in the density of human population in informal settlements, as people moved from rural to urban areas (Brown, 2011). Consequently, there was also an increase in the mobility of human populations, which according to Coetzee, (2006), could have been responsible for the appearance of the disease in geographically widely separate locations throughout KZN. Brown (2011) further argues that expansion of the sprawling shantytowns and informal settlements around the metropolitan centres created a new environment for a whole range of human diseases, from cholera to tuberculosis, to rabies. Even though vaccination coverage of 59% was achieved for dog populations in the period from 1980-1981,, and regardless of efforts by the Directorate of Veterinary Services, rabies has not as yet been brought under control (Bishop *et. al.* 2003). The situation deteriorated with the separation of the veterinary influence (KwaZulu Homeland Veterinary Service and central government veterinary services), and often insufficient vaccination coverage in the more densely dog populated areas.

There is no proof of undomesticated dog populations in KZN and nearly all dogs appear to be reliant to a greater or lesser extent on humans. The movement of rabies northwards from KZN into south-eastern Mpumalanga Province and southwards into the former Transkei and Ciskei areas of the Eastern Cape Province was to be anticipated following massive migration of families and their pets (Kaplan, 1977). The disease was confirmed in the northern east areas of Transkei in 1986. Over the next four years, canine rabies continued to spread throughout Transkei and by the early 1990s had reached East London (van Sittert *et. al.*, 2010).

Brown, (2011) reported that rabies has been on the rise since the latter part of the twentieth century despite the availability of post exposure treatments and regular inoculation campaigns for dogs. The first rabies outbreaks which manifested in KwaZulu-Natal spilled over from Mozambique but it was completely eradicated in 1966. It is also mentioned that the exodus of rural families to urban areas as the main cause of escalating of rabies during the second phase of outbreaks. It is anticipated that the lack of

continuous control of rabies due to circumstances beyond the control of veterinary fraternity led to the second phase of rabies outbreaks. The socio-political landscape during the first outbreak is not the same as that of the second phase. Therefore the second phase is still the problematic one up to this day. In this study it is envisaged that the control method will be one of the strategies to control and eradicate rabies. It should be borne in mind that technology alone could not control or eliminate disease (Brown, 2011).

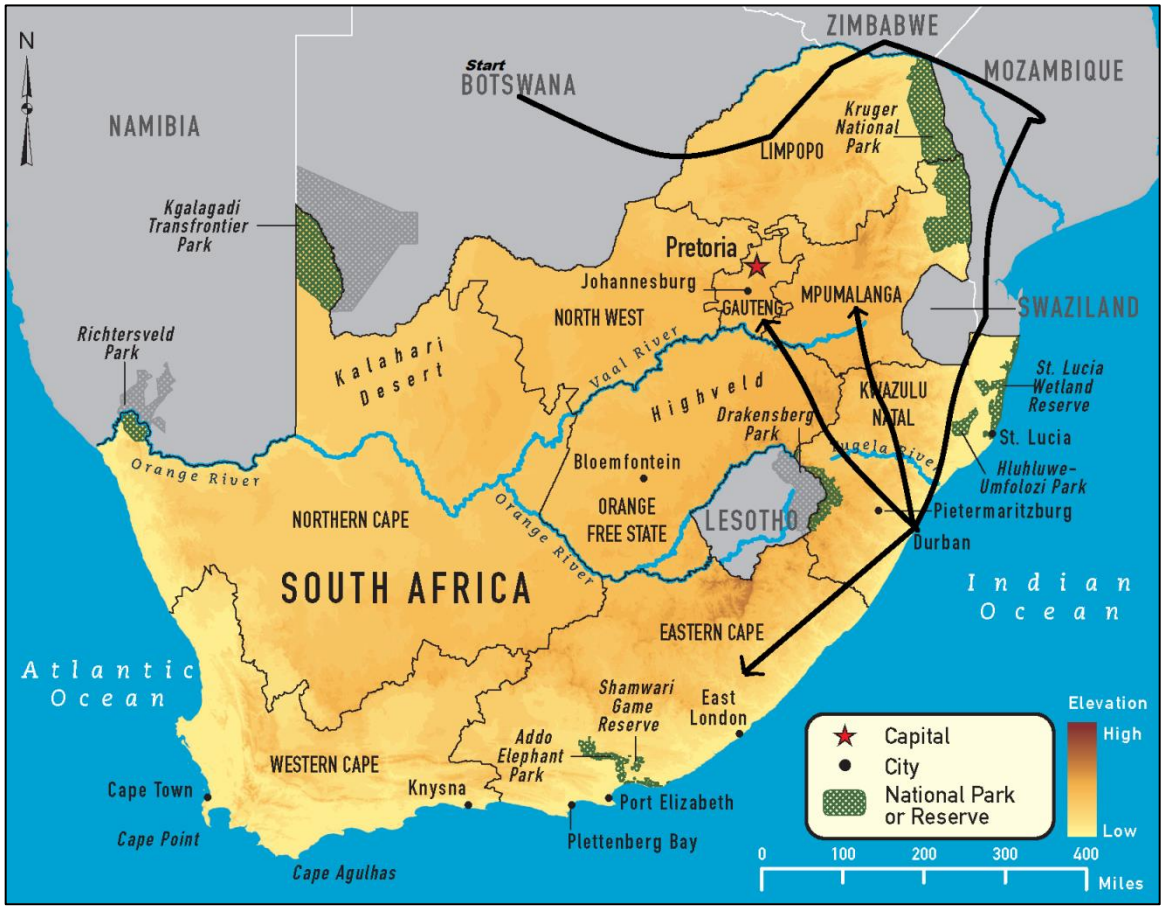


Fig 2.1 *The rabies outbreaks route from Angola in 1947 to Gauteng in 2010 (Google Earth)*

When the new political dispensation came to South Africa in 1994, the whole of KwaZulu-Natal was engulfed in severe rabies outbreaks. The highest incidences of rabies were experienced in 1997. Drastic steps by the state to fight the rabies scourge was inevitable.

2.4 Controlling and eradicating rabies

Controlling and eradication of rabies should follow a holistic approach pattern. When dealing with a holistic approach, Worth (2008) argues that people do not live unconnectedly distinct lives and are usually incorporated parts of socio-economic systems outside their individual families. This influences the way in which communities can or should be engaged with information regarding rabies.

As a consequence of Worth's (2008) theory, the HH program operates in tandem with socio-economic system. Therefore, the HH rabies vaccination strategy does not take place in isolation. The "outcome of *communiqué* of discipline" (Sekokotla, 2005: 25) differs according to the socio-economic and environmental circumstances in which it occurs. Development of interventions is significant and understanding of the distinctiveness of the inhabitants, its collective and material possessions, perceptions and traditional practices, the intensity of knowledge and technology and the cost/benefit ratio of the interventions can be determined through a situational (systems or holistic) analysis, where all the potential factors likely to persuade the conclusion are scheduled and assessed (Fig 2.1). Intrinsic (built-in) factors are those that are within the classification, extrinsic factors are those that are exterior of the system being investigated but have an influence on the connections within the system (Amir and Knipscheer, 2009; Lazlo, 1983; Mettrick, 1993. For example, the implementation of extension as an integral part of the whole veterinary system will have an intrinsic effect on the population and it will have an influence on the outcome of HH rabies vaccination programme.

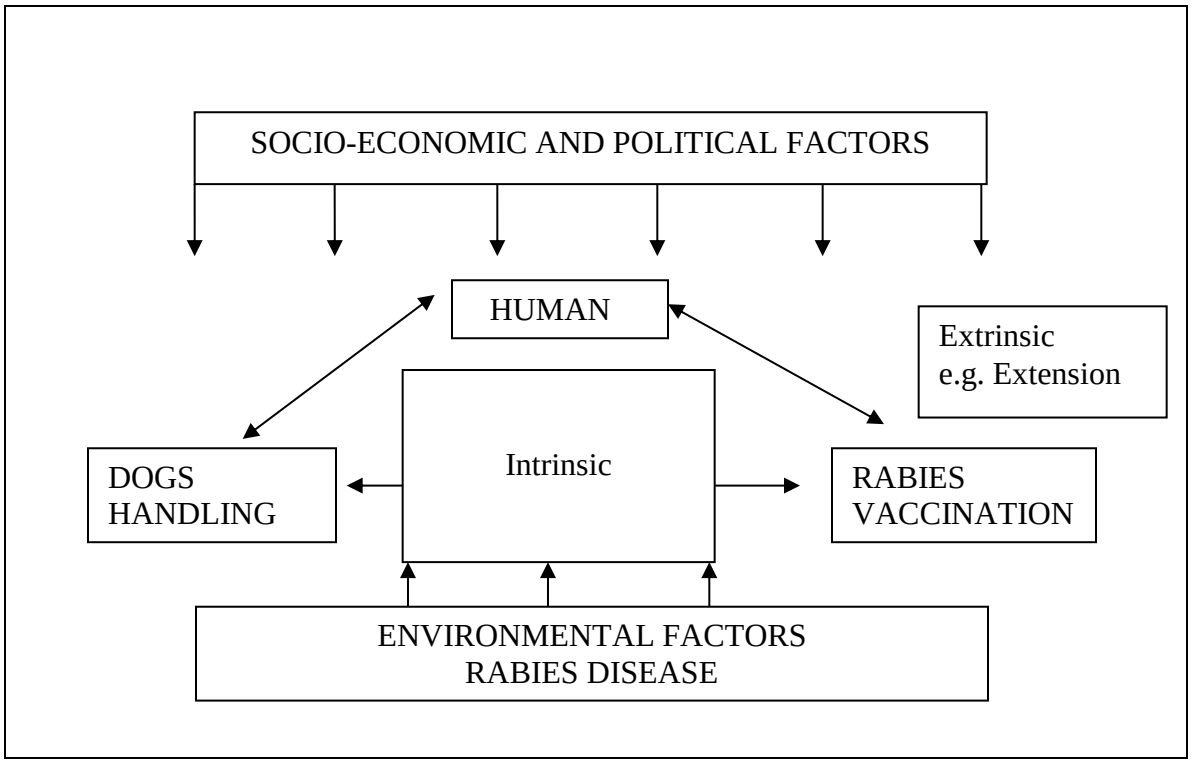


Fig 2.1: *Holistic, systems approach in veterinary science, where the system being studied is the interaction between humans, animals and diseases (Source Sekokola: 2005)*

Veterinary public health in South Africa deals with safety of food of meat, ecological health and impediment of diseases that are common to both humans and animals. The importance is that it is prearranged in terms of the human beings, rather than the animals or the diseases. It is suggested that the approach should be participatory and the veterinarian should be received and trusted by the target community, as the health and security of animals is associated with the health and wellbeing of their owners (McCrindle, 2004).). This approach is distinguishable to one which is more focused on getting the job done (i.e. controlling rabies) rather than taking time, effort and resources needed to engage the owners in the planning and implementation of the programme.

There are serious challenges that South African animal health technicians face. These include serving heterogeneity (different farmers and different farming sectors) of farmers and the insufficient funds allocated to extension budgets, under-spending and appropriation of funds intended for agricultural extension to other activities that receive

priority over extension (Sekokotla, 2005). These challenges impact on the planning and execution of rabies programmes. Such limited (even absent) support from extension in implementing programmes often results in a poor turnout of pets during vaccinations campaigns. There is a correlation between lack of extension and poor dog turnout during rabies vaccination campaigns.

2.4.1 Progress in the control of rabies among animals

The World Health Organisation (WHO) raises four related central points: 1) funding human rabies vaccines over funding controlling rabies at its source; 2) the disparity between first and third world control programmes; 3) lax enforcement of rabies legislation; and 4) devaluing the true cost of post-exposure treatment for humans. This information is included, primarily as an effort to capture the framework for rabies control according to WHO, as South Africa is working within that framework and attempting to meet the standards set therein.

2.4.1.1 Funding human rabies vaccines over funding controlling rabies at its source

According to WHO, the so-called developed countries have substantial resources that are expended in research and development to fight rabies. This has resulted in improved laboratory procedures, on more potent and safer vaccines for humans and on the epidemiology and control of wildlife rabies. In South Africa, rabies research and control of the disease is well funded (Nel, 2013). The concern is about neighbouring countries such as Swaziland and Zimbabwe who sometimes lacks funds for animal health activities (Duffy, 2011).

2.4.1.2 The disparity between first and third world control programmes

In 1972 the WHO Expert Committee on Rabies did not see a special research problem with respect to dog rabies elimination. It has, however, now become apparent that only a limited number of countries were able to eliminate the disease, namely those in which the recommended standard procedure of dog rabies elimination could be applied without great difficulty. At a certain point, progress came to a standstill in most countries (perhaps with the exception of some countries in Europe and South America) because of lack of funding. (Kings, 1957; WHO, 2005).

It appears, from news reports that efforts have been made to reduce the disparity between third and first world control programmes. The establishment of Rabies Project in KwaZulu-Natal resulted incorporation of rabies control programmes with international standard (Miya, 2011).

The critic of these interrelations is that the international connection does not come down to the grass root level. There is a feeling that people on the ground should be part and parcel of planning and implementation of programmes concerning rabies control. Civic organisations should be brought on board to enhance participatory approach regarding elimination of rabies.

2.4.1.3 Law enforcement of rabies legislation

WHO raises the concern that in developing countries, regulations are generally not fully adhered to in the daily work of health and veterinary services where coordinating principles and the frameworks and specific budgets of programmes do not exist. Under such circumstances, vaccine potency or vaccine application may be inadequate or stray dog control ineffective. All this must be seen in the light of an enormous annual turnover of dog populations which calls for continuing efforts if rabies control is to be successful (WHO, 2005; Recuerico *et. al.* 2007).

This is an important point as people do not adhere to regulations regarding rabies vaccination of their pets due to the independence of most provincial states. Many dogs are left unvaccinated as the law is not enforced to citizenry. The rabies outbreaks occurring in South Africa suggest that South Africa (in particular KwaZulu-Natal) experiences similar problems to those raised by WHO concerning rabies control in developing countries. Therefore it is the right time to implement a house-to-house rabies vaccination strategy

2.4.1.4 Devaluing the true cost of post-exposure treatment of humans

Socio-economic analyses of the increasing expenses and other burdens of human post-exposure treatment and the effectiveness of the counteracting policy of eliminating the infection dog rabies have not been made (Lembo *et. al.*, 2011). National programmes for dog rabies elimination will need particular attention in view of the increasing costs of human post-exposure treatment (WHO, 2005; Finley, 1998).

The offer of more potent and safer vaccines of human rabies immunoglobulin (HRIG), is an attempt to place even more weight on the human post-exposure treatment (which may now be given almost indiscriminately) and to neglect animal rabies control. Such actions do nothing to reduce human exposure to rabies. The high cost of the current products for post-exposure treatment call for a critical assessment of this trend and of national investments in the different components of rabies prevention and control. The current trend to deal with rabies by concentrating on human post-exposure treatment to a certain extent than dealing with the disease in the increasing dog population must be reversed. There seems to be nothing more urgent in the field of rabies than the development of national programmes of dog rabies elimination and strategies and procedures for international cooperation. The purpose of the following guide is to re-orient research, to strengthen managerial processes of programme planning and execution, to ensure community cooperation, intersectoral cooperation and international technical cooperation and to improve, accordingly, legislation and international control procedures (WHO, 2005; Bishop *et. al.* 2003).

2.4.2 International rabies control

The international control of rabies has two dimensions. One is the protection of travellers from contracting rabies in countries where rabies is endemic. The other is preventing the spread of rabies from one country to another through domestic animals that cross borders.

As noted by Kaplan (1977) rabies was prevalent in Europe in the Middle Ages. From 1500 onwards rabies was widespread and frequent, largely among dogs but there are

many references to madness among wild beast of many kinds (Kaplan, 1977). There were major outbreaks of rabies in the early eighteenth century when the disease spread from Eastern European countries, involving both dogs and wild life (Wasik, 2012). Also in the mid-eighteenth century, rabies was prevalent in North America and a high frequency of occurrences was reported in Boston, a city with large population in the state of Massachusetts, United States of America which is located in the continent of North America. (Zuckerman, 2013).

Another wave of outbreaks swept through Europe during the Napoleonic Wars. The serious outbreaks of rabies disease in foxes continued until 1835, and the area most affected bore the brunt of the fox rabies epizooty of the 1960s, which is France and eastern Europe (Kaplan, 1977). This highlights the fact that rabies is an international issue rather than a local problem.

As the movement of people across borders became more common these outbreaks highlight the need for controlling both the spread of rabies and human contraction of the disease. Rabies has become a significant disease for the rapidly increasing travelling community (Lundy and Sharyn, 2003). In the United States, for example, 37% of people dying from rabies are infected in overseas countries. Canine and cat rabies are widespread in the developing countries of Asia, Africa and South America. This poses a danger to travellers, predominantly in the backpacking category. Debates on reducing rabies danger is one of the topics often ignored by travel medicine advisors during pre-travel consultations. Travellers must be well-informed concerning the risk of rabies exposure and knowledge regarding local reservoir group so that they can avoid contact with potentially rabid animals. They should also receive training on precise wound cleaning, the value of correct post-exposure treatment with vaccine and immunoglobulin, and their accessibility at the traveller's destination (Coetzee, 2006).

The number of animal bites and contacts in international travellers has been projected to be two to four people per thousand and in many of these cases there are some anxieties regarding the disease (Rupprecht and Shlim, 2004). Nevertheless, where correct post-

exposure treatment is available, this is valuable in preventing humans from contracting rabies. The main limitation, faced by customs administration in any country with endemic rabies to protect incoming travellers remains the price of pre-exposure vaccination; the cost prohibits the requirement for vaccination (unlike in the case of yellow fever and other such diseases). The cost, for example, of preventing rabies in United States tourists to Thailand by custom pre-exposure vaccination was predicted at between US$ 40 to 50 million per rabies death prevented (Coetzee, 2006).

In 2010, during the historic FIFA, which is known as Fédération Internationale de Football Association in French**,** World Cup soccer tournament in South Africa, the rabies question was put to the fore as the country was expecting around 250 000 to 300,000 additional international tourists to South Africa. While the country and tourism industry were preparing themselves for this event, travellers were educated about the potential risk of rabies, which is pandemic throughout Africa, including South Africa and neighbouring southern African countries (Malerczyk *et. al.*, 2010).

In terms of controlling the spread of rabies from one country to another there is no record of any system in place in any country that attempts to control the movement of wild dogs across borders. The buffer zone should be created by vaccinations of dogs along the borders. Veterinary cordon fences are erected to control the spread of Foot and Mouth Disease (FMD) to cattle. The example of this situation is Botswana which has been constructing a 500 kilometre electric fence along its north-eastern border. This fence, according to Gaborone authorities, is to prevent interaction between two country's cattle and buffalo herds and halt the spread of FMD. Unlike in the case of FMD where the carrier is a single species that cannot easily cross fences, rabies is carried by species that are much more mobile such as mongooses, jackals and bats, which are, of course, able to fly. Thus the control of movement of animals can only realistically be applied to domestic animals travelling through formal border systems. In this regard, worldwide and regional surveillance systems have been established and much attention has been given to international regulations for the transfer of domestic animals (WHO, 1997) which help prevent the spread of rabies from one country to another. Another aspect of this is the

WHO which says that if 70% of a country's domestic animals are vaccinated against rabies, rabies will be contained and managed.

2.4.3 The role of the State in rabies control in South Africa

Since the 1970s, most human rabies cases in South Africa have occurred in KwaZulu-Natal Province, where the major animal vector is the domestic dog. Human rabies is much less common in areas such as Limpopo Province, where the major animal vectors are wild animals such as the black-backed jackal species (*Canis mesomelas)*, because these animals are less likely to come into contact with humans (Cohen, *et. al.* 2007). Nel, *et. al.*, (2009) further emphasise that most of the cases of animal and human rabies in South Africa occur in KwaZulu Natal (KZN) province, which is located along the eastern side of the country and is one of the smallest (92,100 km2) but most populated (approximately 9.5 million people) of the nine South African provinces. It extends from Swaziland and Mozambique in the north, to the Eastern Cape (EC) Province in the south, while inland it is bound by the provinces of the Free State and Mpumalanga Provinces, and by the Kingdom of Lesotho (Coetzee and Nel, 2007).

Rabies is a prevalent and re-emerging disease in South Africa particularly in rural areas with high human densities. Outbreaks are seldom reported in the north and eastern parts of this country. Nevertheless, 21 people have died after being bitten by infected animals and 48 animals were confirmed to have the disease in Limpopo in 2006 (Mlindiwa, 2006), Dog rabies has commonly been associated with the eastern and southern border areas in Mpumalanga province, and the Nkomazi district in the east has been most affected. In other parts of the province, canid rabies has been under control for many years; however, in 2008, dog rabies spread to other parts of the province and resulted in a widespread outbreak (Mkhize *et. al.*, 2010). During August-October 2010, rabies has been confirmed in 17 domestic dogs in the greater Johannesburg area. The areas affected include: Sophiatown, Bushkoppies (Eldorado Estates), Meredale, Kibler Park,

Dobsonville (Soweto), Eikenhof, Lenasia, and Highlands North (Sabeta *et. al.*, 2013). However, dogs in surrounding areas could also be infected. These dogs were pets that had not been vaccinated against rabies. A campaign, managed by the Gauteng Veterinary Services and City of Johannesburg Environmental Health, to vaccinate pets within the affected areas was undertaken (Sabeta *et. al.*, 2013). All pet owners were strongly encouraged to take their pets to local veterinary clinics for rabies vaccination. It was found that the recent canine rabies outbreak in the Gauteng Province came from the introduction of the rabies virus from KwaZulu-Natal, with subsequent local spread in the susceptible domestic dog population of southern Johannesburg (Sabeta *et. al.*, 2013). The above-mentioned outbreaks illustrate that rabies is imminent everywhere in South Africa.

Rabies is a controlled disease according to the South African Animal Disease Act of 1984, and therefore its control is entirely dependent on the State. The national government serves as a monitor to the prevalence of the disease and international liaison. However, the onus is on the provinces to control rabies. The local government is the important stakeholder in carrying out rabies advertising and bringing the rabies concept closer to the community at local level (Coetzee, 2006). The other stakeholders that might be involved are traditional structures, non-governmental organisations such as Rabies Alliance, civic organisations, schools, churches and livestock associations.

While the Animal Disease Act addresses rabies in domestic animals, another important aspect of rabies control is the occurrence of rabies in wild animals and the effect this can have on the survival of endangered species and on the transmission of the disease from one species to another. The seriousness of this is demonstrated by Hofmeyr *et. al.* (2004) and amplified by Brown (2011) using the case of rabies among wild dogs. The responsibility of rabies control in relation to conservation is still ambiguous, as wildlife authorities are not yet clear about its control. A team that included local and national experts from the Department of Health, from Veterinary Services and Wildlife Department was convened to oversee this issue (Nel *et. al.*, 2009). This team would jointly control domestic and wildlife rabies outbreaks. But it should be envisaged that

public health impact dog rabies greater than wild animal rabies (Sid Ahmed Sayied, 2004).

The KwaZulu-Natal Department of Agriculture and Environmental Affairs, Veterinary Services Division has embarked on intensive mass campaigns in the past. The problem with these massive campaigns is that they yield results for a short period (Bishop, 1999). The practice was failing to have all dogs vaccinated. The disease habitually manifests itself again. At present there are sporadic outbreaks of the disease in eThekwini Metro and at UGu District Municipality, which is on the south of eThekwini Metro. The epicentres are at Umdoni Local Municipality, which is located near Scottburgh, Vulamehlo, which is at Dududu Town, and Hibiscus Local Municipalities, which is composed of Port Shepstone up to Margate and rural area. (Bishop, 1999). Some rabies outbreaks are coming from UThungulu District Municipality of the North Region of KwaZulu-Natal.

In this study, the researcher has explored the rabies campaigns strategies that have been carried out in the past in the above mentioned areas. Through personal participation in rabies campaigns in KwaZulu-Natal since 1978, the researcher has observed the following. Prior to 2008, rabies campaigns were run mostly independently by each district. In 2008, a pilot rabies campaign was launched that would bring all the provincial rabies control resources together as a concentrated series of vaccination campaigns. Substantial public resources were mobilized and utilized in logistics. Training was given to personnel who were to do the vaccination of pets. The personnel expressed great hope and enthusiasm in carrying out the programme. No less than 20 vehicles were dedicated to the programme and were deployed in sequence to the Pietermaritzburg, through eThekwini Metro, Stanger, Port Shepstone and Ixopo veterinary districts. It attracted funding from the Bill and Mellisa Gates Foundations. However, while there was an improvement in the number of dogs vaccinated, but it was far from desired to prevent future outbreaks. The problem that the programme experienced sporadic resistance against vaccination from the communities of these areas. The ultimate failure of this initiative in terms of eliminating rabies even in the face of having concentrated resources, highlighted, as with previous initiatives the need to engage the communities participation

as an integral part of the campaign strategy. Another setback that tarnished the image of this initiative was the serious outbreaks of rabies in KwaZulu-Natal, which resulted in the death of three people in 2012 (Carlyle, 2012).

2.4.4. Strategies for controlling rabies

Bishop *et. al.* (2003) and Richard *et. al.* (1997) propose that rabies control strategies should be uniquely designed to address each specific rabies outbreak. This does not address rabies control where there is no outbreak, i.e. prevention. It is suggested that rabies control should not be restricted to a reactive process, but should include preventive control as well.

In South Africa control strategies are predominantly organized in the context of proactive outbreaks and potential outbreaks – either responding to a specific outbreak or running prevention programmes in areas where rabies is endemic and, an outbreak is likely to occur but has not yet happened. Whether responding to an outbreak or running prevention programme, the general practice is to notify the health authorities, local farmers' alliance or district livestock association union or any organized agricultural entities of outbreaks or potential outbreaks. In this way, the population of the area is alerted to the outbreak or routine rabies vaccination. In metropolitan areas, the community is commonly notified through the print media, radio and television in case of rabies outbreaks (Carter: 1997).

When an outbreak has been established, the responsible state veterinarians decides on the area requiring vaccination. The common practice for urban outbreaks is to vaccinate all dogs and cats in the affected street and neighbouring blocks. With farming areas' outbreaks, dogs and cats on the infected property should be vaccinated. With outbreaks on small holdings it is important to vaccinate animals in surrounding properties. If the outbreak is established in the rural area, the intention should be to vaccinate all dogs and cats within the immediate neighbouring area up to a radius of approximately 25 km, at the discretion of the state veterinarian. Unpublished research undertaken in KwaZulu-

Natal, Provincial Department of Agriculture, estimates that the average distance that is travelled by a rabid dog before it dies is approximately 25 kilometres (Carter: 1997).

A prevention programme runs in a very similar manner to an outbreak programme. The relevant authorities, structures and communities are informed of the intended programme and urged to participate (Carter. 1997).

Although there are several rabies vaccination strategies, Bishop *et. al.,* (2003) propose six strategies for controlling rabies: large scale vaccination; barricade vaccination; circle vaccination; house-to-house (HH) vaccination; midpoint (CP) vaccination; and oral vaccination. Vaccination strategies that have been applied with some success in the KwaZulu-Natal province include large scale, cordon, ring house, central point and oral vaccination (Bishop *et. al.* 2003). Each of these is discussed below. These strategies are not mutually exclusive and often more than one strategy is employed at the same time.

2.4.4.1 Large-scale vaccination

Large scale vaccination is referred to as mass vaccination. The aim of synchronized large scale vaccinations is to achieve 70% vaccination coverage in the shortest time possible, to break the transmission chain of the epidemic (Kramer, 2007). Large-scale vaccination is the primary response to rabies outbreaks in high endemic areas. The province of KwaZulu-Natal has been declared an endemic high risk area according to *Government Gazette 32234, Regulation Gazette 9073,* (Government Notice 558).

In keeping with international standards, the aim is to vaccinate, at least, 70% of the animal population in danger in a single campaign within as short a time as possible. The Rabies Project Section is a special unit within the Veterinary Directorates of KwaZulu-Natal Department of Agriculture, Environmental Affairs and Rural Development that is responsible for this kind of rabies strategy. It looks at the trends of outbreaks in all areas of the province and conducts mass vaccinations campaigns. It is often the case that mass vaccination programmes include one or more of other strategies that will be discussed.

2.4.4.2 Cordon vaccination

Cordon vaccinations are performed to prevent the spread of rabies disease from affected to rabies-free regions. This strategy is used to form a cordon of 20 to 30 km wide in regions bordering areas from which the disease may be introduced or reintroduced (Coetzee, 2006). Cordon vaccination is typically performed along international borders to prevent the introduction of rabies from neighbouring countries and along regions bordering game parks to prevent the spread of the disease to wildlife (Coetzee, 2006). The intention of cordon vaccination is to build a barricade of animal immunity. This strategy has become significant during the second phase of rabies vaccination campaigns after large scale vaccination strategy of canine rabies eradication, particularly in the environments of international boundaries, national and provincial game reserves. This is essential to prevent reinfection of areas presently free from rabies and to protect rabies-free areas (Bishop *et al.*, 2003).

2.4.4.3 Ring vaccination

Ring vaccinations are performed to reduce the chance of the transport of an unvaccinated animal which may be incubating the disease, to a distant geographic location (Bishop *et. al.* 2003). Effectively it involves setting up a 'ring' with a radius of 20 to 30 km around areas with high prevalence of rabies and then ensuing that all potential rabies carrying animals are vaccinated. This is done with the aim of reducing the possibility of spreading rabies outside the ring when animals are transported across the barrier to other parts of the country.

The long-distance transportation of animals, mainly dogs, that may be incubating the disease, is of concern to veterinary authorities attempting to restrict the spread of rabies. This issue may result in outbreaks of canine rabies anywhere in the countryside at any time. It is therefore crucial that instantaneous vaccination of the vulnerable dog and cat population be performed during the crucial outbreak to prevent further sporadic outbreak

of the disease. In areas where an isolated case has been diagnosed, ring vaccination (with a radius of 20 to 30 km), is implemented, where at least 70% of all dogs are vaccinated. This has proven successful in controlling or eradicating rabies.

2.4.4.4 House-to-House (HH) vaccination

House-to-House (HH) or door-to-door vaccination involves moving from house-to-house in a predetermined area and attempting to vaccinate all dogs and cats in that area. This attempt should follow the census of dog population in the area concerned. HH vaccination takes rabies vaccination to individual households without the necessity of a specific request from an individual pet owner. Miranda (2000) argues that door-to-door vaccinations have proven to be particularly useful for achieving higher vaccination coverage than that which is usually achieved by other strategies as part of mass vaccination**.**

Bishop *et. al.* (2003); Hergett and Nel, 2013 and Kaare *et. al.* (2007) agree that HH is the most expensive system but also the most effective with coverage exceeding 70% of the dog population. A cost benefit analysis conducted on HH vaccinations in Tanzania found that the cost per dog was more than US$6 (R45/dog) and US$4/dog (R31/dog) respectively for pastoral and non-pastoral communities (Kaare *et. al.*, 2007). However, Kaare *et. al.* (2007) favours the combination of HH and central point (CP) vaccination, which was studied in Tanzania's rural areas.

Table 2.1 *Comparing of HH vaccination to CP vaccination strategies*

	HH	**CP**
Cost	High	Low
Coverage	High	Low
Results	High	Low

An instance of the success of the HH strategy in the vaccination of dogs is demonstrated by a campaign in Eerstehoek, a rural constituency in Mpumalanga in South Africa. In

1998, 20 animal health technicians vaccinated 6 498 dogs in rural communities extending over 594 square kilometres on a house-to-house basis. All immunized dogs were recognized with neckbands. Approximately 95,4% of the dog population were vaccinated within seven days and the direct expenditure per dog vaccinated was calculated at R4. This cost is influenced by many factors, among others the spatial and demographical setting of the population (Bishop *et. al.*, 2003). The spatial setting of rural areas make it difficult to cover large population within short distances as in towns. In towns small area can yield same number of dogs but at the same time cost less.

2.4.4.4.1 History of House-to-House (HH) Rabies Vaccination Strategy

House-to-House (HH) rabies vaccination in its present form was introduced to counteract the rabies problem in KwaZulu-Natal. HH was introduced during the height of rabies outbreaks in 1996. It was not the first time that the system was practised by the Department of Agriculture and Environmental Affairs, Veterinary Division, but it has been practised for some time and it was only used sporadically in those areas that an outbreak of the disease had occurred. Therefore it is very difficult to attribute this milestone to a single individual. Joey Peens, eThekwini control animal health technician, is a pioneer in shaping and redesigning the HH vaccination system to its present form. Furthermore, Joey helped in changing the system from reacting to rabies outbreaks to routine annual rabies vaccination. It is the only system that was adopted by the KwaZulu-Natal rabies project manager in pursuing mass vaccination campaigns in rural areas. It was adopted to curb future outbreaks of the rabies disease in KwaZulu-Natal. Furthermore, the technicians were heeding the KwaZulu-Natal government's slogan of 'bringing the government to the people' (Barnard, 2007: 43). This system involves traveling on foot or by car to each and every household, vaccinating pets. This is preceded by advertising the campaign through a public address system and meeting the leaders of the area to discuss vaccination dates (Peens, 2010).

The downside of the HH vaccination system is that it is expensive. However, in its favour, it significantly improves the percentage of vaccination. Since the introduction of

this system the number of pets vaccinated has increased and almost doubled. It is the method that is used even in big cities and suburbs when an outbreak of rabies has occurred. According to 1996/97 annual report there 240 rabies positive cases and in 1997/98 positive cases escalated to 246 reported cases (1996/97 Veterinary Annual Report and 1997/98 Veterinary Annual report). After the introduction of HH strategy 480 000 dogs were vaccinated in KwaZulu-Natal. The prevalence of rabies in KZN continued to decline until May 1998 (1998 Veterinary Annual Report. The number of reported positive cases recorded over the first 10 months of 1998 totalled 133. The areas of cases concern, with respect to rabies, included Pinetown and Eshowe. In eThekwini more than 100 240 pets were vaccinated in 1999 (eThekwini Veterinary Annual Report, 2000). This mark has never been achieved before the introduction of HH vaccination strategy. Before that CP system failed to reach 100 000 mark. Therefore the introduction of the HH system is considered a mile-stone in the eradication of rabies in KwaZulu-Natal and eThekwini (Veterinary Annual Report, 1998).

In conclusion the latest statistics of rabies vaccination is not promising as according to Annual Report – Agriculture Development Services 2011/12, the target of 480 000 was not achieved as only 327 836 pets were vaccinated. This backlog was caused among others by the outbreak of Foot-and-Mouth Disease (FMD) at UMkhanyakude District Municipality in 2011 since more resources and personnel were invested in fighting that outbreak. This means that HH strategy should be intensified in the future to curb downward trend of rabies outbreaks.

2.4.4.5 Central-point (CP) vaccination

Central-point vaccination is where all animals are brought to a central place where they are vaccinated. Central points are comprised of government animal clinics and temporary points established in various locations. CP campaigns are conducted at least every twelve months in areas where the occurrence of outbreaks is high. The community is requested to bring their pets to known venues. Epidemiological information, good publicity and sufficient arrangements are of importance to guarantee high coverage. Outcomes vary from 20 to 80% and depend on the level of advertisement and other factors which include

population which are at work during the day, ability to handle dogs, availability of transport and distance from the venue. Coverage is usually better if the campaign follows soon after a well-publicised rabies outbreak (Kaare *et. al.*, 2007). Kaare *et. Al.*, (2007) said this system was found to be more effective in Tanzania's agro-pastoral communities compared to pastoral communities which are found in remote areas of that country (Kaare *et. al*., 2007). This can be compared to eThekwini metro where CP is practiced in the densely populated areas such as suburbs, which are composed of people with a higher income.

Another form of CP vaccination is linking vaccination to cattle dipping. Bishop *et. al.*, (2003) state that inoculation of dogs and cats against rabies during custom cattle-dipping in rural areas is relatively cheap but, unfortunately, does not reach a high percentage of the dog population as rabies affects people from all walks of life.

The criticism of this strategy is that it cumbersome and not suitable for the rural areas. Brown (2011) argues that many rural people could not afford transport, and walking several miles to an inoculation centre on designated days is often out of question because of other commitments. Brown (2011) also cites Dr. A. B. McCulloch, a veterinarian at Allerton Veterinary Laboratories, Pietermaritzburg, South Africa, who depicted this scenario as follows;

> "For most people in KwaZulu getting the dog to the rabies venue means, coaxing, leading, dragging, or carrying the dog to the centre, uphill or downhill, often over rough terrain in areas where the hills are incredible steep. Walking is a time hungry activity in KwaZulu context, walking is not altogether a leisure activity. This is especially so for the elderly person, who may be the only one free to take the household dog or dogs to the vaccination centre, as the other members of the family are committed to predetermined tasks, such as, paid employment, school attendance and community, agricultural and rural activities. Quiet often the elderly can only control one dog at a time (Brown, 2011: 160).

Lastly, bad weather can also play a role in the failure of this campaign. Muddy roads become inaccessible for vehicles and even on foot.

In conclusion, CP vaccination strategy is cumbersome in the rural setting regarding the aspects that have been touched above. But as mentioned earlier the strategy will still be used in the future or together with other strategies to curb rabies outbreaks.

2.4.4.6 Oral Vaccination

Oral vaccination is a process whereby the rabies vaccine is taken through the mouth. Sylvatic rabies has been effectively eliminated in Switzerland and other European countries using bait vaccine. A bait containing live, active rabies transformed, Surface Antigen 2 (SAG2) has been formulated specifically for dogs and the first field trials were conducted in South Africa (Bishop, 1999). Bait vaccine was presented to 755 dogs and more than 75% of these dogs accepted it willingly. The vaccine is effective against challenges that is faced by physical rabies vaccination method and safe for use in both target and non-target species. The challenges such as dog bites, needle prickles and others, which are faced by Animal Health Technicians when they are administering vaccine subcutaneously, are eliminated. Although oral rabies vaccines are not yet registered for use in South Africa, the benefits of this strategy are obvious as the handling of dogs is eliminated and the approach is less physical than other vaccination strategies. There are other aspects of oral vaccination, for example, stronger dogs can deprive weaker dogs of baits, thus resulting in double dose for former and non-vaccination for the latter. Children can confuse it with something edible. Education of communities before embarking on this course of action is imperative (Bishop *et. al.,* 2003).

2.4.5 Mass vaccination as a tool for dog rabies control 1950 – 1970

Among the zoonoses whose control continues to pose international public health challenges, rabies is one of the world's main diseases. Mass vaccination has been used successfully in Europe and North America, illustrating that the disease can be controlled and eliminated by vaccination of reservoir animal populations. Japan, the first country to implement mass vaccination of dogs, successfully eliminated rabies in 1956. Compulsory vaccination and destruction of stray dogs in Malaysia in 1952 brought rabies under control, indicating that the disease could be controlled even in less developed countries. In Africa, both Zimbabwe and Uganda reported impressive declines in canine rabies cases over the 10 years before 1961 (Kaare *et. al.,* 2007).

From 1950 to 1970, a number of European countries brought rabies under control. In the 1950s dog rabies elimination programmes were strengthened, in particular by the swift mass vaccination of dogs (following the example by Hungary). Sporadic reappearance of dog rabies following a successful campaign was due to reintroduction from infected neighbouring areas or to spill over from rabies reservoirs in wildlife (Baer *et. al.*, 1996).

Malaysia, Japan and Hong Kong all reported free of rabies in 1956, and the Republic of Taiwan (China) and Portugal in 1961. Zimbabwe became free of the disease with only sporadic cases at its borders in 1961 (only two canine cases versus 129 recorded cases in dogs in 1952). Similarly, Uganda reported a drop in the number of recorded cases from 55 in 1952 to two cases in 1953, and Israel from an average of 64 cases annually for the years 1950-1959 to an average of 14 cases annually for 1960-1969. Sporadic cases in dogs have been reported from the USA since 1968 (in that year 296 cases) and dogs were still the cause of over 5000 cases of rabies in the USA in 1953. This caused a surprise as dog rabies was considered as eliminated (Baer *et. al.*, 1996).

Since 1970, new successful programmes of dog rabies control have become rare and have been limited mainly to Latin America and Europe. During the last decade, progress of countrywide programmes from South America was implemented, where canine rabies was spread due to a border problem, the good example was Chilean rabies outbreaks.

Many other areas in that region showed an improvement due to well-designed national and regional projects. For example, the number of animal rabies cases dropped in the Province of Buenos Aires from 4 759 in 1976 to 714 in 1979 (Animal Health in the Americas, 1983; Perry, 1995).

All remaining cases of canine rabies were eliminated in some European countries, namely in southern Italy in 1971, in Greece in 1979, and records from 1979-82 indicated that the dog rabies epidemic was close to its elimination or actually eliminated in the south of Yugoslavia (Bögel, 1987).

Apart from recent successes in Latin America and Europe, very few reports have been received from other continents, such as Asia, Africa and Australia, of successful dog rabies control programmes. Local efforts, such as the project in Manila and in some islands and provinces of the Philippines, are exceptions and have been of temporary success or have been restricted to limited areas due to the lack of extended national programmes (Bögel, 1987).

The above incidences illustrate the need of mass vaccination against rabies. Therefore, rabies project of KwaZulu-Natal, South Africa is on the right track in embarking on this noble endeavour of controlling rabies disease.

2.4.6 Rabies control in reinfected areas

Outbreaks of dog rabies in previously rabies-free areas or countries always cause much public concern, activate great control efforts (and surveillance) and lead to socio-economic consequences due to injection of resources. It took years for re-introduced rabies to be completely eliminated in several countries where it had been re-introduced, including South Africa. Thus, in the north-eastern part of Austria canine rabies was a problem for several years following the Second World War. A short epidemic of dog rabies caused four human deaths in Amsterdam in 1962 and almost all dogs in the

country had to be vaccinated in a swift campaign. On the island of Guam, which is the largest and southernmost of the Mariana Islands in Atlantic Ocean, an outbreak involving 90 cases of animal rabies was brought under control during 1967. An epidemic in the region of Malaga in Spain lasted from 1975 to l976 (Animal Health in the Americas, 1983).

Rabies was introduced in Hong Kong through an imported rabid dog. Suspected cases or outbreaks called for extended programmes of containment and e1imination in Belgium in 1961, in French Somalia in 1962 and in Malaysia in 1966 and 1970. In two episodes in the United Kingdom in 1969 and 1970 rabies cases were diagnosed in two dogs after release from quarantine. Unfortunately, most episodes of this sort are not detected early, since services and the general population is often unaware of the risk. In such cases dog-to-dog transmission occurs and regrettably the index case is often a case of rabies in man. (Animal Health in the Americas, 1983; Perry, 1995; Bögel, 1987).

In concluding, over the last 15 years, effective countrywide programmes eliminating dog rabies have become rare, with existing programmes lapsing and much-needed programmes not being developed. This is the case of the availability of improved methods of surveillance and control and of an increasing health significance of the disease. South Africa is one of countries in which rabies is endemic (Wasik and Murphy, 2012).

2.4.7 Rabies in the developing world: rationale of control and elimination

Rabies is often perceived as a minor problem, especially in developing countries plagued by many hardships (Fooks, 2005). Rabies competes with countless other human and animal health problems for both economic and human resources. Despite being considered as an infectious disease with the highest case fatality ratio (if timely post exposure prophylaxis is neglected) and being rated as the 10^{th} most common lethal infectious disease, rabies contributes to less than 1% of the global mortality caused by

infectious agents. However, deaths caused by rabies are responsible for 1.74 (90% CI: 0.25 – 4 – 57) million Disability Adjusted Life Years (DALYs) lost each year. An additional 0.04 million DALY are lost annually through morbidity and mortality following side-effects of nerve-tissue vaccines, and the psychological impact of fear and trauma induced by suspect rabid dog bites (WHO, 2005). This accounts largely for its inconsequential status (Martinez, 2000; Rupprecht *et. al.*, 2002). However, the problem is substantial than currently understood because of severe underreporting and lack of proper surveillance programmes in developing countries (Cleaveland *et. al.*, 2002). Rabies is frequently considered only an animal health problem. Although rabies is most definitely an animal health problem, it poses a public health burden. In most developed countries where dog rabies is rife, human cases are reported. The control of the disease in these animals, that are more often than not free roaming, is difficult (Quak, 2010).

To be eligible as epidemiologically meaningful, a vaccine delivery approach needs to be cost effective and effectual. Hypothetical and experimental analyses indicate that vaccination of 70% of dogs is sufficient to reduce susceptible thus avert epidemics and eradicate endemics rabies virus. However, this level of coverage was seldom achieved in dog inoculation programmes in sub-Saharan Africa (Kaare *et. al.*, 2007) and neither vaccination programmes are assessed. Exposure levels and rate per dog vaccinated, fluctuate in different settings. For example, coverage levels achieved using central-point (CP) dog vaccination campaigns in high-density metropolitan and countryside areas of Kenya and Tanzania in 2007 have been adequate to cause declines in canine rabies, although none of these studies quantified the delivery costs (Kaare et. al., 2007).

Prevention in humans is complicated by a scarcity of biologics such as Rabies Immunoglobin (RIG) and the exorbitant prices of cell culture vaccines. For reasons such as these, post-exposure prophylaxis (PEP) regimens are often not completed and may lead to preventable deaths. In countries where rabies in towns and cities has been brought under control, wildlife rabies often poses a risk (Perry, 1995).

Control strategies of rabies in wildlife are by no means less intricate. For example, there are no existing strategies for the sustainable management of rabies in bat species. Furthermore, rabies poses an economic burden which can be estimated to billions of Rands. Shwiff *et. al.,* 2007 quantify rabies cost as direct and indirect costs of suspected human rabies exposure which were estimated for San Luis Obispo to run into billions of dollars. This burden is the loss of livestock and other animals and the cost of vaccination and continued control programmes, which requires the public health infrastructure and diagnostic services. The cost associated with PEP and pre-exposure vaccination for humans is considerable with millions of doses of PEP administered annually (WHO, 1998; Kramer, 2007).

An insightful way of looking at the burden of rabies is considering disability adjusted life year (DALY) scores which are estimated by taking factors such as those discussed above into consideration (WHO Expert Consultation on Rabies, 2005). DALY scores revealed that the public health burden due to rabies is higher than of important communicable diseases such as chagas disease and dengue (Weingart and Wyer, 2006).

2.5 Conclusions

In conclusion, the first phase of rabies in KwaZulu-Natal was successful wiped out. Paradoxically, there is no lesson to learn from that first eradication and elimination of rabies. The environment under which the first one was conducted is different from the second one that still exists today. The political landscape was not the same. The first phase was characterized with the apartheid system where the black majority lived under oppressive laws. Blacks were subjugated and coerced to adhere to stringent rules (Magubane, 1994). After 1961 Sharpville massacre the South African authorities became more violent. The defiance was carried by city blacks, but blacks in rural areas showed little resistance as there were some patches of revolting in Pondoland, Sekhukhune and other places (Kepe and Ntsebenza, 2011). People in rural areas were triple oppressed as the authorities were from Pretoria, homeland authorities and tribal chiefs. People knew

that they should do what the authorities wanted from them. Their allegiances to authorities were unquestionable. The manner in which the first outbreak was contained came from the fact that rural people paid due respect to white government as well as their surrogates which were homeland leadership and chiefs (Adam and Moodley, 1993). During the second phase of outbreak of rabies the socio-political scene was not the same. The massive movement of people to cities and the South African easing of repressive laws caused people to be at ease with adhering to government rules although they were not oppressive. People could not be coerced or imprisoned if they did not bring their animals for vaccination. The civil servants were then engaging people through extension and practicing procedures that would not carry burden to them. That is why house-to-house rabies vaccination strategy, accompanied by extension find the place in controlling of rabies in rural and township areas.

The various factors raised in this literature review influence the manner in which house-to-house rabies vaccination can be practiced. The deeper one goes into rural areas the more intense is the need for house-to-house rabies vaccination. The level of education in these areas is lower and the flow of the latest information is delayed as people are more secluded. Lastly by bringing in Schoones *et. al.,* (1994) theory I anticipate that the playing field for both officials and the rural people should be levelled to accommodate better communication between them. The House-to-house rabies vaccination strategy will go a long way in helping these people to avoid the dangers of rabies. In the above literature review, if one looks at the countries that have eradicated rabies from their shores, there is a light at the end of the tunnel. There is an assumption that third world countries should not work in isolation but they should converge to fight the rabies scourge and other trans-boundary diseases. Learning from other countries' achievements should be an on-going practice and International bodies such as WHO should serve as an umbrella body and learn from Third World in order to fight rabies.

CHAPTER 3

3. DESCRIPTION OF THE STUDY AREA

3.1 Description of the study site

Rabies cases are distributed throughout the KwaZulu-Natal province, but predominantly restricted to the densely populated coastal regions (Brown, 2011). Magabheni Township was chosen for this study with that in mind. Figure 3.1 shows the distribution of rabies throughout South Africa. It is evident that the greatest concentration of the disease is in and around the eThekwini municipality (or Durban area).

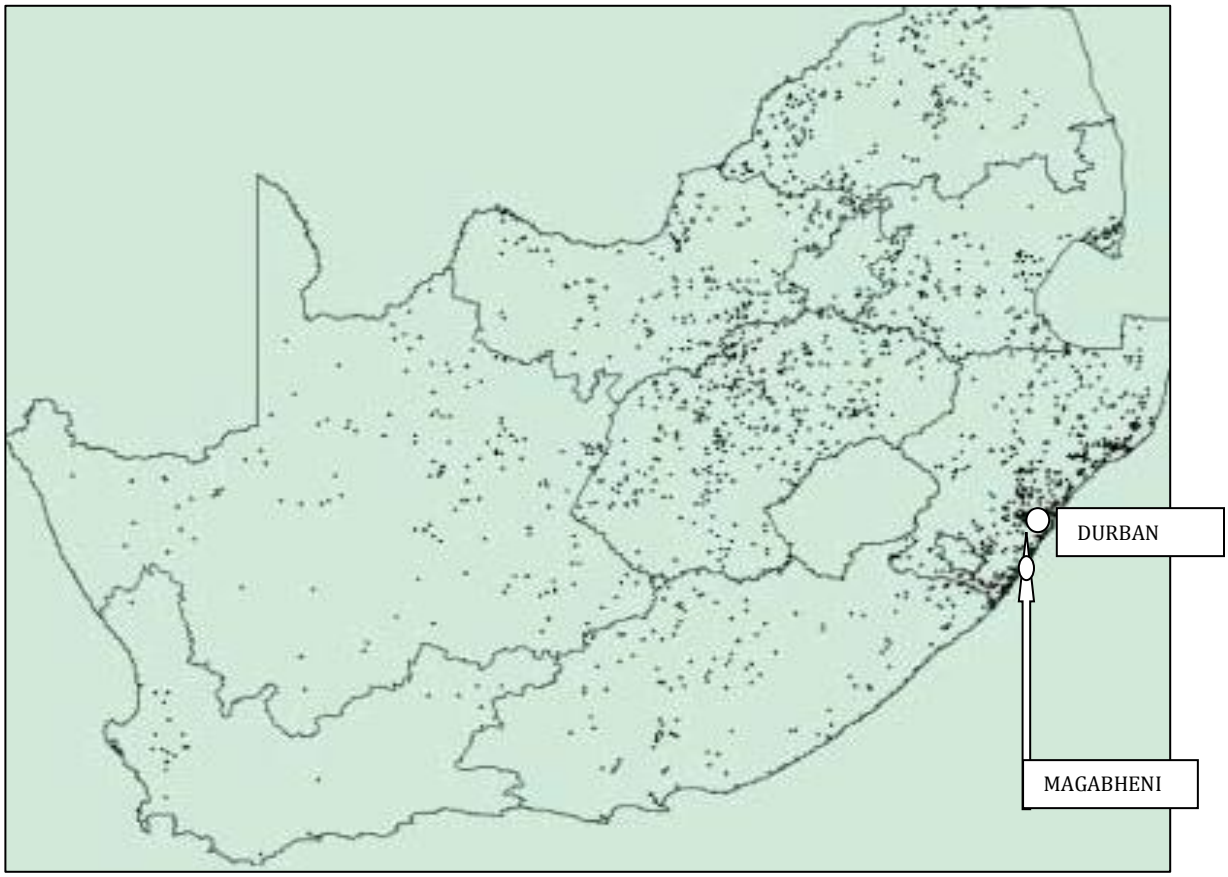


Fig 3.1 Geographical locations of animal rabies cases diagnosed over the five-year period, 1995 to 2013 and a map of South Africa showing the location of Magabheni Township in South Africa (Source Bishop et. al., 2003)

As shown in Figure 3.2, Magabheni is part of the eThekwini Municipality. It is located at the extreme southern end of the municipality and borders with the UGu District Municipality to the south. The nearest formal town is Umkomaas which is 5 km away.

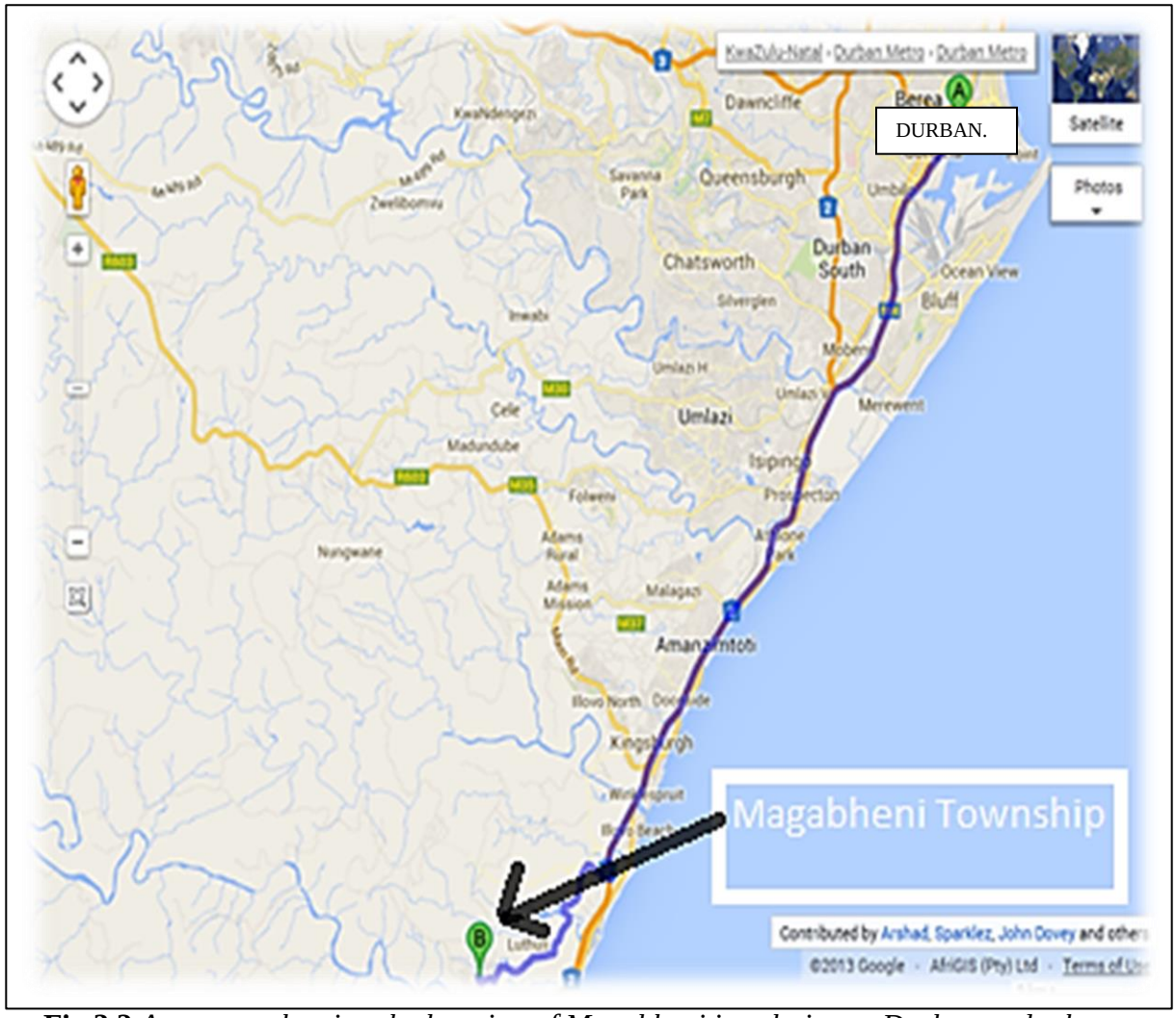


Fig 3.2 *Area map showing the location of Magabheni in relation to Durban and other urban areas (Google earth)*

Magabheni is a rural township, and is surrounded by rural areas on the western, northern and eastern sides. Further, rabies outbreaks have been taking place unabated in the township for several years raising the question of the most appropriate rabies management approach.

Magabheni is adjacent to Umgababa on the North where political unrest was rife in 1980s

and 1990s. As discussed before in this study, unrest caused massive relocation of people, thus abandoning pets to fend themselves. This upheaval became breeding ground where diseases fester. This unrest led to outbreaks of rabies that later spilled to Magabheni (Dlamini, 2013). Finally, Magabheni's close proximity to major urban cities (e.g. Durban) makes these cities more vulnerable to rabies that can potentially spill over from Magabheni. Rabies control at Magabheni is crucial for the controlling of rabies disease in the greater Durban area. Like any other areas which are found on eThekwini boundaries, the emphasis is on controlling of spill-over of rabies from other areas that falls outside of eThekwini.

Magabheni was also chosen for its accessibility, its size and spatial arrangement which is not dense but resembles close settlement. Magabheni is accessibly from N2 freeway to the south of KwaZulu-Natal. There is a tarred road that passes Magabheni to SAICCOR factory at the banks of Umkomaas river. The township is reasonable small and is located in the Mnini Tribal Authority in the southern part of eThekwini municipality, approximately 30 km from Durban's urban area. The township has approximately 5000 inhabitants (Raber, 2010).

Magabheni is a rural township located in the southern part of the eThekwini Metro. The township was established in the early 1940s to provide accommodation for the black population of Sappi SAICCOR paper factory workers at Umkomaaas.

The township is situated among the rolling hills of the Umkomaas valley on the south and the Illovo River on the north. Figures 3.3. and 3.4 show that Magabheni is unlike most other rural settlement in the eThekwini Metro which are more typically village-like. Magabheni is more formally laid out like a township. It has clearly defined roads, even and more formally constructed houses that are situated fairly close to each other. It has not encroachment of informal housing which typically found in other rural townships near the industrial side of the city. This was the ideal place to conduct random sampling. The surrounding area is rural and supposed to be one of the poorest areas within eThekwini Metro (Raber, 2010).

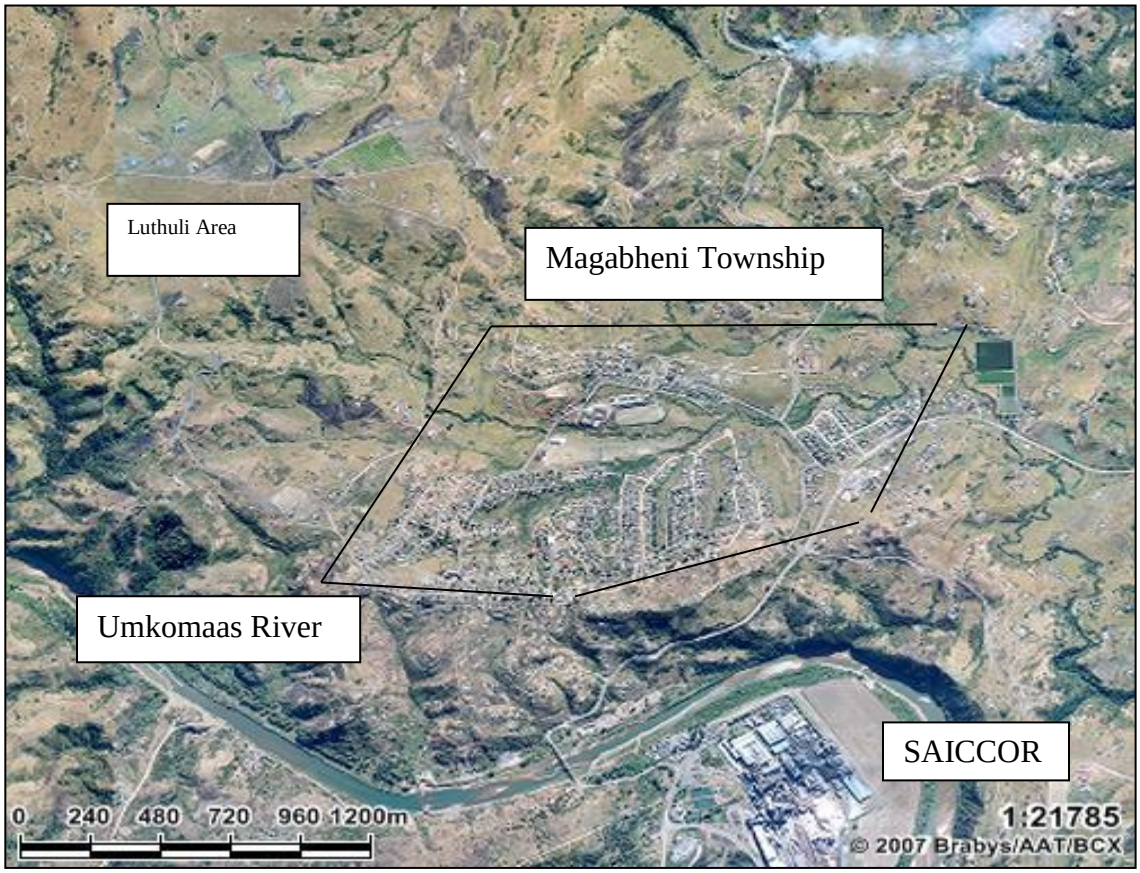


Fig 3.3: An image of Magabheni Township (Source: Minus One Track CC)

While it has the physical structure and appearance of a township, the people in Magabheni retain a rural/village life style. They keep livestock and have kraals in their homesteads. There is a dip tank as there would be in most rural settlements. They still use traditional leadership structures as an important element of community governance; the chief and induna systems are functioning. Like any other rural areas in South Africa, there is a democratically elected councillor. They are used to this type of dual leadership.

3.2 Population and Economy

Magabheni is sparsely populated. As of 2009, it had an estimated population of 1075 people comprised of approximately 565 males and 510 females. In 1991 the population of Magabheni was 992 people according to Statistic South Africa Census, 2001(Encyclopaedia Britannica, 2013). Although no published statistics could be found,

it has been observed that there is a high percentage of children and youth and that most of the residents appear to fall into the working class bracket as most of them are working at the Sappi SAICCOR pulp factory as labourers (Dovers *et. al.* 2002). Other residents are employed as government workers or in supermarkets and hotels in the Umkomaas area (Olivier, 2009).

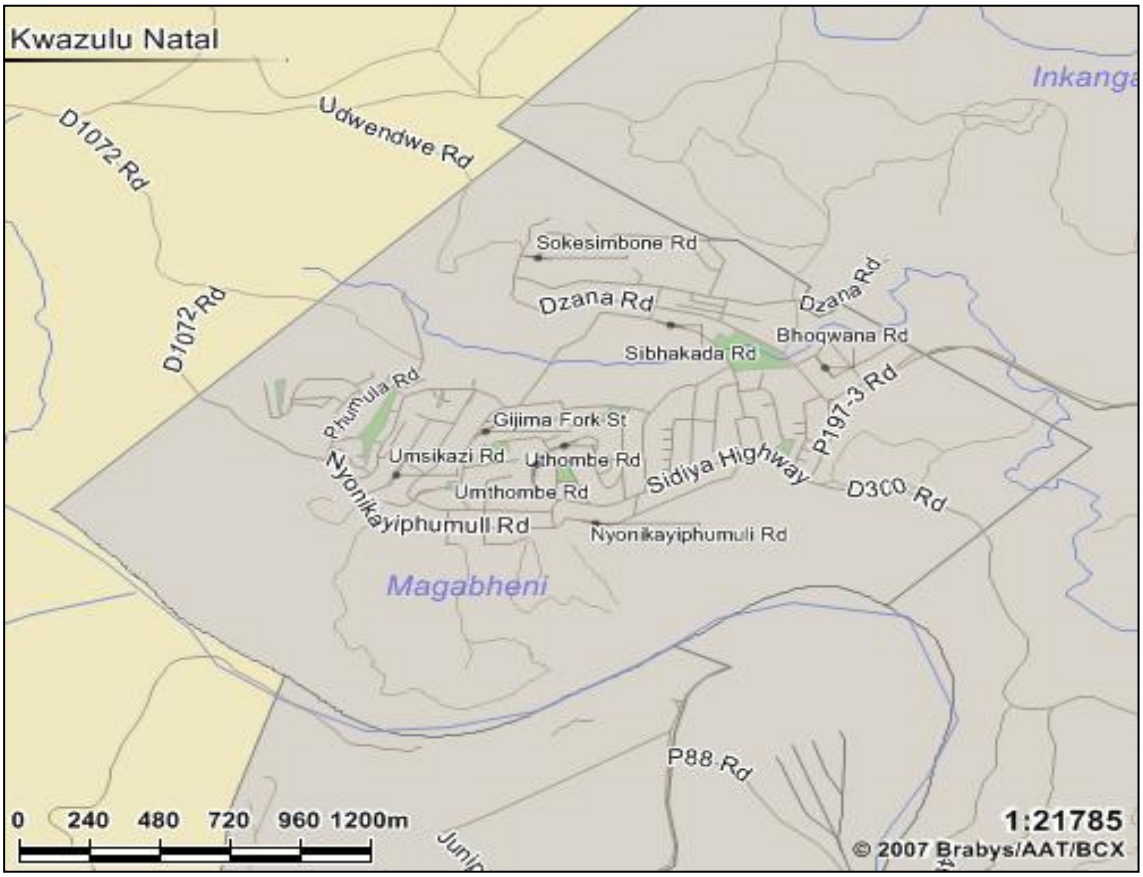


Fig 3.4: Magabheni Road Map (Brasby)

Sappi SAICCOR is the main employer in the area and is the only industry near Magabheni – situated near the Umkomaas River. There are also some small industries at Saiccor Village located between the pulp factory and the town of Umkomaas. There are few opportunities for economic growth (Dover *et. al.*, 2002).

3.3 The composition of the dog population

No formal statistics exist for the exact dog population at Magabheni. Thus it was necessary for the researcher to make an estimate based on observation and vaccination records that is kept at eThekwini Veterinary offices. It was assumed that this would shed light on the previous outcomes of rabies coverage. It was estimated that there are approximately 508 dogs in Magabheni. We looked at vaccination records of previous vaccination campaigns.

Before any rabies control can take place, the dog population of a given area should be studied by means of a dog population survey. The dog population is categorised into the following groups: roaming dogs, owned dogs and community dogs (Bishop *et. al.*, 2003).

3.3.1 Roaming dog

A roaming dog is a dog that is not presently under direct control or currently constrained by a physical barrier. This expression is often used interchangeably with 'free-roaming', 'free-ranging' or 'stray' dog. Note that this term encompasses both owned and unowned nomadic dogs and individual does not make a distinction whether the dog has an 'owner' or 'guardian' (Stafford, 2006). In many countries, the majority of dogs that would be defined as roaming dogs have an owner but are permitted to roam on public property for all or a portion of the day. This class is a problem in South Africa as the majority of dogs that transmit rabies fall into this group. It was estimated that there were four roaming dogs that were observed in Magabheni; some of these were owned and other were not owned. Magabheni was visited on two evenings when the roaming dogs were more active. The places that were observed were dumping sites and by travelling along the roads. However, this needs a thorough observation of the behaviour of a dog as there are many houses that were not fenced. A roaming dog is distinguished by extreme nervousness and withdrawn when someone approaches it.

3.3.2 Owned dog

For the purposes of this study, an 'owned dog' was one that someone states it was their possession or claims some right over it. Indeed possession could range from 'loose' ownership in the form of irregular feeding of a dog that roams freely in the streets, to a dog kept as part of a commercial breeding facility, or to a well-cared for, legally registered and restricted pet. In reality, what constitutes dog ownership is highly variable and fitted along a range of incarceration, provision of resources such as food and shelter and the significance of companionship. The majority of dogs in the study area came from this owned dog group. It should be noted that owned dogs could have been roaming dogs or constrained dogs (Waldan, 2010).

3.3.3 Community dog

There might be situations where more than one individual claimed possession of a single animal. These could be identified as community dogs (Waldan, 2010). In Magabheni, there were 4 community dogs; they were included in the total number of owned dogs. They may also be roaming or constrained.

3.3.4 Responsible dog ownership

Regardless of the category into which a dog falls, rabies vaccinations are influenced by the concept of responsible animal ownership. This is a principle of dogs' wellbeing that owners have a duty to provide adequate and suitable care for all their animals and their offspring. This 'duty of care' requires owners to provide the resources (e.g. food, water, health care and social interaction) necessary for an individual dog to sustain an acceptable level of health and well-being in its environment. The 'Five Freedoms' (freedom from food shortage and thirst, freedom from distress, freedom from pain, injury or disease, freedom to express normal behaviour; freedom from fear and distress), as spelt out by the Farm Animal Welfare Council (FAWC) (2009) serve as a useful guide. Owners have a duty to minimise the prospective risk their dog may pose to the public or

other animals. In some countries, this is an authorized requirement (Garcia-Alvarez *et. al.*, 2012). In rural South Africa it is not expected that these five freedoms are adhered to. Due to the range of cultural and economic reasons, "many people who contract rabies do not seek medical treatment and die at home" (Brown, 2011: 10). This means that large number of dogs in rural areas which are infected by rabies virus are killed and buried without being reported to appropriate authorities. That is the reason why rabies statistics are always not the true reflections of rabies situation in the area.

From a population management viewpoint, it is most useful to characterise the dogs first in terms of their behaviour or location (in other words, whether they are confined or roaming) and then by their ownership status. This would characterize the dog's behaviour which would, in turn, facilitate the vaccination of that dog. Brown, (2011) further argues that history shows that rabies in South Africa is the results of poverty, ignorance, political incompetence, and neglect of dogs.

3.5 Conclusions

The location of Magabheni township makes it easier to do fieldwork compared to other locations in Durban. Due to his experience of working among Magabheni people, the researcher discovered that it was easy to communicate with people. From observation and through fieldwork, dog composition of Magabheni fitted to the majority of owned dogs and community dogs, which are popular among hunters. Hunters can form relationship with dogs from neighbourhood. Hunting dog are associated with sylvatic form of rabies disease, based on hunter's habit of hunting wild animals. Magabheni has a known history of rabies. Rabies control in Magabheni is also influenced by the occurrence of rabies in the surrounding areas of UGu District Municipality and thus is a key factor in rabies control in the Durban area. There has been several rabies outbreaks spill over form UGu District Municipality. There is a manageable dog population and the infrastructural arrangements of road and houses made this study possible.

CHAPTER 4

4. RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

For this research, a qualitative method of data collection was used, namely interviews and informal discussions took the format of case a study, which could delve into the individual stories to understand the degree of rabies disease control and eradication at Magabheni in the province of KwaZulu-Natal. Banister, (1994) says that qualitative research means that there will be direct focusing on context and integrity of the material. Banister (1994) continues to define qualitative research as having three components: first, an effort to confine the logic that lies within. Second, an investigation, embellishment and systemisation of the impact of a recognized observable fact, and last, the illuminative illustration of the connotation of a delimited issue or problem (Banister, 1994). Banister (1994) concludes by saying that this type of research is able to "build a bridge between the world and us, between our objects and our representation of them, but it is important to remember that the interpretation is a process that continues our relation to this world keep on changing" (Banister, 1994: 7**)**. Mouton (2001) proposes that data can be classified into various categories and the most common ones are observation, self-reporting (also called 'indirect observation'), archival sources and physical sources. Mouton (2001) concludes by saying that different research designs and methodologies use different formats for fieldwork documentation, for example, in qualitative research the researchers have a tendency to maintain field comments as they contribute to the fieldwork often in natural field settings. Observation and classification evolving social structures were made to identify stray and owned dogs in homesteads and dump areas.

The study adopted a case study approach. According to Yin, (2009), a case study is an approach that is characterized by focusing on one case of a particular phenomenon with a view to providing an in-depth account of events occurring in that particular instance. There are various reasons for choosing a case study as a research strategy. Denscombe (1998) has identified the following advantages for using case study approach:

"It allows for a variety of methods depending on the specific needs and circumstances of a situation. It tends to prefer small numbers, which are investigated in depths. It allows a researcher to make a choice from a number of organizations. There is no pressure on (the) researcher to impose control. A case study is cost effective and saves time" (Denscombe, 1998: 32)**.**

Neuman (2001) argues that qualitative research has lengthened to the highest degree in decades and is speedily displacing outmoded epidemiology-pattern research. Lately, qualitative research had surpassed quantitative research. Neuman (2001) further emphasizes that even though both styles of research allocate fundamental philosophy of science, the two approaches differ in notable ways. Each has its strengths and confines, topics or issues where it glitters, and archetypal studies that provide unbelievable insights into social life Neuman, (2001)**.** There is an agreement with Neuman, (2001) when he states that the best research often combines the qualities of each. Neuman, 2001 concludes by depicting the following scenario:

"The key features, which are more common to all qualitative methods, can be seen when they are contrasted with quantitative methods. Most quantitative data techniques are data condensers. They condense data in order to see the big picture. Qualitative methods, by contrast, are best understood as data enhancers. When data are enhanced, it is possible to see key aspects of cases more clearly." (Neuman 1991: 72)**.**

Denscombe, (1998) identified that negotiating access can be reliable and is disadvantageous if it using a case study approach. The existence of the research can guide the researcher to the observer effect. Boundaries can prove difficult to define. Visits were made to all household which were in precinct of the study area. Case studies are often perceived as producing 'soft' data (Chenoweth, 2002). The data that were obtained from the study can be comparable with that of Eerstehoek, Mpumalanga in 1997 (Bishop *et. al.,* 2003).

House-to-house rabies vaccination strategy is not an end but it is a means to an end. Therefore extension methods was also used to transform scientific knowledge for the

better understanding for semi-illiterate people of Magabheni. Convenience of household dogs for parenteral vaccination is affected by diverse socio-economic, cultural and spatial factors and dog distinctiveness (i.e. age and degree of restriction), which need to be accounted for in the intention of control strategies. In the case of domestic dog immunization, socio-economic and cultural factors are likely to manipulate dog–human relationships and the public awareness of and attitudes towards rabies. Therefore their approaches to keep dogs differ considerable (Delahay, 2009).

The use of the Sender-Message-Channel-Receiver-Effect (SMCRE) method, using an extension campaign on rabies (Sekokotla, 2005)

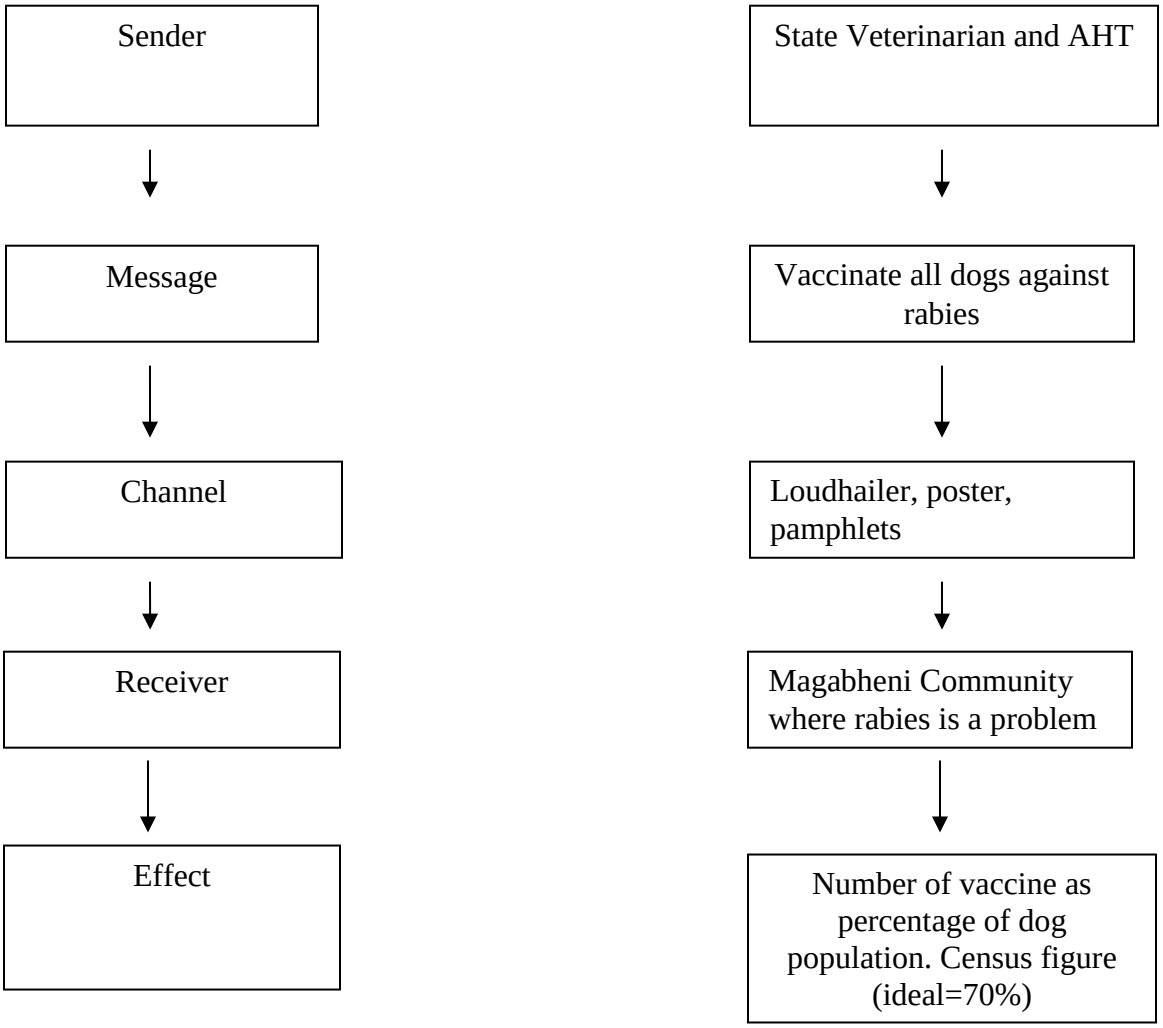


Fig 4.1 *Extension Methods used*

There are many agricultural extension methods that could be implemented for educating farmers (most of whom are adults) in different situations. Veterinary systems are part of agriculture as it envisage part of farming that deals with animal diseases. In the whole world veterinary services are always integral part of agriculture. The examples are:

- The Farming Systems Research and Extension (FSR-E) method (Adams *et. al.* 1982; Bembridge, 1991; Benoir *et. al.* 1984; Chuma *et. al.* 1996; Clark, 1985; Hawkins and Van den Ban, 1996; Mollen and Antipas, 1999; Russell, 1985; Sekokotla, 2005; Subair, 1994; Thabethe and Uzodike, 2013).
- Farm-led and Farmer-to-Farmer Extension Methods (Francis and Sibanda 2001; Sekokotla 2005).
- Visit and training system (Sekokotla, 2005).

The veterinary system in its entirety conforms to the first (FSR-E) method which is practiced in eradicating and controlling rabies. In this study this method was used to communicate with pet owners.

The above figure 4.1 shows the extension process Sender-Message-Channel-Receiver-Effect evaluation as described by Sekokotla, (2005) and Bembridge (1991). From the Figure 4.1 the following are processes of an extension session:

- Sender: The person or organization sending the message.
- Message: The extension message. It should be short, easy to use and measurable.
- Channel: The way in which the message reaches the target audience or receiver e.g. farm visits, radio, TV, farmers' days, pamphlets and news media.
- Receiver: The target audience. Their socio-economic and cultural circumstances must be characterized as well as language, age, interests, education, etc.
- Effects: Does the message result in the desired effect? This is how extension is measured (Sekokotla, 2005).

This study conformed to the above extension methods which will be used as part of qualitative research.

4.2 Sample selection

A researcher cannot study everyone across all settlements or across all countries, due to time and cost restraints, and therefore researchers need to rely on samples. In selecting these samples they need to select sites, research population and sample size based on the total frequency of each category.

It is imperative to identify research site before a sampling method can be identified. A research site could be chosen for various reasons. Neuman, (2001) put forward the following two main considerations when choosing a research site. It could be on theoretical grounds or it could be for practical reasons. If a research site is chosen based on theoretical grounds, it might be because a researcher wants to test a theory. Therefore, a researcher would think of the best possible way in which he/she might test the theory. In other words, a researcher will choose a site that he/she thinks is the best to test the theory. If a research site is chosen based on practical reasons, it might be due to difficulties when it comes to gaining access. Second, it might be because some organizations are more convenient than others. Therefore, the researcher might choose to study there or study a settlement where he/ she knows someone who will help gain access without argument and trouble. When it comes to this project, a research site was chosen based on practical grounds. Therefore, it was easy for the author of this study to negotiate and gain access and to make arrangements since this study prefer randomly selected numbers, investigated in depths.

Random sampling was implemented for this study. Random sampling is also known as "probability sampling" or "chance sampling". Under this sampling design, every item of the universe has an equal chance of inclusion in the sample (Woolson et. al. 2012). At Magabheni stratified random sampling was used. Kothari, (2004) contextualize stratified sampling as a method whereby the population is divided into several sub-populations that are individually more homogeneous than the total population (the different sub-populations that are called a strata'.) and then items are selected from each stratum to constitute a sample. Kothari, (2004) further argues that since each stratum is more homogeneous than the total population, one is able to get more precise estimates for each

stratum and by estimating more accurately each of the component parts, one obtains a better estimate of the whole. Therefore, stratified sampling results in more reliable and detailed information (Kothari, 2004). For example at Magabheni the stratum was composed of individuals that keep dogs. Abbott and McKinney, (2013) conclude by stating that probability samples eliminate conscious and unconscious biases as a representative probability sample approximates the aggregate characteristics with the population.

Magabheni has 535 houses and 267 owned dogs were found in houses that were interviewed. A random sampling was selected and 52 households were interviewed. This type of random sampling can be used when the size of the population elements is unavailable. A stratified sample is a probability sampling technique in which the researcher divides the entire target population into different subgroups, or strata, and then randomly selects the final subjects proportionally from the different strata (Maindonald and John Braun). In this procedure, units in a series are selected according to a predetermined technique (Cantor and Schneider, 1967) In this research, samples were chosen on a random sampling basis. Every 5^{th} household with dogs was interviewed. The method that was used guaranteed representativeness (Neuman, 2001). The sample was representative of the Magabheni population. In other words, it had the same characteristics as that of the entire households.

4.3 Observation

During the time of stability, when there was no unrest as previously reported, the proportion of stray dogs in the communities is likely to be small (Farlan, 1987). However, attempts were made, before rabies vaccination campaign and during fieldwork in 2009, to estimate the percentage of feral dogs present in the population and their impact on the vaccination coverage achieved. Within 24 hours after the vaccination campaign, one person travelled along all major roads, refuse points and popular township centres to observe the stray dogs. Direct observations were carried out from

17h00 to 19h00 and 06h30 to 08h30 as free-roaming and feral dogs are likely to be more active when human movement is low and the weather is cool. The surveillance of feral dogs was very critical in this instance as none of the dogs were marked during the vaccination as we had no paint and neck-belt to put on vaccinated dogs. Therefore, it was very difficult to differentiate vaccinated and unvaccinated dogs. The only differentiation was obtained from laboratory's rabies neutralising of anti-body level by means of titres (van Sittert et. al., 2010). Since neither owned nor unowned dogs were marked, the behaviour of all dogs was taken into account. For example, dogs that are not familiar with people are very shy and aggressive when approached. These dogs did not allow people to get closer and like wild animals they soon run for cover when they see moving objects.

4.4 Data collection methods

Face-to-face interviews were conducted with the dog owners of Magabheni Township. The questionnaires are attached on Appendix 2. Dog owners are regarded as the most important link in the vaccination against rabies. The vaccination process can take place after the owner has securely held his/her dog firmly. Failure to do so will result in the dog not being vaccinated. To avoid disrupting work's programmes for animal health technicians' mail and electronic surveys were conducted with the fellow animal health technicians. This meant that animal health technicians would answer the questionnaires at the comfort of their homes. The researcher did a telephonic interview with his supervisor. The supervisor provided the logistical details of rabies vaccination . That would help in calculating the cost per each vaccinated dog. As an empirical study, the data source was from the dog owners of Magabheni Township, animal health technicians and the researcher's supervisor. The data about the demography and population of Magabheni was found from the eThekwini Municipality, Statistic South Africa and electronic access information.

It was thought that it would be unnecessary to conduct a house-to-house rabies vaccination surveys on non-dog owners and there was an assumption that they would lack knowledge of dog vaccination process. Access was made possible by the fact that

fieldwork was done while the researcher was doing rabies vaccination and dog owners had been notified about the presence of animal health technicians at the area. In this project face-to-face interviews were used as a way of collecting data. Denscombe (1998: 114) suggests the following reasons for using one-to-one interviews

After Magabheni Township was chosen for data collection, the author talked to his subordinate who is responsible for the Magabheni area. The rabies campaign of Magabheni should have taken place in March, but was postponed to a later date.. The interviews were tested in Lamontville as a pilot study with the intention of ensuring their validity. The details of changes will be discussed later under "pilot study".

In August rabies vaccination was advertised by the researcher in Magabheni. As with the HH method, the author went through all of Magabheni's streets advertising the rabies vaccination by using a public address system which is fitted to his vehicle. The success of rabies vaccination is determined by good advertising that inform people about vaccination. The informed people turn out in large numbers on the day of vaccination (Bennet, 2005). Advertising should be systematic and spoken slowly and clearly, so that everyone will hear what is being announced. During advertisement, the speed of vehicle was low so that everyone will capture the announcer's talk. The weather plays an important role too, as if it is raining, people tend to stay indoors and switch on music loudly. In that instance it is imperative to use sirens to draw their attention. The sirens sometimes can be a nuisance to the user or the public, and should be used cautiously. The community of Magabheni understood the dynamics of using sirens to draw their attention as is the case in all other areas the author has worked in.

The mode of advertising in any given community is very important for the success or failure of the vaccination process. Most people in the cities and towns are literate. Their economic level is higher than those of the rural areas and they can access TV's, internet and other media. In contrast, some people in rural areas cannot read and the strategies of advertising in these two areas are not the same. As peri-urban people who are biased to rural settings the messages are transmitted through word of mouth. Therefore, public

address systems are fitted to all technicians' vehicles. Before vaccination can happen loud hailing takes place.

The time of advertising before vaccination is determined by past advertising methods and communication with that community. Some people like advertising to be early so that they can ask for leave from work. Others like it to be the day before vaccination as, if the period is longer they will forget by the time the day of vaccination comes. To combine the two is the best option. At Magabheni Township the community preferred a period of one to five days' notice. Other departments such as health and local government were invited especially in providing extension services, advertising and helping during campaigns. On vaccination day, the demarcated area was described to all technicians. The procedure was agreed upon. The vehicles' public address systems were engaged to alert people about technicians' presence in the area.

Residents came out of their houses and wait at the entrance or gates of their households. The vehicle or technician that arrives first would stop and vaccinate their pets. Sometimes the individual encountered a problem, such as problem animals, and bring this to the attention of animal health technician. These problems vary, and could range from difficult dog, or dog that was tied by its leash in the backyard, and dog that was vicious which needs a muzzle or catch-pole to hold it. The whole process of having a dog vaccinated takes approximately 5 seconds. In other instances 20 minutes lapse especially when the owner has difficulty in handling his or her dogs.

In some townships one can experience a maze of roads and each road that has been visited are marked with small pieces of papers which are thrown on the road, especially where the road splits. This alerts the following vehicles that the area has already been covered. This saves unnecessary repetition, which is time-consuming. Sometimes this can be good when the technician finds dogs or cats that have been left out by other technicians. This is caused by the different responses to advertisement by the community. Therefore it is recommended that although there are papers on the intersections, it is advisable to go there quickly and speedily to check late respondents. Those papers

(9.5cm X 9.5cm) do not litter the environment as they are only few pieces which are bio-degradable. After a week there used to be no sign of littering on all Magabheni's streets.

In this case public relations and extension are of the utmost importance. Extension should be an ongoing exercise in promoting rabies vaccination strategies and serve as awareness and education campaign. The researcher played a major role in promoting house-to-house rabies vaccination programmes. Radio talks have been done on Radio Ukhozi, which caters for Zulu speaking listenership, since the 1996 outbreaks. Radio Ukhozi have +- 8million listeners in KwaZulu-Natal, Gauteng, Mpumalanga, Free State, Eastern Cape as well as neighbouring countries such as Swaziland and Lesotho (McKaizer, (2013). The rabies outbreak was successfully eliminated and extension ensured sustainability of rabies vaccination. Rabies in different themes had been addressed and successfully held phone-in programmes where radio listeners ask questions regarding rabies and other diseases. Radio talks together with different prominent figures like the minister of Agriculture and Environmental Affairs and other senior managers were held. There have been invitations to do radio talks on other programmes besides those that are allocated to agricultural programmes. These programmes has been Ezanamuhla, Abasiki bebunda (both current affairs programmes), Ezangesonto (which was originally reserved for government ministers and head of departments), After-Eight programme, which is also used by ministers and senior government officials, and Jabul' Ujule which is women's programme. There have been several invitations to address nurses in hospitals, health workers, livestock associations, agricultural shows, minister's tours and traditional leaders. These radio talks have contributed to the fighting of rabies scourge by adhering to house-to-house rabies vaccination strategy. These activities were carried above the routine duties of rendering advanced Animal Health Regulatory Support Service in terms of the Animal Health Diseases Act (Act 35/1984), Medicine Control Act 101 of 1965, Meat Safety Act of 2000, and the Livestock Improvement Act. All these activities of parading house-to-house rabies vaccination strategy were done to targeted marginalized population, who cannot afford expensive and cumbersome central point (CP) rabies vaccination strategy. It should be emphasized that the CP programme is not thrown into

oblivion, but it is still the programme of the future in suburbs and even in rural areas when the rabies situation becomes better.

A week before the campaign, the researcher met with the research assistants that would help him in collecting data. Training was given on how to collect data while adhering to research ethics. The author gave them the rationale behind this research and the main research question. They were also warned about bias when collecting data. They were showed on how he did sampling of the whole Magabheni population. It was urged that sometimes they had to abandon vehicles and walk on foot if possible because there should be interconnection between interviewers and interviewees. Most of the time animal health technicians work from their vehicles but due to this study they had to go extra mile. The data collected were to be reliable. It should be borne in mind that by this questionnaires had already been formulated and tested at the Lamontville pilot study.

The inoculation date was communicated to dog owners at least one week in advance through authorized letters to village authorities, and posters were placed in regular places within the township including schools and shops. It should be remembered that illiteracy that was mentioned earlier does not prevent AHTs to use posters as school children can read and pass the message to their illiterate or semi-literate parents. One day before the inoculation, a publicity team travelled from street to street announcing the rabies vaccination using public address systems which are mounted on vehicles. In the advertisements, dog owners were informed that inoculation was complimentary and were asked to bring their dogs and wait at the main gates of their properties when vaccination team arrived over the following day. On the vaccination day, dogs were registered and the name of the owner, name of the dog, its age, and sex and vaccination history was recorded after each owner have completed the whole process of having his or her dog or dogs vaccinated. Dogs were subcutaneously vaccinated with 1 ml Rabisin Rabies vaccine (Medial South Africa (Pty) Ltd.) and 0.5 ml per 50kg Ivomectin (Intervet SA (Pty.) Ltd.) against mange to those that had skin diseases. Certificates for each vaccinated dog inoculated were issued to owners. In this study, only costs for the rabies component of vaccination were considered. Disposable needles and syringes were used. Needles were

used once for each dog, while syringes were recycled for every 20 dogs. This would reduce transmission of diseases from one dog to another.

4.5 Household interviews

Household questionnaires were conducted during HH inoculation day to assess vaccination coverage and to accumulate data on household to earmark unvaccinated dogs, and reasons for failure to bring dogs for vaccination. No effort was made to calculate the rate of loss of vaccination certificates. The AHTs keep records of vaccinated dogs through duplicate certificates that are kept at their offices. At the end of each month rabies vaccination statistics are recorded on monthly returns. These include remarks about outbreaks and rabies surveillances. All these are sent to head office each month. This has nothing to do with elimination or controlling of rabies, but safe-keeping of certificates issued after vaccination will help the owner to have a proof of vaccination if his/her dog bite someone. They were advised to refrain from relying from vaccinators' records as sometimes they could not be reliable. It was used to keep the records of vaccinations for those who still regard rabies vaccination as a way of elimination of black peoples' dogs by the government. The locality of each household was recorded using a Global Positioning System (GPS) and this would help in locating visited houses when need arise. The sampling methodology of households in township communities was based on random selection of every fifth household.

All fifth households with dogs within units were interviewed. An open-ended questionnaire was conducted in a language understandable to the respondents (mainly IsiZulu) and in another local language whenever necessary by a team of four people, with the unchanged team carrying out the questionnaires in each household. As adult household members assume responsibility for overall household matters including authorization of dog vaccination, the household head, or, in his/her absence, any adult (>18 years) was interviewed. Families' income are not included among questionnaires as that is a very sensitive matter which sometimes generates wrong responses. Gould,

(2010) argues that the reliability of confidential information like income, credit relations and production levels, to mention few, revealed to an anonymous passer-by has its limitations. Gould, (2010) further recommends that interview design should focus on practical matters of recent occurrence. Therefore households were assigned a socio-economic category according to the conditions of the dog and house quality. Individuals were classified as high socio-economic status if their dogs were free from mange, owned houses that have undergone some change from the original municipal four-roomed houses and were plastered and painted. Although it is difficult allocate mange dog to the status of the owner but mange is a prevalent situation in low-income communities. When vaccination is conducted in these low-come areas, AHTs always carry mange remedies with them as part of department's community outreach programme known as Primary Animal Health Care (PAHC). In conclusion, Weathington *et. al.,* (2012) argues that there is a positive correlation between income and level of education. A positive correlation means that an increase in one variable corresponds with an increase in another variable (Weathington *et. al.,* 2010). By focusing on income, it was envisaged that at least 75% or three quarters of household at Magabheni fell on low-income bracket, according to practical matters that was mentioned before.

4.6 Analysis of questionnaires

Knowledge and understanding of rabies disease is very crucial in controlling the disease. Ignorance regarding rabies has caused rabies campaigns to fail in the past as people do not see the need to bring their dogs for vaccination or do not make any effort to have their animals inoculated against rabies. Therefore, the first questionnaire was to introduce topic regarding rabies.

Dogs are social animals – they depend on the owner for love and protection (PETA, 2012). The researcher's observations reveal that the majority of people in rural areas with few animals (1 or 2 with or no puppies) do not care whether their animals are cared for or not. Few of these people purchase or acquire dogs and many of them become dog

owners after someone gave them dogs as gifts or it just happened that an unowned dog has come to premises looking for food and found that there are no competitors for food in that household. There are many reasons for that type of ownership. Most people with four or more dogs have a better understanding of dog's health as most hunters are found in this category. Some people in this category have a large number of dogs as the dogs are naturally increasing but most of the time the owner have no means of keeping many dogs.

Handling of dogs by the owners is crucial in controlling and eliminating rabies. Therefore, the researcher asked this question to address the problem of failure to handle animals. Much can be spent in training of personnel and acquisition of expensive equipment but the success of house-to-house vaccination strategy rests with the owner's ability to handle dogs. The AHT cannot help in handling dogs as they are administering vaccine. In some instances the animal health technician can help by using a catch-pole or a net but, there is a need of a certain degree of cooperation between the dog and the owner. Therefore, the owner is the only person who can ensure that each and every dog is vaccinated, and the eradication of rabies can be a reality. The failures of previous rabies campaigns to totally eradicate or eliminate diseases were mainly the results of the above-mentioned point.

Advertising to inform HH dates of rabies vaccination is very important as dog owners should prepare themselves for the process. The technicians are used to work during week-days , but by that time most people are at work and children are at school. It may happen that those who are left behind in homesteads are unable to handle the dogs. Therefore, if the community can be informed some times before vaccination, they can tie the dogs and wait for the vaccinators to be undertaken. Some take time off from work to attend to this important task. Although some attempts have been made to do vaccination during evenings and week-ends, it did not materialize as AHTs were off-duty. Furthermore, it will be too costly as government has to pay overtime. It is envisaged that if the pilot project can be conducted on this issue. The amount of overtime pay and other expenses for that pilot project can result in more commitment for complete eradication of rabies. This can save huge amount in future expenditure on rabies vaccine and equipment. At present, the process of applying to work over the week-end is cumbersome and time

consuming as this should have the approval of the managers. Rabies Project should look at this issue for future controlling of rabies. This study was undertaken to entice the policy-makers about the plight of people regarding rabies.

The people themselves should have an input in improvement of this vaccination strategy. Therefore the researcher asked the residents for any weaknesses they detect in the existing system. There was a comparative study of the different kinds of government services i.e. registering for identity documents, water provision, electricity supply, to mention a few. This is another attempt at improving this service by copying other services that are closer to the community such as HH. This is part of systems thinking which tends to conceptualise a holistic approach to every situations. This is done by incorporating rabies control programmes as part of the whole systems of other government services.

4.7 Data analyses

Vaccination coverage and costs between the house-to-house (HH) and central point (CP) strategies were compared. To examine factors influencing vaccination coverage, statistics were analysed at (a) the village level; (b) the household level; and (c) the individual dog level. These data did not make any assumptions about how data are distributed. Therefore non-parametric statistics was used by means of transformation(Willis, 2011). The information was analysed using generalised linear models with binomial errors and miscellaneous effects (Kaare *et. al.,* 2007; Margolis, 2006). At the household stage, the parametric method was used which included number of dogs owned and number of people in a household. At the dog level, qualitative variables which included dog age, class, sex and whether a dog is constrained or not was used. Distances from nearest clinics, schools and shopping centres, which were used for CP strategies were categorised as near if $\leq$10m and far if >1 km.

4.7.1 Rate per dog vaccinated (HH)

Expenditure analysis was carried out from the state veterinarian perspective with costs implicit as being incurred by the KwaZulu-Natal Department of Agriculture and Environmental Affairs alone. The cost of vaccinating a dog was derived from the overall cost of the vaccination programme divided by the total number of vaccinated dogs at Magabheni, the study area. Vaccination costs for supplies and consumables (vaccine, needles and syringes) were estimated from 2008 market prices and *per diem* and allowances were based on 2008 applicable government rates for animal health technicians and animal health assistants. This was done due to the fact that no new equipment have been bought since then. Principal costs were amortized (reduced or extinguish a debt by money put aside) on a 6% discount rate and 5- and 10-year life duration for capital equipment (vehicles and refrigerators, respectively). The capital equipment costs is included as vaccination involves travelling daily from headquarters in Durban to Magabheni. The annual cost (measured over one year) was multiplied by the number of days the capital equipment was used for the vaccination campaign, and then divided by the number of days in one year assuming the capital equipment was productively used throughout the year. It should be noted that in eThekwini regular rabies programmes are organized for the whole year. Therefore utilization of capital equipment is non-volatile. Expenses related to cold chain (keeping of vaccine cold until it is used), transportation, vehicle repairs, community mobilisation and sensitisation, and supervision and training of vaccinators were included in the costing. Costs were based on expenditure in South African Rand at the time the study was undertaken, then converted to US dollars (US$) at the 2009 applicable exchange rate of R7.38/US$ (The Mercury September 21, 2009).

Confidential household costs were not estimated for two reasons: (i) observations at HH indicated that the majority (>80%) of people who brought dogs for vaccination were children <14 years old who are generally considered to be economically inactive, making estimation of opportunity costs due to lost time intricate and (ii) rabies control was considered a public rather than a private good and vaccination was provided free of charge. Confidential household costs entail the names of respondents and detailed address

information that do not appear on the records. The records for household specifies that the records for individual must be treated as confidential (Koocher and Keith-Spiegel, 1998).

4.7.2 Rate per dog vaccinated (CP)

The central point (CP) rabies vaccination strategy entails vaccination strategy entails vaccination of dogs from well-defined venues. It is time to look at CP vaccination strategy for the comparative study of the two strategies. The campaigns are regularly conducted annually in areas where rabies is endemic and the pervasiveness of outbreaks is high. The public are requested to carry their pets to identified venues. Epidemiological information, good advertising and adequate planning are of paramount significance to ensure high coverage. Outcome varies from 20 to 80% and depends on the degree of attention to detail. Coverage is generally better if the campaign follows soon after a well-publicized rabies epidemic. Kaare, *et. al.,* (2007) said this system was found to be more effective in Tanzania's agro pastoral communities compared to pastoral communities which are found in remote areas of that country (Kaare *et. al.,* 2007). In eThekwini metro this strategy is practiced in the densely populated areas like Durban suburbs which are composed predominantly of people with a high income. Magabheni, as the study area was excluded from CP strategy as it is composed of predominantly low income population. CP was practised before the introduction of HH strategy. To examine factors influencing vaccination coverage, data were analysed at (a) the village level; (b) the household level; and (c) the individual dog level by the researcher. Like the HH vaccination strategy the statistics were analysed using generalised linear models with binomial errors and mixed effects. At the family level, fixed effects included number of owned dogs and number of people in a household. At the dog level the rigid effects included dog age, class, sex and whether a dog is restricted or not. Distances from nearby clinics, schools and shopping centres, which were used for CP strategies, were categorised as near if ≤10m and far if >1 km. Within 1 km individuals do not normally pay for public transport and often either walk or use bicycles to travel to the nearest vaccination point. In conclusion, the CP strategy posed challenges for the public and technicians alike

4.8 Verification

A central issue in qualitative research is trustworthiness and validity to guarantee excellence (Sokoya, 2006). According to Lincoln and Guba, (1985), there are many different ways of establishing trustworthiness, including member check, interviewer corroboration, peer debriefing, prolonged engagement, negative case analysis, auditability, confirmability, bracketing, and, auditability, confirmability, bracketing, and balance. Sokoya, (2006: 348) further described validity in qualitative research as: "Trustworthiness: grounds for belief and action". She conceptualized justification as the process through which researchers make claims for and evaluate the trustworthiness of reported observations, interpretations and generalizations. Sokoya, (2006) concludes by saying that the whole assessment of a study's trustworthiness and validity should be high enough to be acted upon, the findings of the study would be granted a sufficient degree of validity to invest one's time and energy in, and place the reputation of the researcher(s) at risk as a competent investigator. Lincoln and Guba, (1985) further summarise this argument by stating that the enquiry's findings are "worth paying attention to". The following steps were taken to ensure trustworthiness and validity of the research findings;

Qualitative interviewers are interested in how meanings are produced and reproduced within particular social, cultural and relational contexts. They recognize the interview itself as one such context of interactive meaning-making. Therefore, interpreting qualitative data requires reflection on the entire research context. Reflexivity involves making the research process itself a focus of inquiry, laying open pre-conceptions and becoming aware of situational dynamics in which the interviewer and respondent are jointly involved in knowledge production. In this study it was construed that the researcher and the research participants belong to the same culture and they would share the same representation and construction regarding the research themes. Therefore, reflexivity is a vital part of the study. Reflexivity according to Reay, (1996), is a frequent deliberation of the ways in which the researcher's social characteristics and values affect the data gathered and the picture of the social world produced. Reflexivity entails a process of self-consciousness, and of researching one's own position in the research process. In this research, self-reflexivity is preferred to 'bracketing' because it is believed

that total distancing of oneself from the participants and the research situation may be unrealistic (Sokoya, 2006; Neuman, 2003). Cantor and Schneider, (1967) argues that if one does not reflect on reflexivity the research conclusions are usually fruitless exercise.

In conclusion, findings do not emerge only at the last stage of the research, but there is a deepening of insight throughout the research process. Emergent findings from intermediate stages inform subsequent interviews and analyses. Reflexive practices provide opportunity for revising questions and even re-framing the research topic as the project unfolds (Creswell, 2003).

4.8.1 Accessible language

Both the interviews and focus group interviews were conducted in ‘isiZulu’, which is the language in the project area. Translation between languages involves interpretation as well. The message communicated in the source language has to be interpreted by the translator (often the researcher him or herself) and transferred into the target language in such a way that the receiver of the message understands what was meant (van Nes *et. al.*, 2010). As stated under 'Household interviews’ the language question was broad enough to accommodate other languages. It was discovered that all respondents spoke or understood Zulu. The instruments for data collection were translated into ‘Zulu’ while responses were translated back to English, to avoid misinformation and distortion of data, which might lead to misrepresentation of the participants’ views and opinions. Many efforts were done to eliminate misrepresentation when translating and synthesizing respondents’ remarks.

4.8.2 Training of field assistants

Often researchers undertake "pilot" interviews to help identify the areas of greatest conceptual complexity. The pilot interviews were done at Lamontville, a small township on the outskirt of Durban. In early interviews some questions do not seem to "work." The researcher will become aware that questions were rebuffed because concepts were not understood or were seen to be inappropriate. Ongoing analysis also entails examining the dynamics of the interview. What was not said can be as revealing as what was said. As

the researcher comes to identify his or her assumptions and preconceptions, questions are revised for the next round of interviews. Two AHTs and two animal health assistants were recruited as field assistants for this study. The aim of the research and procedure were explained to them and practical training and demonstration sessions were conducted to ensure competence and mastery (comprehensive knowledge or skill) before the commencement of fieldwork. Although no funding was received for the research assistants, they were proud to be associated with this study as the outcome of this study would help in improving rabies control which is a panacea. Therefore the outcome of study would be beneficial even to them as it will fine-tune the system that has been adopted.

4.8.3 Pilot study

The term 'pilot studies' refers to mini versions of a full-scale study (also called 'feasibility' studies), as well as the specific pre-testing of a particular research instrument such as a questionnaire or interview schedule (van Teijlingen and Hundley, 2001). A small study conducted in advance of a planned project, specifically to test aspects of the research design (such as stimulus material) and to allow necessary adjustment before final commitment to the design. Although not unknown in qualitative research, these are more common in large quantitative studies, since adjustment after the beginning of fieldwork is less possible than in qualitative work. van Teijlingen and Hundley, (2001) further argues that pilot studies are crucial elements of a good study design and conducting a pilot study does not guarantee success in the main study, but it does increase the likelihood (van Teijlingen and Hundley, 2001).

The initial study was conducted in Lamontville Township. The aim of the pilot study was to explore, and gain more insight into the research problem. It further enhanced conceptualization of the questions used in in-depth interviews. The involvement of the respondents at this stage enhanced the instrument’s content validity.

The first step was to identify the type of research during planning. Therefore open-ended type questionnaires were chosen. The interpretation was done with bi-lingual

animal health technicians, who had IsiZulu as their first language. After that the questionnaires which had a hallow-effect or irrelevant were omitted or modified. As a pilot study only one section of Lamontville by the name of KwaGijima was chosen. The sample of 50 households was taken and 10 households were interviewed. The questionnaires were further modified to be ready for the actual studies in Magabheni. It was discovered that interviews conducted during vaccination days are almost accurate as most pet owners are at home waiting for vaccination of their pets. The data were analyzed and data analysis tools were identified. Trustworthiness which include member checks, interviewer corroboration, peer debriefing, prolonged engagements, negative case analysis, auditability, confirmability, The training of animal health technicians was formulated after some errors and shortcomings were identified during pilot studies.

4.8.4 Issuing of rabies certificates

All dogs that were vaccinated were issued with certificates in the 'owner's name and thus contained the street address. There were descriptions of each and every vaccinated dog which included the dog's name, breed, colour, sex and age. The certificate further contained the vaccine's name, batch number and expiry date. The signature and designation of the vaccinator should appear at the bottom of the certificate. The duplicates are kept and filed at the researcher's headquarters for any complaint that might arise and for future reference.

4.8.5 Animal Health Technicians' Questionnaires

AHTs are one of the stakeholders in controlling rabies. Therefore there were semi-structured questionnaires which were directed to AHTs. These questionnaires ranged from conceptualization of HH programme to the practicability of the programme. There were no face-to-face interviews but electronic communication were used that include emails and faxes.

4.9 Shortcomings and sources of error

The financial constraints and time factor hampered the collection of data for the Magabheni Township. A random sampling was used. In stratified random sampling the researcher attempts to stratify the population in such a way that the population within a stratum is homogenous with respect to characteristics chosen as on the basis of which it is stratified (Kumar, 2011). The number of feral dogs could not be counted with any degree of certainty as the number of dogs counted during dawn and dusk cannot be absolutely referred to as unknown dogs as there are many dogs which are under this category of community dogs. Feral dogs are normally wild, unlike other categories of dogs. In the future, every dog vaccinated should be marked for easy identification of stray dogs. The practice that was used in the past was to paint every vaccinated dog with silver paint. The method was reliable but it was cumbersome as some dogs were too aggressive to be painted. Furthermore, dogs would jump and splash the paint in such a way that all personnel and equipment were painted. In the recent past an organizations which supplied vaccine presented the department with neck belts which was fitted to the neck of each vaccinated dog. This would make vaccinated dogs conspicuous for some days. These methods of identifying vaccinated dogs helped in persuading people to bring their animals for vaccinations because this would intrinsically ostracise those whose dogs were not vaccinated.

4.10 Conclusions

Observations were carried out on the behaviour of feral dogs to find out about dog population by visiting dumping sites in the evenings. This was the only time when these stray dogs were active. Face to face interviews, technicians' mail and electronic surveys and telephonic interview were implemented in this study. The data about the demography and population of Magabheni was found from the eThekwini Municipality and Statistic South Africa. Household questionnaires were conducted during HH inoculation day to assess vaccination coverage and to accumulate data on household and dog distinctiveness for unvaccinated dogs, and reasons for failure to bring dogs for vaccination. Advertising of rabies vaccination before it can take place is important. Therefore the researcher asked

the residents for any weaknesses they detected in the existing system. Vaccination coverage of the house-to-house (HH) and central point (CP) strategies were compared. Expenditure analysis was carried out from the animal health technician perspective with costs implicitly as being incurred by the department. The cost per dog vaccinated was derived from the overall cost of the vaccination programme divided by the total number of dogs vaccinated. Trustworthiness and validity are the distinctive validation for validity judgment to guarantee excellence. Both the interviews and focus group interviews were conducted in 'isiZulu', which is the language in the project area. Two animal health technicians and two animal health assistants were recruited as field assistants for this study. The pilot study was conducted in Lamontville Township with a view to explore, and gain more insight into the research problem. The financial constraints and time factor hampered the collection of data for the Magabheni Township. All dogs that were vaccinated were issued with certificates that bore the 'owner's name and address. Therefore these research methods will ensure the investigation into the effectiveness of HH vaccination strategy a reality.

CHAPTER 5

5. FINDINGS AND DISCUSSION

5.1 Introduction

This chapter presents and discusses the findings of the research derived from research questions and research sub-questions. The overall effectiveness of the HH programme was determined through a number of research methods focusing on three key indicators: customer satisfaction, practicality and cost. This was a qualitative research which incorporated epidemiology.

This section illustrates how the results are discussed and what was found in relation to both the research questions and existing knowledge. This is the opportunity to highlight how the research reflects or differs from and extends current knowledge of the area in which one has chosen to carry out research. This section is the chance to demonstrate exactly what one knows about the topic by interpreting the findings and outlining what they mean. At the end of the discussion one should have discussed all of the results that were found and provided an explanation for the findings. A Discussion section should not be simply a summary of the results

The instrumentation that was used was questionnaires and observation schedules. 'It is relatively easy to arrange. The opinions and views expressed throughout the interview stem from one source. It is relatively easy to control" (Denscombe, 1998: 42). To expand further Denscombe, (1998) meant that the information emanated from the people targeted. The open-ended questionnaires used was very easy to control if the responded strayed away from the point.

The instrumentation that is prevalent in rabies control is that 70% percent of dogs if vaccinated will control the disease. Bishop *et. al.* (2003) said that the expenses of controlling rabies are through house-to-house strategy is 14c per each dog. Therefore, the questionnaires that were used were formulated bearing in mind the validity and reliability assessment of the instrumentation. Rubin and Babbie, (2011) define reliability as the

report that indicates ways in which the researcher searched thoroughly for disconfirming evidence, such as by looking for other cases or informants whose data might not fit the researcher's interpretation. For example systems thinking approach had been implemented in compiling instrumentation. Cheery, (2013) argues that validity is a test measures what it claims to measure. He further states that it is important for a test to be valid in order for the results to be accurately applied and interpreted.

For the purpose of this study, the beneficiaries of the rabies vaccination programme were the pet-owners in Magabheni Township. These pet-owners were interviewed to provide their views on the effectiveness of the HH programme in terms of service delivery. The pet-owners compared the HH programme to the Central Point (CP) programme as to other house-to-house service delivery programmes offered by the government (not necessarily related to rabies disease. (See Appendix II). It should be borne in mind that all respondents were familiar with both vaccination strategies. CP programme was practiced before the 1996 rabies outbreaks. Due to unrest before 1994, offices, shops and schools were used as centres for CP programme and simultaneously, it provided safety for animal health technicians.

Animal health staff in the Department of Agriculture and Environmental Affairs was asked to provide their views on the effectiveness of the HH programme in terms of how practical it was from the point of view of their capacity to deliver the service. This took into account factors such as time, equipment, and personal physical capacity.

Cost effectiveness of the HH programme was determined by comparing the costs of the HH programme with that of the Central Point vaccination programme. This information was drawn from historical financial data and service delivery records. This was augmented by an interview with the State Veterinarian responsible for the vaccination programmes. It should be borne in mind that other strategies except the two have never been practiced at Magabheni. The other strategies are used in very specialized circumstances. For example, cordon vaccination is used near borders and ring vaccination strategy is implemented after rabies outbreak in an area to prevent further transmission of rabies.

According to the Animal health technicians' perspective, house-to-house (HH) rabies vaccination reflects in the maximum number of vaccinated dogs and accessing a high proportion of dogs. Their perceptions were based on the premise that under normal circumstances house-to-house (HH) rabies vaccination is the method in which one drives along the street and calls dog owners to bring their pets to the entrance of their properties for vaccination. The open-ended unstructured questionnaires that were used during survey paved the way for better understanding of house-to-house rabies vaccination programme to the public. Open-ended questions allow for diverse and complete information if the respondents are verbally expressive and cooperative. Finally, some respondents object to choosing from alternatives that do not reflect their opinion precisely (Profetto-McGrath *et. al.*, 2010).

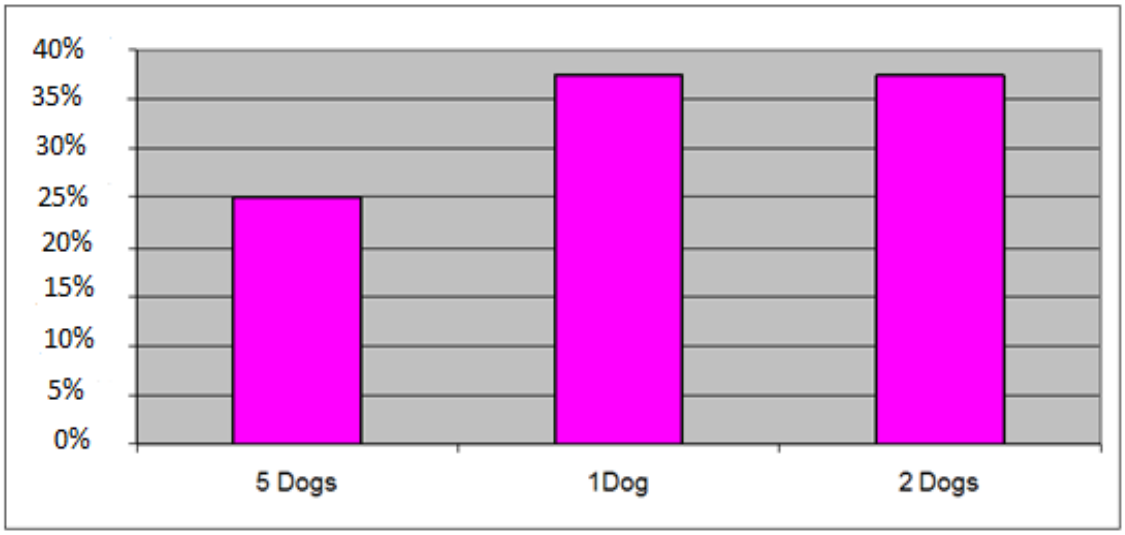
5.2 Results of the survey conducted among dog owners in HH programme area

Fifty-two households out of 267 households were interviewed accounted for 267 dogs. Of these, 177 dogs, (66%) were vaccinated in 2009. These households had the number of dogs that varied between one and five. Twenty-five percent of households interviewed had five dogs, 37.5% had one dog and an equal number of households had two dogs. No household in this sample had three or four dogs (Figure 5.1).

Historically it was believed that one of the major contributing factors to the escalation of rabies was the unwillingness of pet owners to have their animals vaccinated (Kazez, 2009). This study found that only two percent (2%) of the households interviewed did not want their animals to be vaccinated. However, 37.5% of the respondents had difficulty in handling at least one of their animals during the HH vaccination campaign. Animals that cannot be handled are difficult to be vaccinated and those constitute a potential risk of being infected with rabies (West, 1973). This is a critical factor indicating that the inability to handle an animal poses a greater threat to the control of rabies than do uncooperative pet owners. Before the researcher undertook this study, it was strongly believed that non-vaccinated dogs belong to people that resist vaccination of their pets.

After the survey it was discovered that failure to handle dogs by pet owners is the second, after puppies, that are not vaccinated.

Fig 5.1: *Percentages of pet owner and the number of dogs they had by the time of interview*



All of the respondents knew about or had heard about rabies. Almost 80% knew the critical symptom of rabies disease (i.e. madness) but did not know the stages of rabies symptoms. Failure to understand the stages of rabies disease symptoms would prevent them from comprehending the most dangerous stages of the disease. Therefore, there was a need for intensification of veterinary extension to address these gaps in knowledge.

All of respondents had heard about the rabies vaccination campaign through the public address system which was used before and during the campaign. The respondents also preferred the PA system mode of advertising instead of newspapers, radios, school children or through their leaders. These are some of their comments; "Your PA systems are more audible than that of the fruiterer'; "Even if I am not at home, my neighbours come and tell me about your advertisement" and "The behavior of my dogs illustrate that they can also hear you speaking to us". The majority of them have never been to school or rather they left school early to be able to read newspapers. The researcher tried several times to approach isiZulu newspapers to write about rabies but the reporters were less

interested in this topic than other sensitive news. Much has been written in English newspapers regarding rabies but there are few people in rural areas who can read foreign language newspaper. That is why public address system is the best tool for better communication.

All of the respondents preferred the house-to-house rabies vaccination strategy instead of the central point rabies vaccination strategy. None of the respondents had anything to contribute about ways of improving the HH campaign.

In comparing the HH campaign to other government house-to-house services, 50% of the respondents indicated that the HH campaign is service that is closest to the people and can be rendered right at their doorsteps. It should be emphasized that community involvement is critical in controlling rabies. It means that this service was rendered perfectly, without causing any financial loss to the public in terms of money or time loss. Further, it was not cumbersome except to those who cannot handle their pets. Even in that instance, there is a lifeline, of using catch-pole and catch-nets, which is done before the dog can be left unvaccinated. Therefore there is considerable effort which is done to have a pet vaccinated. Twenty-five percent said the Municipal Water Department is close to the people in terms of service delivery. Some 12.5% of the respondents felt that the Department of Housing was performing a similar service of bringing government to the people. Finally, another 12.5% said the Welfare Department is doing similar work.

5.3 Results from interviews with Animal Health Technicians

After the 1996 rabies outbreak in KwaZulu-Natal, the Animal Health Technicians deliberated and in 1997 changed from the Central Point system of rabies vaccination to the house-to-house rabies vaccination programme (pers. comm. Peens 2010). The rationale behind this shift of strategies was that these rabies outbreaks were escalating and the death of people was increasing. Therefore it was imperative to consider an alternative strategy. Since then no studies have been conducted to evaluate the practicability of the HH programme. As noted in Chapter 3, the investigation into the

practicality of the HH programme entailed semi-structured interviews with 12 Animal Health Technicians (AHT) in Durban (Peens, 2010). Rather than predetermining the indicators of practicality, this was made part of the interviews. The interviews addressed twelve key issues: the definition of HH campaigns, and measurement of practicality.

5.3.1 Definition of HH campaign

Eighty-eight percent of the AHTs identified the element of a HH campaign as being the initiative of the AHT rather than of the pet owner in order to have the maximum number of dogs vaccinated; it may include walking to the houses that have dogs. Ten percent of the respondents argued that the programme should not be called 'house-to-house' but 'street-to-street' (SS) rabies vaccination programme where the AHT would go to a point in a street and the pet owners bring the dog to the AHT. They cited the reason that the community will be spoiled and the exercise will be time-consuming and impracticable. They advocated that the contact between technicians and the public should take place in the street and end there. This small percentage was vocal against house-to-house rabies vaccination strategy. They further argued that the behaviour pattern of domesticated dogs is that they become more aggressive in their own territory which then makes vaccination difficult.

All the respondents agreed that the disease control (public health) is the purpose of practicing the HH system. The AHT's point of departure was that community empowerment referred to the developmental suggestion of helping people to help themselves. In this instance, the pet-owners need only be aware of the dangers of the rabies disease and thereby are willing to have their animals vaccinated. The actual vaccination is carried out by the Department, not by the owner. They argued that the Department is responsible for controlling enzootic diseases and the pet owners are meant to participate by cooperating.

The AHTs were asked to identify the main focus of the AHT's involvement in the HH approach. Forty percent indicated that the main focus was to facilitate rabies vaccination only. Fifteen percent of the respondents indicated that the main focus was veterinary

extension. Twenty-five percent indicated that the main purpose was controlling of the rabies disease through a combination of vaccination and extension. None of the AHTs saw capacity building or facilitation among the pet owners as part of the HH programme. Research has some surprises as this is against what was said previously. The main focus before was based on community development. The findings on this study shifted away from that notion although this was not a key finding.

The majority, 78% of the respondents, said the fundamental benefit of HH is to provide effective veterinary services to the public. While they recognize the benefit of establishing a joint working relationship with the pet owners, at present this is not possible as there is a significant shortage of staff. Therefore, provision of extension services is almost non-existent except the limited communication with the community through the public address system which offers no two-way communication, which is a prerequisite of extension. This is one of the difficulties of carrying out a robust HH campaigns as awareness campaigns are absent from the tight yearly vaccination schedules.

The AHTs identified a number of other constraints. The main difficulty of carrying out HH vaccinations is the lack of commitment from some sectors of the community. Some pet owners regard AHTs as outsiders who invade their privacy and cause a nuisance by making a noise with their PA system. Some expect AHTs to handle the dogs for them while they sit back. Women in the households where dogs are where vaccinated often regard handling of dogs as the responsibility of menfolk or boys and are thus unwilling to cooperate. Sometimes gender aspects come to the fore when the male household head, according to tradition, is controlling every aspect of livestock and pet keeping at home. One finds that during the absence of the male head at the house no-one will handle the dog without permission. However, resistance towards rabies vaccination is very low and this is attributed to Departmental radio talks promoting rabies awareness. It is noted that the impact of the radio talks have not been studied and that this was merely the subjective view of the AHTs.

The AHTs indicated that the department should provide more sophisticated equipment for the proper handling of difficult animals. The HH rabies vaccination strategy is labour intensive. Therefore the department should employ more AHTs so that each and every corner of the Durban area is covered. Furthermore more staff will intensify rabies awareness campaigns which they perceive as a prerequisite for success, which in turn enhances the practicability of the HH rabies vaccination strategy. As stated in Chapter I, HH is repetitive and does not entail critical thinking during its implementation. Therefore it does little to promote job satisfaction.

In conclusion, the AHTs felt that the HH programme is practicable in theory. They acknowledge that the HH approach ensures greater coverage wherever it is employed. They are concerned, however, that without additional staff and equipment, the spread of the impact will be very limited as it is time consuming. But that does not constitute a paradigm shift from the effectiveness of house-to-house rabies vaccination strategy.

5.4 Vaccination coverage

One way a vaccination campaign is considered effective is if at least 70% of the dog population is vaccinated (WHO, 2005). This would require knowing the number of dogs vaccinated and the total population in the campaign area by doing sample survey. The total number of dogs in any community, such as Magabheni, should include the number of dogs kept in households plus the number of stray dogs.

It was not possible to determine the number of dogs in Magabheni. The way the Department records vaccination data does not provide enough data to extrapolate a total dog population. What is recorded is the number of dogs actually vaccinated (as recorded by the number of certificates issued). The number of households visited by the campaign is not recorded, nor is the number of dogs in the households visited by the campaign. When determining the vaccinated dogs' totals at the end of the campaign, the empty vaccine containers are counted. The estimation of the number of dogs is done on half-full bottles. The totals are then checked against the totals reflected on the certificates issued.

Ten dogs are vaccinated per each 10 ml bottle. When an accident happens and bottles are destroyed, the full bottles that were not used are counted and subtracted from the grand total to find the number of used bottles. Issuing of certificates may not be accurate when the copies are destroyed or the owner forgets to join the certificate queues. But that is a very rare occurrence as most people are scared of being legally charged if they cannot produce certificates after their dogs have bitten someone. Sometimes all these methods are used simultaneously to complement each other to calculate accurate totals. Only dogs with identifiable owners are vaccinated; feral dogs are not vaccinated and thus cannot be counted. The Animal Health Technicians reported sighting only four stray dogs. In general, the community confirmed that most dogs had identifiable owners.

In KwaZulu-Natal and part of Eastern Cape rabies virus is maintained in both stray and domestic dogs. The animals that are most affected are domestic dogs and cats. Almost everyone that has ever infected with rabies in KwaZulu-Natal caught it from a dog that had rabies. Therefore it is crucial to vaccinate dogs. Although cats are usually vaccinated with dogs, but very few turn up during rabies vaccination. Their numbers are always insignificant. Few cats that turned up during this study have been recorded together with dogs. The appendix on Magabheni rabies vaccination illustrates this point.

During this campaign, 436 dogs were vaccinated. (See Appendix IV). A further 90 sighted or known dogs were not vaccinated for various reasons. Table 5.1 presents the range of reasons for failure to vaccinate and the corresponding number of dogs and cats.

Based on the campaign statistics, there are a minimum of 526 dogs in Magabheni. However, because the total dog population cannot be established, it cannot be determined if the campaign was effective based on the percentage covered. However, according to WHO (2005) again, if there is no rabies outbreak in 28 days after completion of a vaccination campaign, the campaigns is considered effective (Dodet *et. al*., 2001).

Table 5.1: Reasons and number of dogs not vaccinated

Reasons for dogs why dogs were not vaccinated	Number of dogs
Unable to handle the dogs	20
Households were too busy or engaged	16
Dogs have been vaccinated recently	1
Owners thought their dogs were too young	36
Non-availability at the time of vaccination	4
Dog lactating	1
Mistrust of government vets	8
Feral dogs (Stray dogs)	4
Total	90

Thus, using the latter standard, the 2009 Magabheni campaign is considered effective as, according to the Department, there has not been a rabies outbreak since the campaign. Carter (1997), estimated that the average number of dogs per each household is three but that has no source. It is anticipated that in the near future that a survey should be undertaken to alleviate any doubt about it. The statistics of Magabheni population has been included in this study to have an estimation of coverage of the area. According to WHO (2013), the human: dog ratio has been recorded as 6.5:1 in the tribal and informal land areas of KwaZulu-Natal.

The human: dog ratio is fluid as there is no standard benchmark or formula for its calculation. Further, there are very few studies of dog population sizes reported for eastern and southern Africa (Hergett, 2013). Using the estimated range of dog: human ratios of 1:8 - 1:11 presented by Bögel *et. al.* (1982), Perry (1993) calculated the dog population sizes of Kenya, Tanzania and Malawi for 1990, using projected human population figures of the World Bank (1986). These were estimated to be 2.3 - 3.2 million (Kenya), 2.5 - 3.4 million (Tanzania) and 0.73 - 1.0 million (Malawi). When compared to rabies vaccine issue statistics published for the three countries (Luusah, 1988; Machuva, 1988; Msiska, 1988), estimated vaccination coverage rates of 2.4% (1979), 3.9% (1988) and 5.0% (1987) were calculated for Kenya, Tanzania and Malawi, respectively (Perry, 1993).

However, the most comprehensive study to date of dog population size at a national level in eastern and southern Africa was that of Brooks (1990), in which a full national dog census for Zimbabwe was carried out. The total dog population was found to be 1.3 million, providing an overall dog: human ratio of 1:6.3 (based on an estimated human population of Zimbabwe for 1986, the year of the dog census, of 8.5 million; World Bank, 1986). At the sub-national level, dog population sizes and dog: human ratios have been estimated in studies in South Africa and Kenya (Perry, 1993).

5.5 Cost effectiveness: A comparison of costs with the CP programme

This section presents the findings from the investigation made at Magabheni was from the key informant regarding the cost of running the HH programme.

5.5.1. Cost per dog vaccinated (HH)

Data on costs per dog vaccinated was obtained through an in-depth interview with the two key informants within the Veterinary Services Directorate. One key informant was the Project Manager for Mass Vaccination Campaigns in KwaZulu-Natal and the other key informant was the State Veterinarian for eThekwini. The findings presented as follows are an amalgamation of the data collected from these two key informants. They each responded to a checklist that was drawn up by the researcher based on secondary data regarding human resources and equipment used in rabies control (See Appendix V).

The annual cost, which expresses expenditure, applied or measured over one year, of the human resources and the equipment used in the Magabheni campaign was divided by the number of working days in a year. This established a cost per working day for the campaign. This was then multiplied by the number of days of the vaccination campaign to determine the total cost of the campaign. These calculations were based on the assumption that the capital equipment was used throughout the year. Items included in the annual costs were costs related to the 'cold chain', transportation, vehicles, community mobilization and sensitization, supervision and training of vaccinators and the salaries and allowances of the staff involved and the disposable items used in the

campaign. The cost of running the Magabheni vaccination campaign is shown in Table 5.3. Disposable costs were calculated by multiplying the number of each disposable item used during the campaign times the cost per item used. 'Annual' costs are estimates, as records are not kept for the individual costs listed in Table 5.2. They were calculated by dividing the Vet Division's annual cost for each item by the number of workdays in the year and then multiplied by the number of days for the campaign (i.e. four). The cost per dog was calculated by dividing the total costs by the number of dogs vaccinated during the campaign (i.e. 436).

Table 5.2*: Detailed breakdown of the costs of Magabheni HH campaign*

Cost Area	(R)	Vaccination cost per dog (R)
Disposables		
• (a) Syringes (32)	R14.40	R0.03
• (b) Needles (436)	R80.00	0.18
• (c) Certificates (436)	R19.68	0.05
• (d) Other stationary (4)	R05.24	0.01
Sub-total	R119.32	0.27
Annual costs		
Fuel	1752.72	04.02
Personnel	5341.00	12.25
Vaccine	701.96	01.61
Vehicle Maintenance	803.23	01.84
Capital Costs	483.96	01.11
Sub-Total	9082.87	20.83
Total cost	9209.19	R 21.12

As shown in Table 5.2, the total cost for the Magabheni vaccination campaign was R9209.19. The total cost of disposables R119.32 and the total annual costs were R9082. The campaign ran for four days; during which 436 dogs were vaccinated. Thus the cost of running the campaign was R21.12 per dog vaccinated.

The international standard for cost effective vaccinations is US$25 per dog. At a conversion rate of R7.38/US$ (Reuters, 2009), the cost of running the Magabheni Campaign was US$2.85 per dog.

It was hoped that the cost per dog under the HH campaign could be compared to the cost per dog in a CP campaign, but it was established that it would be unfair to compare the two as they differ. When the AHTs and veterinarians were interviewed they agreed that HH programme was more expensive than CP regarding equipment and efforts in its implementation. However, the state veterinarians interviewed state there is unpublished data and service delivery records which showed that the cost per dog vaccinated in CP campaigns run throughout the province in 1996 was R1.00, which is approximately R2.50 at 2009 prices. In 2012 dog vaccination costs are as little as US$ 0.50 per dog, which is R5.00 according to South African currency WHO, (2012). These prices may look cheap compared to that of HH rabies strategy, which is R21.12, but the efficiency of HH far surpass CP in coverage and the number of pets vaccinated. In concluding remarks, Cleaveland *et. al.,* (2006) and Knobel *et. Al.,* 2005 provided CP vaccination strategy cost at R13.77 and R9.59 respectively depending on the demography of the area.

The key differences in the cost per dog between the HH and CP approaches are much more hours, transport and equipment. In conducting HH system, man hours are not wasted through idling, but if there are no dogs in that area the team moves forward to the next houses with dogs. The HH being a mobile approach is more capital intensive than the CP approach, which is based in a temporary but fixed location in the community. While the cost per dog under the CP approach is significantly less than that for the HH approach, as explained in chapter 2, the CP approach is not effective in low-income areas because fewer clients avail themselves of the service and thus fewer dogs are vaccinated. According to the records available, this was the reason that the HH campaign was introduced in 1996 for its effectiveness. When it was tested at Mpumalanga's Eerstehoek Campaign the cost was R4.52 in 1997, twelve years before this study.

5.6 Summary of findings

5.6.1 The household survey

The study found that the majority of households interviewed indicated that the HH strategy was effective. They also indicated that they preferred the HH strategy to the CP strategy. The main reason they cited was that it was easier to handle and vaccinate dogs when they are at home and with the help of the AHTs. The AHTs may seem reluctant about their safety as the dog is in its environment or territory and therefore vicious dogs tend to be more aggressive. That To take their dog to the venue for a CP strategy was difficult and time consuming which acted as a deterrent to vaccinating dogs.

5.6.2 Perceptions of the Animal Health Technicians

All of the AHTs interviewed indicated that the HH strategy was effective and their perception was that it was more effective that the CP strategy. The main reason they cited was the high turnover of vaccinated dogs; more dogs were vaccinated using the HH approach. The AHTs also highlighted a number of key issues that qualify the effectiveness of the HH strategy. It is very time consuming, labour intensive, physically demanding, and the work is repetitive. Using the HH strategy exposes the AHTs to the extreme weather patterns. CP strategy is used to be carried out in public places like shopping malls, public halls, schools, libraries, public offices, parks which always provide shelters in bad weather. They felt that there were too few AHTs to get the work done. This applies to eThekwini metro where there are only twelve AHTs instead of forty-five but that is an administrative issue which can be partially solved by AHTs.. Lastly, it is said HH was dangerous when compared to the CP strategy because the nature of this strategy is to invade the dog's territory. After the introduction of the HH strategy, there were more dog bites reported than before. It is encouraging that lately, dog bites have decreased as the AHTs are used to it and there are fewer casualties compared to earlier period of its initiation. It is anticipated that the AHTs are now used to the strategy and they take great care to their safety. That does not mean that they are inefficient but they have developed good tactics of doing the job safely and efficiently.

The researcher has observed a number of issues around the implementation of the HH system; and a number of setbacks have been observed. Technicians have complained that the work is repetitive which is demotivating. Daft, (2010) says that investigation indicates that group production technologies have a tendency to create job generalization, which means that the multiplicity and degree of complication in tasks performed by a single individual are reduced. Daft, (2010) further argues that the effect is lacklustre and monotonous task that generally provides little job satisfaction. This can be somewhat reduced if the technicians are empowered. Technicians have tried to eliminate this problem by working fewer hours than before the introduction of the HH system but they intensify the coverage to achieve optimum results. Even the animals appear to adapt to the HH system, especially cats. Finally, in any given community there are innovators, early adopters, early majority, late majority and, laggards. (Hodson and Sullivan, 2002) all of which appear to affect and influence the progress of the HH programme's success or failure. Innovations are not adopted by all individuals in a social system at the same time. Instead they tend to adopt in a time sequence, and can be classified into adopter categories based upon how long it takes for them to begin using the new idea. Early adopter is a person who starts using a technology as soon as it becomes available. Late adopters are also known as late majority and they are distinguishable from other categories as they are cautious about innovations, and are reluctant to adopt until most others in their social system do so first. Laggards are part of group that are traditionalists and they are usually the last to adopt an innovation (Rogers, 2003).

Another problem observed is the time factor. Even if the date is advertised well in advance, it is impossible to give beneficiaries a specific time of the day when the technician will appear at a specific house. This poses a problem for the working people; they generally cannot take time off from work to wait for the technician to vaccinate their pets. The researcher has observed that these and related time factors all contribute to reduce participation in the HH programme.

5.6.3 Vaccination coverage

The HH campaign was found to be more effective in terms of vaccination coverage and high totals per area than CP. However, this could be established only on the basis that since the campaign was completed, there has not been another rabies outbreak in Magabheni amid high incidences of rabies outbreaks in the adjacent UGu District Municipality areas. The study was not able to establish in fact, if at least 70% of the dogs in Magabheni were vaccinated. While the current record-keeping system records the number of dogs vaccinated, it does not provide any means for determining the total number of dogs in a campaign area, which is needed to calculate percentages. Not being able to calculate the percentage covered means that the entire campaign must 'wait and see' if it was effective, instead of relying on an international standard of 70%.

5.7 Conclusions from findings

Based on the findings from the household survey, the interviews with AHTs, and the vaccination records, the HH strategy was effective in Magabheni. However, the campaign has limitations that, if addressed, might make it more effective and provide greater certainty regarding the impact of the campaign.

The three aspects that were addressed were customer satisfaction, practicality and cost. In customer satisfaction it was discovered that all respondents preferred HH to CP because of its proximity to their dwellings. The practicality of HH was measured by animal health technicians and it was discovered that although there are shortcomings, the government could intervene by addressing the staff shortage and the time factor in implementing the HH strategy. Cost effectiveness was considered bearing in mind that although HH is expensive compared to CP, HH is result intensive. Therefore it is the ideal strategy in alleviating and controlling the rabies disease.

CHAPTER 6

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The effectiveness of the House-to-house (HH) vaccination strategy in the control and elimination of rabies. The study was motivated by the fact that the KwaZulu-Natal province of South Africa has experienced serious dog rabies epidemics over the past three decades. Rabies infection of domestic and wild animals is a critical disease in third world countries such as Africa and Asia – of which South Africa is a part. This study was conducted to explore methods of controlling or totally eliminating the diseases as has been successfully achieved by Western countries. The control and elimination of rabies is dependent on rabies vaccination no other method has been developed. Several strategies have been attempted over the past decades. One of these is the House-to-house (HH) rabies vaccination strategy which is used for the control of rabies in rural areas. As rural areas are regarded as a major breeding ground of rabies, this study of the HH strategy is of particular importance; how effective is the HH vaccination strategy in controlling and eliminating rabies? The sub-questions that were raised in Chapter 1 were as follows:

1) How the HH programme compares to other vaccination programmes?
2) What are the animal health technicians' views on the practicability of the HH programme?
3) How cost-effective the HH programme is in terms of numbers of dogs vaccinated and cost of the programme?

This chapter will discuss each of the research questions in light of the findings presented in Chapter 5.

6.2 The HH vaccination programme compared to other vaccination programmes

There are various rabies control strategies that had been practiced since Louis Pasteur developed the rabies vaccine. The paradox is that rabies continues to be a public health problem a century after the development of rabies vaccine. As explained in Chapter 2, a rabies vaccination strategy does not take place in isolation. The countries that have eliminated rabies, did not carry out rabies vaccination strategies in isolation. The natural aspects such as country's topography, peninsular, national borders, to name few, played an important role in helping to eliminate rabies. South Africa and KwaZulu-Natal do not experience such nature and topography. Therefore, the identification and shaping of the vaccination strategy is critical to controlling the disease. The two main strategies for controlling rabies are: the CP strategy and the HH strategy. The HH method has been practiced extensively in controlling rabies, and this study indicates that the HH strategy is proposed to be more effective than the CP method in terms of the actual control of rabies.

Two indicators can be used to determine if a vaccination campaign strategy is successful. The first is the international benchmark set by the WHO which indicates that if a minimum of 70% of the dogs in any specified area are vaccinated, this will eliminate rabies and prevent an outbreak in that area. The second is whether, after the vaccination campaign, there is an outbreak of rabies in the campaign area.

With respect to the first indicator, as stated in Chapter 5 (Section 5.6.3), the study was not able to establish if in fact at least 70% of the dogs in Magabheni were vaccinated. While the current recordkeeping system does record the number of dogs vaccinated, it does not provide any means for determining the total number of dogs in a campaign area which is needed to calculate percentages. This study did identified 616 dogs in Magabheni Township including 526 vaccinated and 90 unvaccinated dogs. Thus 85% of the dogs were vaccinated in Magabheni Township. This is above the WHO international standard of 70%. While not entirely conclusive, the percentage coverage is indicative of a successful vaccination campaign.

More convincingly, with respect to the second indicator, there has been no outbreak of rabies since 2009 in Magabheni Township since the HH campaign was implemented and completed in 2009, it can be reasonably concluded that the HH vaccination campaign was successful and that rabies has been contained in Magabheni Township.

The study's determination of the relative efficacy of the HH strategy over other strategies was a subjective determination based on the views of the AHTs who have experience with the HH and the CP strategy – the latter being an alternative strategy used in KwaZulu-Natal. It was also based on the views of dog owners in Magabheni Township. Both the dog owners and the AHTs generally shared the perspective that the HH method was more practicable than the CP method. However, they had very different views regarding the HH method in practice. Dog owners preferred the HH method, not only because it was effective, but it was easier for them to participate and increase the likelihood of their participation. The CP method required dog owners to bring their dogs to a central point. This was often difficult, particularly if they owned more than one dog. This difficulty often influenced them not to participate in the vaccination campaign. Conversely, the HH method did not require moving the dogs as they were vaccinated at home. In this setting it was easier to handle the dogs and took less of the dog owners' time. However, they had to be at home at the time the programme reached their home which was often not the case. While the daily starting time for the campaign is generally known, it is impossible to provide each household with a specific and fixed date and time when the AHT will arrive at the homes. It depends on how long the preceding vaccination has taken. This was seen as a limitation to the HH strategy.

Although the AHTs agreed the HH method was more effective that the CP method, it was time consuming and physically tiring. Thus, from their perspective, the effectiveness was dependent on them. They felt that the workload was too heavy and clearly pointed to the need for additional AHTs to carry the workload.

6.3 Animal health technicians' views on the practicability of the HH programme

The study found that AHTs believed that although there are some challenges in implementing HH rabies vaccination strategy, the overall system is practical. As noted earlier, however, it requires more effort than the CP strategy. Further, the study exposed some limitations with the HH system. The main problem is that it is labour intensive and staff shortages in the department made it a difficult method to implement. Furthermore, AHTs expressed concern regarding the long hours spent doing repetitive work. They said this could be overcome by employing more technicians which could result in a 100% vaccination rate.

They AHTs noted that the HH campaign could be more effective if the extension service was intensified. This would create greater awareness of the importance of controlling rabies and increase the level of participation on the part of dog owners.

6.4 The cost-effectiveness of the HH programme in terms of numbers of dogs vaccinated and cost of the programme

As explained in Chapter four the study determined that the cost of vaccinating each dog using the HH strategy was $2.20 per dog vaccinated. This is below the international standard of $25 per dog established by the WHO. The HH strategy is, thus, potentially cost effective and leaves considerable room for increasing the workforce as suggested by the AHTs and still remain cost-effective. This is achievable as rabies is heavily subsidized by the government and international donors.

6.5 Conclusions and Reflection on findings

The study indicates that, based on the three key questions of comparative effectiveness, the views of the AHTs and cost factors, the HH rabies vaccination strategy is effective. It has a number of limitations that need to be addressed to assure and increasing its

effectiveness. The findings of this study point to two additional areas of learning: the dependence on the cooperation of dog owners; and the need for an awareness campaign prior to the vaccination campaigns.

6.5.1. Dependence on the cooperation of dog owners

A key factor in the success of any rabies vaccination campaign is the cooperation of dog owners and the practical possibility of actually vaccinating dogs. The long held perception among AHTs was that the largest percentage of dogs that were not vaccinated comprised dogs belonging to those individuals who refused to have any of their animals vaccinated. However, this study has changed this perception.

In 81% of the households interviewed, at least one dog was not vaccinated; leaving 89 unvaccinated dogs . In all but one case, there was a single reason for not vaccinating the resident dog(s). In one household two reasons were established. This illustrates that in practicing HH vaccination strategy dogs that are left without vaccination per each household are still a problem. But that cannot be compared to CP strategy where one finds that the half of the area is not attended to. In this study the reasons for not vaccination was spelt out.

With respect to the 89 dogs that were not vaccinated from the households in this study, various reasons for not vaccinating were given. Among those dogs that were not vaccinated, 40% were dogs whose owners felt they were too young (3 months to 1 year old) to be vaccinated. Twenty-one percent were dogs that could not be handled for some reasons, and 18% were dogs whose owners were absent or otherwise engaged. The rest of the dogs that were not vaccinated as the owners did not trust the state vets (9%), the dogs were feral (4%), the dogs were not available (4%), the dogs had been recently vaccinated (1%) or the dogs were lactating (1%). It anticipated that this is the indication of the need of awareness campaigns and more rabies education.

It is of concern that the most common reason for failure to vaccinate a dog was that it could not be handled. This highlights the importance of the envisaged relationship between the owners and dog(s) to the success of vaccination campaigns as vaccinations depend on the help of the owner and ability to handle dog(s). This would most likely be reflected in CP campaigns and requires serious consideration in planning future HH campaigns. It should be envisaged that dogs that that come to the venues in case of CP, are usually dogs that can be handled easily by the owners but there are those that follow at a distance and keep that distance between the dog and the owner. This is an important point which is an essence of controlling rabies.

Of perhaps greater concern is the conscious choice of dog owners not to have their dogs vaccinated. Reasons for non-vaccination, include three stand out as reflecting dog owners' attitudes: households were too busy; dogs were considered too young; and mistrust of government vets. Of these, the most common reason why dogs were not vaccinated was because the owners believed the dogs were too young (26%). This needs to be taken into consideration when planning future vaccination campaigns. It is of value to note, however, that until February 2011, it was common practice of the Department not to vaccinate puppies under the age of three months. However, recent training has changed this and a new standard (based on an international standard) is now being implemented where puppies should be vaccinated from birth. This new standard will have to be communicated to dog owners in South Africa. Furthermore, it has not yet codified to become official government regulation.

6.5.2. The need of awareness campaigns

As has been mentioned earlier, rabies can be eliminated or eradicated even in wildlife, but to achieve this requires a change in the attitudes of people towards the rabies disease. The attitudes expressed by a significant percentage of the dog owners who participated in this suggests that while the vaccination campaign itself may be generally effective in containing rabies, the process could be facilitated through greater awareness on the part

of dog owners. The AHTs should play a bigger role in facilitating these awareness campaigns by taking part in rendering of extension and education about rabies.

The attitudes leading to puppies not being vaccinated, to being 'too busy' at the time of the campaign and not trusting state vets are all issues that indicate a lack of awareness of the importance of controlling rabies. They also point to the need for building greater trust between the Department and dog owners. Thus, before designing a vaccination campaign, it may be necessary to conduct a more comprehensive awareness campaign to overcome the misunderstanding.

The study further suggests that as rabies outbreaks are more sporadic in nature compared to some infectious diseases such as AIDS, or cholera, people do not see imminent danger of the disease. Therefore, besides the awareness, an on-going rabies education and extension should be embarked upon.

6.6 Recommendations

This study suggests a number of recommendations to improve the effectiveness of HH rabies vaccination campaigns.

6.6.1 Determining the percentage of dogs vaccinated

The study found that the current recordkeeping system does not provide a means for establishing the total number of dogs in a campaign area. Thus it is impossible to determine if the international standard of 70% coverage is actually achieved. Therefore, it is recommended that the record system be improved to include a method for determining the total dog population in a given campaign area. It is further recommended that rural areas should be visited and dog census should be done. This should not be a once-off exercise as there should be a recording of increasing and decreasing trends in dog population such as births, deaths and movement of dogs from area to area. This exercise should precede rabies vaccination campaign. Diseases with high mortality rates like

biliary fever, distemper and parvo virus should be closely monitored in order to record the massive decrease in dog population. All the above should be done if there is more staff members but, community based individuals like hunters can be organized to help in monitoring the situation in each area.

6.6.2 Pre-campaign awareness programmes

To improve cooperation of dog owners at the time of vaccination campaigns, and to overcome misconception regarding rabies vaccinations, it is recommended that an intensive awareness campaign be designed and implemented prior to the vaccination campaign. Radio talks that are currently being broadcast should be augmented by face-to-face and two way communications with dog owners. The incorporation of communication and training divisions together with veterinary division in the department should be at the forefront in leading these campaigns. The public address system currently used should be continued, but not relied on as the primary means of creating awareness.

6.6.3 Dealing with feral dogs

The study highlighted the issue of feral dogs. The HH method does not deal with feral dogs, but is perhaps in a better position to do so than the CP method. When practicing HH strategy all areas are covered and some dynamics can be observed while the AHTs are driving all over the area vaccinating dogs. It is recommended that a policy and procedure be developed for including the vaccination of feral dogs in any given HH campaign. I recommend that oral vaccination should be introduced in South Africa to ensure that more dogs are vaccinated.

6.6.4 Veterinary extension

Although it was not a specific aspect of this study, another factor that should be taken into account is veterinary extension. In the 1980s and early 1990s, extension was part and

parcel of veterinary directorate and included in Animal Health Diploma curriculum. It appears that not much has been done in this field, and the study suggests that without good extension, which serves as a bridge of knowledge between the scientists and the community, good rabies strategies will be undermined. In the veterinary fraternity the use of a public address system appears to be regarded as extension, but this method is a one way-communication that does not meaningfully engage the dog owner and does not incorporate local specific social and cultural factors which might impact on the vaccination campaign. Issues of illiteracy and cultural beliefs can contribute negatively to rabies control. It is recommended that a participatory extension approach be used in to understand dog owners and to learn how best to engage them with the issues regarding rabies.

6.7 Further research

The findings of this study highlighted the need for additional research to improve the overall effectiveness of efforts to control and eradicate rabies.

6.7.1 Impact on rabies outbreaks by dogs from outside the campaign area

This study did not investigate the impact of rabies carriers coming into an area after a vaccination campaign has been completed. Such a study would include the distances that can be travelled by dogs after being infected by the rabies virus. The common belief among the AHTs, based on advice from state vets is that a rabies infected dog can travel up to 25 kilometres. Such a study would help in understanding the epidemiology of the rabies disease.

Related to this is the relationship between low-density dog population areas and high-density dog populations. In some low-density populations, rabies infection may not persist on its own, but may instead result from sporadic spill over from endemic higher density populations. If endemic infection in high-density populations can be eliminated

through mass vaccination, this may mitigate the need to vaccinate in very low-density populations that are relatively inaccessible and where costs of control are high. This is an important area for future research which could considerably reduce the costs of long-term national rabies elimination. The socio-economics of the area should be taken into consideration. For example, houses that are well-fenced provide security to pets from outside invasion of rabid animals.

6.7.2 The cost-effectiveness of increasing the number of AHTs and upgrading equipment

The AHTs included in this study suggested that they were too few to be able to be truly effective in containing rabies. This view was not tested in this study, but is worthy of investigation. Thus, it is recommended that thorough research be conducted with a view to establishing a benchmark for AHT posts relative to the need for rabies control. But this is an administrative issue which can be communicated to the appropriate division.

Similarly, the question of vaccination equipment should be studied. The AHTs raised issues of there being too little equipment and the equipment being difficult to use in the HH campaign. This should be investigated with a view to equip AHTs with means of assisting pet owners in handling pets during the campaign.

6.7.3 Frequency of campaigns

One of the critical factors for the sustainability of vaccination programmes is their affordability by third world countries. For rabies, the question of frequency of vaccination campaigns to maintain critical coverage levels required to prevent rabies outbreaks and eliminate endemic infections is likely to be important. How often campaign should be carried out should depend on the dynamics of each area. Research into this would help create realistic plans and budgets. Such research would need to include turnover rates of dog populations relative to vaccination coverage.

6.8 Conclusions

In conclusion it is critical that the HH programme compared to other vaccination programmes as sometimes programmes should conform to geographical areas and to certain class of society. CP strategy should still be considered but could be improved and practised in high income areas, where people can afford to bring their pets to the venues. CP strategy can be used by the state to save funding for HH vaccination strategy. However, most of the time only people on the upper echelons that usually hold seminars on rabies, leaving AHTs to carry out spadework, without informing them about the outcomes of those meetings. The cost-effectiveness of the HH programme is its salient feature of numbers of dogs vaccinated and cost of the programme. Reflection on findings should recognize dependence and the cooperation of dog owners. Rabies is 100% preventable and there is a belief in the notion that prevention starts with the animal owner (Bill and Murphy, 2012).

There is a need of awareness campaigns to determine the percentage of dogs vaccinated. Feral dogs are still a problem in keeping rabies disease in its present form. Furthermore the issue that is no more practised is veterinary extension which will enable AHTs to pass rabies knowledge to the populace. Further researches should be conducted on the disease especially behavioural studies. Animal Health Technicians have a task of ensuring that rabies is eliminated or drastically controlled to fulfil Pasteur's work of improving public health as rabies is a zoonotic disease. Seminars and symposiums for decision-makers, civic organisations, academics, and communities should be held countrywide. Rabies Indaba, which will include all role-players, should be convened to find the African solution to rabies epidemic. World Rabies Day which takes place each year on 28 September, the anniversary of the death of Louis Pasteur who, with the collaboration of his colleagues, developed the first efficacious rabies vaccine should be commemorated. World Rabies Day aims to raise awareness about the impact of rabies on humans and animals, provide information and advice on how to prevent the disease, and how individuals and organizations can help eliminate the main global sources.

Lastly, steps should be taken to replicate the HH approach in other provinces through the following means;

- This strategy should be debated in bi-annual Animal Health Technician Association's congress, where AHTs from all provinces meet to discuss work-related issues.
- Share the findings of this study with relevant structures in each province.
- Sending the findings to other stakeholders such as Rabies Alliance, which is an international civic organization, with the aim of developing and adopting strategies that will help in controlling rabies?
- Consultation with national Department of Agriculture, Forestry and Fisheries should be encouraged to develop policy guidelines for rabies control that include HH as a national strategy.

REFERENCES

Abbott, M. L., and McKinney, J. A. 2013. *Understanding and Applying Research Design*, A John Wiley and Sons, Inc., Publication. Hoboken. New Jersey.

Adams, F. C., Futuzzo, M., Freese, K., Tarle, G. and Watkins, R. 1982. *Extension of the Parker Bound on the Influx of Magnetic Monopolies.* University of Chicago Astrophysics Centre: USA.

Adam, H., and Moodley, K. 1993. *The Opening of the Apartheid Mind Options for the New South Africa*, University of California Press, Berkely and LOS Angeles. California.

Amir, P. and Knipscheer, H. C. 2009. *Communicating with Rural Communities to Improve Quality of life.* http://onlinelibrary.wiley.com/doi: [Accessed on the 23 July 2009].

Animal Health in the Americas. 93. Proceedings of the III Inter-American Meeting, at the Ministerial Level, on Animal Health, Washington, D.C., 11-14 April 1983. 1984, Washington, D. C.; Pan American Health Organisation, Pan American Sanitary Bureau, Regional Office of the World Health Organisation, ix, 156 p.

Annual Checkup and Vaccination Manual. 2009. Aloe Veterinary Clinic. www.aloevets.co.za [Accessed 24 October 2010].

Annual Report – Veterinary Services (1 April 1989 – 31 March 1990)
http://www.nda.agric.co.za [accessed on 24 October 2013]

Annual Report – Veterinary Services (1 April 2011 – 31 March 2012)
http://www.nda.agric.co.za [Accessed on 28 August 2013]

Auth, P. C. and Kerstein, M. D. 2012 *Physician Assistant Review*, Lippincott Williams and Wilkins, a Wolters Kluwers. Philadelphia.USA.

Baer, G. M. 1991. *The Natural History of Rabies***,** CRC Press: USA.

Baer, G. M., Neville, J. and Turner, G. S. 1996. *Rabbis and Rabies: A Pictorial History of Rabies through the Ages.* Laboratorios Baer, S.A. DE C.V.: Mexico.

Banister, P. 1994. *Qualitative Methods in Psychology: A Research Guide.* Open University Press: Buckingham, UK.

Barnard, R. 2007. *Apartheid and beyond: South African Writers and Politics*. Oxford University Press.

Barrett, J., Briggs, D., Cliquet, F., Fooks, A.R., Lumlertdacha, B., Meslin, F. X., Müler, T., Nel, L. H., Schneider, C., Tordo, N., and Wandeler, A. I. 2009. *Human epidemiology of rabies in South Africa.* Presentation at Rabies seminar 22 September 2009. Centre for Infectious Diseases. Stellenbosch. South Africa.

Belotto, A. J. 1987. *Rabies – An Epidemiological Study of Human exposure in Brazil*. Department of Tropical Hygiene, London School of Hygiene and Tropical Medicine. University of London: London (Unpublished Thesis).

Bembridge, T. J. 1991. *The practice of Agricultural Extension* – A training Manual. Development Bank of Southern Africa: Halfway House.

Bennet, R. 2005. *Dog Day-care: A blueprint for Success* Dogwise Publishing. USA.

Benoir, J., Harrison J. Q. and Baxter, M. 1984. *Agricultural Extension- The training and visit system.* World Bank: USA.

Biggs. H. C. 2003. *The Kruger Experience: Ecology And Management Of Savanna Heterogeneity,* Island Press. USA.

Bishop, G. C. 1999. *Rabies.* Unpublished Data.

Bishop, G. C., Dunheim, D. N., Kloek, P. E., Godlonton, J. D., Bingham, J., Speare, R. and the Rabies Advisory Group. 2003. *Rabies: Guide for the Medical Veterinary and Allied Professions.* Government Printer: Pretoria.

Bleck, T. P. and Rupprecht C. E. 2005. Rhaddoviruses. In: Mandell, G. L., Bennett, J. E., Dolin, R. (Eds). In: *Principles of Infectious Diseases*, 6th ed. Churchill Livingstone. Philadelphia, pp 2047-2056. 6th ed

Bögel, K. 1987. *Guidelines for Dog Rabies Control***,** Veterinary Public Health Unit, Division of Communicable Diseases, WHO: Geneva.

Bögel, K., Andral, L., Beran, G., Schneider, L.G. and Wandeler, A.I., 1982. *Dog rabies elimination: a trend analysis and programme proposal*, prepared by a WHO working group. International Journal of Zoonoses

Brooks, R., 1990. *Survey of the dog population of Zimbabwe and its level of rabies vaccination.* Veterinary Record.

Brass DA: *Airborne transmission of rabies virus. Rabies in bats: Natural history and public health implications.* 1994. Livia Press Ridgefield, Conn 169-175

Brown, K. 2011. *Mad Dogs and Meerkats: A History of Resurgent Rabies in Southern Africa*, Ohio University Press series in ecology and history: Athens

Bryant, T. 2005. *The life & Times of Hammurabi.* Bear: Mitchell Lane Publishers. http://www.commonlaw.com/Hammurabi.html (Retrieved on 27th July, 2009)

Burgos-Caceres, S., 2011: *Canine Rabies: A Looming Threat to Public Health.* Chicago

Buss, D. M. 1994. *The Evolution of Desire*. New York: Basic Books.

Cantor, N. F. and Schneider, R. I. 1967. *How to study history*. Thomas Y. Crowell: New York.

Cargan, L. 2007. *Doing Social Research* Rowman & Littlefield Publishers. United Kingdom.

Carla, W. 2012. *Qualitative Interpretation and Analysis in Psychology* Open University Press. UK.

Carlyle, R. C. 2012. *Containing Rabies Outbreaks in South Africa's KwaZulu-Natal Province,* The Disease Daily Jun 20, 2012. HealthMap.

Carter, R. 1997. *Verbal Communication on Rabid Dog's Behaviour,* Former Deputy Director of Veterinary Services, Pietermaritzburg.

Cherry, K. 2013. *What is self-actualization? The role it plays in the Hierarchy of Needs,* http:// psychology.about.com/od/theoriespersonality/a/hierarchy needs_2.htm. [Retrieved March 8 2014].

Chenoweth, H. D., 2002 *Evaluating Worksite Health Promotion*, Library of Congress Cataloging-In-Publication. Leeds. UK.

Child, K. 2013. *KZN's Rabies Success Story*, Timeslive, 2013, September 30.

Childs, J. E., Mackenzie, J. S., and Richt, J. A. (Eds). 2007. *Wildlife and Emerging Zoonotic Disease: The Biology, Circumstances and Consequences of Cross-Species Transmission,* Springer Berlin Heidelberg. New York.

Chuma, E., Hagmann, J. and Murwira, K. 1996. *Improving the output of Agricultural Extension and research through participatory innovation development and extension experiences from Zimbabwe.* European Journal of Agricultural Education and Extension. 1996, vol. 2, no 4: 15 - 23

Clarke, E. and Jacyana, L. S. 1992. *Nineteenth-Century Origins of Neuroscientific Concepts*. University Presses of California: Columbia and Princeton.

Clark, G. C. 1985. *Extension methods involving community organization and local involvement,* Kingston Canada: Agricultural Extension Research and Development Conference papers.

Cleaveland, S., Kaare, M., Knobel, D. L., and Laurenson, M. K. 2006. *Canine*

*Vaccination: Providing Broader Benefits for Disease Contro*l, Elsevier. USA.

Cleaveland, S., Fèvre, E. M., Kaare, M. and Coleman, P. G. 2002. *Estimating human rabies mortality in the United Republic of Tanzania from dog bite injuries.* Bulletin of the World Health Organization 2002; 80(4): 304-10.

Cleaveland, S. Royal Society of Tropical Medicine and Hygiene meeting at Manson House, London, 20 March 1997. 1998. *Epidemiology and Control of Rabies. The growing problem of rabies in Africa.* Trans R Soc Trop Med Hyg.1998 Mar-April, 92 (2): 131-4.

Coetzee, P. 2006. *Molecular Epidemiology of Canid borne-rabies in KwaZulu-Natal,* University of Pretoria (Unpublished Thesis).

Coetzee, P., and Nel, L. N. 2007. *Emerging Epidemic dog rabies in Coastal South Africa: A molecular Epidemiological Analysis,* Department of Microbiology and Plant Pathology, University of Pretoria 0001. South Africa.

Coetzer, J. A. W., Swanepoel, R., Thompson, G. R. and Tuskin, R. C. 1994. *Infectious Diseases of Livestock with Special Reference to Southern Africa*. Oxford University Press: New York.

Cohen, C., Sartorius, B., Sabeta, C., Zulu, G., Paweska, J., and Moqoswane, M. 2007 *Epidemiology and Molecular Virus Characterization of Re-emerging Infectious Diseases, Rabies, South Africa* Emerg Infect Dis 2007;13:1879–8

Coker, R., Atun, R., McKee, M. 2008. *Health Systems and the Challenge of Communicable Diseases,* Open University Press, McGraw-Hill Education. England.

Collinge, S. K. and Ray, C. 2006. *Disease Ecology: Community Structure and pathogen dynamics***.** Oxford University Press: New York.

Community Development Resource Association (CDR) 2004. *Emergence from the inside out.* [WWW Document] URL: http://www.cdra.org.za/AnnualRep/2004.Doc [Accessed 19 May 2010].

Corn, J. l., Jaime, R., Me´ Ndez, A., Edmundo, E., and Catala´, N. 2003. *Evaluation of Baits for Delivery of Oral Rabies Vaccine to Dogs in Guatemala.* The American Journal of Tropical Medicine and Hygiene 69(2): 155-8. USA.

Cotrans, R. S., Kumar, V. and Fausto, N. 2005. *Pathologic Basis of Disease* (7th Ed.). Elsevier/Saunders: St. Louis.

Creswell, J. W. 2003. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches,* Sage Publications Inc. California. USA.

Daft, R. L. 2010. *Organisation Theory and Design* (10th Edition) South Western, Cengage Learning. USA.

Delahay, R. J., Smith, G. C., Hutchings, M. R. 2009. *Management of Disease in Wild Mammals,* Springer. New York Denscombe, M. 1998. *The Good Research Guide: for Small-scale Social Research Projects,* Open University Press: Buckingham.

Denscombe, M. 1998. *The Good Research Guide* for small-scale social research projects, Second Edition. Open University Press. Maidenhead. Philadelphia.

Dlamini, S. 2013. *Verbal communication on history of Magabheni,* Former chairperson of eThekwini Livestock Association

Dodet, B., Meslin, E., and Heseltine, E. 2001. *Rabies Control in Asia:* Symposium Preceding 5-9 March 2001, Hanoi. Vietnam. John Library Eurotext, England.

Dovers, S., Edgecombe, R., Guest, B. 2002. *South Africa's Environmental History: Cases & Comparison.* David Philip Publishers. Claremont.

Drew, W. L. 2004. *Rabies.* In Ryan KJ, Ray CG (editors). *Sherris Medical Microbiology* (4th Ed.). McGraw Hill: Singapore.

Dubos, R. J. 2007. *Louis Pasteur* – Free Lance Science.

Duffy P. 2011. *Environmental Impact Assessment (EIA) training for sustainable agriculture and rural development: lessons and experience from Cambodia, Part 2,* Disaster Risk Reduction. Djibouti.

Encyclopaedia Britannica Book of the Year. 2013. *Statistics of South Africa Population Census 2001,* Chicago Encyclopaedia Britannica. USA.

Encyclopaedia of Life Sciences (ELS). 2002. Nature Publishing Group: New York.

2012/13 *Annual Report,* Published in The Republic Of South Africa, Department of Agriculture and Environmental Affairs. ISBN 978-621-42191-0. PR 267/2013: 57-58

Evans, A. S., and Kaslow, R. A. 1979. *Viral Infections of Humans: Epidemiology and Control, Volume 813.* Plenum Publishing Corporation: New York.

Farlan, E. 1987. *Spacing and Social Organization: Urban Stray dogs revisited.* Elsevier Science Publishers B. V. Amsterdam: Netherlands.

Farm Animal Welfare Council (FAWC**)** 2009. *Five Freedoms*: Available at http:// www.fawc.org.uk/freedoms.htm). [Accessed on 28 August 2009.].

Finley, D. 1998. *Mad Dogs: The New Rabies Plague,* A & M University Press: Texas.

Fleming, D. and Hunt, D. 2000. *Biological Safety: Principles and Practices* Third Edition. Eds. ASM Press: USA.

Fooks, C. 2005. *Health human resources planning in an interdisciplinary care environment: To dream the impossible dream?* Canadian Journal of Nursing Leadership, 18 (3).

Francis, J. and Sibanda, S. 2001. *Participatory Action Research Experiences in Small Holder Dairy Farming in Zimbabwe:* Livestock Research for Rural Development.

Friis, R. F. 2012. *The Praeger Handbook of Environmental Health*, Volume One, Library of Congress Cataloging-in-Publication Data. California. USA.

Garcia-Alvarez, L., Dawson, S., Cookson, B., and Hawkey, P. 2012. *Working Across the Veterinary and Human Health Sectors*, Journal of Antimicrobial Chemotherapy. Volume 69, Issue Suppl. Oxford Journals. UK.

Green, J. S. and Woodruff, R. A. 1993. *United States. Animal and Plant Health Inspection Service* U.S. Dept. of Agriculture, Animal and Plant Health Inspection Service, 1993

Gould, J. 2010. *Left behind: Rural Zambia in the Third Republic*, Lembani Trust. Lusaka, Zambia.

Government Gazette 32234. 2009. *Animal Diseases Regulations*, Amendment Gazette 9073, Government Notice 558 Vol. 527. Government Printing: 43-79. Pretoria [Accessed 22 May 2009].

Gummow, B., Roefs, Y. A. A., and de Klerk, G. 2010. *Rabies in South Africa between 1993 and 2005 – what has been achieved?* Journal of South African Veterinary Association (2010) 81 (1): 16-21 (En).

Hawkins, H. S. and Van den Ban, A. W. 1996. *Agricultural Extension*. Blackwell Science: London.

Hergett, M., and Nel, L. H. 2013. *Dog Bite Histories and Response to Incidents in Canine Rabies – enzootic KwaZulu-Natal, South Africa*, PLOS Neglected Tropical Diseases. A Peer Review Open Access Journal. US National Library of Medicine National Institute of Health.

Hodson, R. and Sullivan, T. 2002. *The Social Organisation of Work* Thomson Higher Education: Belmont. USA.

Hofmeyr, M., Hofmeyr, D., Nel, L. and Bingham, J. 2004. *A second outbreak of rabies in African wild dogs* (*Lycaon pictus*) in Madikwe Game Reserve, South Africa,

demonstrating the efficacy of vaccination against natural rabies challenge. Cambridge Journals. Animal Conservation, 7: 193–198.

Illinois Raptor Centre (IRC). 2002. *Rabies Risks and Responsibilities*. Illinois Department of Public Health Memorandum on Rabies.

India Annual report 2009/10. Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Government of India. New Delhi. Annexure XIV.

Jackson, A. C. 2013. *Rabies; Scientific Basis of the Disease and its Management*, 3rd Edition, Academic Press is an imprint of Elsevier. San Diego USA.

Jekel, J. F., Katz, D. L., Elmore, J. G., and Wild, D. 2007. *Epidemiology, Biostatistics and Preventative Medicine*, Third Edition, Saunders, an imprint of Elsevier, Philadelphia. USA.

Jones, E. G. 2003. *Rural Development and Agricultural Extension.* A Sociology View.

Kaare, M., Lembo, T., Hampson, K., Ernest, E., Estes, A., Mentzel C., Packer C. and Cleaveland S. (in press) 2007. *Rabies control strategies in rural Tanzania*. Onderstepoort Journal of Veterinary Research. Pretoria.

Kaplan, C., Tuner, G. S. and Warrell, D. A. 1987. *Rabies: The facts*. Oxford University Press: New York.

Kaplan, C. (Editor) 1977. *Rabies the Facts*, Oxford University Press. Corgi paperback edition: Great Britain.

Kazez, J. 2010. *Animal kind: What We Owe to Animals*, John Wiley & Sons. United Kingdom.

Kepe, T., and Ntsebenza, L. 2011. *Rural Resistance in South Africa*: The Mpondo Revolts after Fifty Years, IDC Publishers. Leiden. Netherlands.

King, M. 1957. *In: American Association for the Advancement of Science*, Volume F25. University of Michigan

Kisterman, L. 2008. *Rabies*, Marshall Cavendish Benchmark: New York.

Knobel, D. L., Cleaveland, S., Coleman, P. G., Ferve, E. M., Meltzer, M. I., Miranda, M. E. G., Shaw, A., Zinsstag, J., and Meslin, F. 2005. *Re-Evaluating the Burden of Rabies in Africa and Asia*, Bulletin of the World Health Organisation, Geneva 83: 360-368.

Koocher, G. P. and Keith-Spiegel, P. 1998. *Ethics in Psychology and the Mental Health Profession: Standards and Cases*, Oxford University Press. New York.

Koprowski, H. 1985. *World's debt to Pasteur: proceedings of a centennial symposium commemorating the first rabies vaccination held at the Children's Hospital of Philadelphia, January 17-18, 1985.* Liss: New York.

Kothari, C. R. 2004. *Research Methodology: Methods and Techniques*, 2nd Edition. New Age International (Pty) Ltd Publishers. New Delhi.

Kramer, A. R. 2007. *From the Past to the 21st Century*, Published in Volume 21-Wister Institute: Philadelphia.

Kumar, R. 2011. *Research Methodology: A Step-by-Step Guide for Beginners*, SAGE Publications Ltd. London.

KwaZulu-Natal Veterinary Annual Report, 1998

KwaZulu-Natal Veterinary Annual Report, 1996/97

KwaZulu-Natal Veterinary Annual Report 1997/98

KZN DAERD. 2006. *Monthly Rabies Report* September 2006.

Lazlo, E. 1983 *Systems Science and World Order*. Pergammon Press, New York: USA.

Lembo, T., Hempson, K., Kaare, M. T., Ernest, E., Knobe, D., Kazwala, R. R., Haydon, D. T., Cleveland, S. 2010. *The Feasibility of Canine Rabies Elimination in Africa: Dispelling Doubts with Data*, Centre for Disease Control and Prevention, United States of America. PLOS Neglected Tropical Diseases. February 2010. Volume 4. Issue 2.

Lincoln, Y. S., and Guba, E. G. 1985. *Naturalistic Inquiry*. Beverly Hills, CA: Sage Publications, Inc.

Louw, D. A. and Edwards, D. J. A. 1995. *Psychology: An Introduction for Students in Southern Africa.* Lexicon Publishers: Johannesburg.

Lundy, K. C. and Sharyn, J. 2003. *Essentials of Community-Based Nursing*, Jones and Bartlett Publishers, Inc. London

Luusah, C.D., 1988. *Rabies control in the Republic of Kenya.* In: Proceedings of the International Conference on Epidemiology Control and Prevention of Rabies and Brucellosis in Eastern and Southern African Countries, Fondation Marcel Mérieux, Lyon

McCrindle, C. M. E. 1994. *Communicating with rural communities to improve quality of life***.** University of Pretoria: South Africa (Unpublished Paper).

Machuva, P., 1988. *Rabies in Tanzania*. In: Proceedings of the International Conference on Epidemiology Control and Prevention of Rabies and Brucellosis in Eastern and Southern African Countries, Fondation Marcel Mérieux, Lyon,

McKaizer, E. 2013. *A Bantu in my Bathroom*, Bookstorm. South Africa.

Maclachian, N. J., and Dubovi, E. 2011. *Fenner's Veterinary Virology,* Academic Press, San Diego. USA.

Magubane, B. M. 1994. *Reflections on the Challenges Confronting Post-Apartheid South Africa,* This paper was presented at a Conference on Struggles against Poverty, Unemployment and Social Exclusion: Public Policies, Popular Action and Social Development, organised by UNESCO in Bologna Italy in collaboration with the University of Bologna and the City of Bologna, 2-3 December 1994.

Maindonald, J., and John Braun, W. 2010. *Data Analyisis and Graphics Using R: An Example-Based Approach,* Cambridge University Press. UK.

Malerczyk, C, Nel, L, H, Gniel, D, Blumberg, L. 2010. *Rabies in South Africa and the FIFA World Cup-Travelers' awareness for an endemic but neglected disease*. Medical Affairs Middle East and Africa, University of Pretoria, South Africa

Margolis, J. M., Stephen, S. J., Bong-Chul Chu., Eberechukwu, O., Kyle, H., Jose, A., Joseph, G.R. and Mullins, D. C. 2006. *Effects of a Medicaid Prior Authorization Policy for Pregabalin.* The American Journal of Managed Care, University of Maryland, Baltimore. New York

Martinez, L. 2000. *Global infectious disease surveillance and response at the World Health Organization.* Geneva, Switzerland.

Mettrick, H. 1993. *Development-oriented research in agriculture - ICRA textbook.* International Centre for Development-orientated Research in Agriculture. Wageningen: The Netherlands.

Miya, S. 2011. *KZN is winning rabies battle,* 2011, October 11. The Witness

Miranda, M. E. G. 2000. *Rabies in Philippines: Control and Future Prospect.* Public Health Forum: UPCPH Annex II.

Mkhize, G. C., Ngoepe, E. C., Du Plessis, B. J., Reiminhaus, B., and Sabeta, C. T. 2010. *Re-emergence of Dog Rabies in Mpumalanga Province, South Africa Vector-borne Zoonotics,* PUBMED – Indexed for Medline Nov; Dis. 2010 Nov; 10 (9). PMID.: 20370435

Mollen, N. M. and Antipas, U. 1999. *A Comparative study of two agricultural extension approaches in Dodoma Region, Tanzania:* South African Journal of Agricultural ExtensionVol. 28. 62

Mouton, J. 2001. *"How to Succeed in your Masters and Doctoral Studies": A South African Guide and Resource Book.* Van Schaik Publishers: Goodwood.

Msiska, J.G., 1988. *The epidemiology and control of rabies and Brucellosis in Malawi*. In: Proceedings of the International Conference on Epidemiology Control and Prevention of Rabies and Brucellosis in Eastern and Southern African Countries, Foundation Marcel Mérieux, Lyon.

Nadine-Davies, S. A. 2001. *Rabies: Virus and disease*, Els. John Wiley and Sons, LTD. Ottawa. Canada. [Accessed on 19th February, 2014]

Nel L, Le Roux, K, and Atlas, R 2009. *Meeting the Rabies Control Challenge in South Africa*-Eliminating rabies in various areas in Africa is realistic and will depend on controlling this virus in dogs. American Society for Microbiology, Washington D. C.

Nel, H. L. 2013. *Discrepancies in Data Reporting for Rabies, Africa,* Emerging Infectious Disease April 2013: 19 (4): 529-533, Centre for Disease Control and control. Pretoria.

Neuman, W. L. 1991. Social Research Methods: Qualitative and Quantitative Approaches, Allyn and Bacon. Boston. USA.

Neuman, W. L. 2001. *"Social Research Methods: Qualitative and Quantitative Approaches."* 3rd ed. Allyn & Bacon: Boston.

Neuman, W. L. 2001. *"Social Research Methods: Qualitative and Quantitative Approaches."* 5th ed. Allyn & Bacon: Boston.

Ngoepe, C. E., Sabeta, C., Nel, L., 2010. *The spread of canine rabies into Free State province of South Africa:* A molecular epidemiology characterization. Virus Research: 2005 Dec; 114 (1-2); 113-25. Epub 2005 Jul 26. PM10: 16051390 [PubMed-Indexed for MEDLINE].

Oldstone, M. B. D. 2010. *Viruses, Plagues and History, Past, Present and Future*, Oxford University Press.USA.

Olivier, W. 2009. *There is Honey in the Forest: the History of South African Forestry.* South African Institute of Forestry.

Oucho, J. O. 2006. *Cross-border migration and regional initiatives in managing migration in Southern Africa*, sited in Kok, P., Gelderblom, D., Ochuo, J, O., van Zyl, J., Migration in Southern Africa. HSRC Press. South Africa.

Parija, S. C. 2009. *Textbook of Microbiology and Immunology*. Elsevier, a Division of Reed Elsevier India Pvt. Ltd. Haryana, India.

Perry, B. D. 1995. *Increasing Rabies Vaccination Coverage in Urban Dog Population,* Elsevier Science Medicine. Volume 22, Issue 1-2 February 1995. Nairobi University Press: Nairobi.

Perry, B.D., 1993. *The epidemiology of dog rabies and its control in eastern and southern Africa.* In: Proceedings of the International Conference on Epidemiology, Control and Prevention of Rabies in Eastern and Southern Africa, edited by KING, A.A., Editions Fondation Marcel Mérieux, Lyon.

Peens, J. 2010. *Verbal Communication on HH vaccination Strategy*, eThekwini Control Animal Health Technician, Durban.

PETA, 2012. *People for the Ethical Treatment of Animals*, Norfolk USA.

Peter, W. and Scott, W. 2006. *Emergency Medicine Decision Making: Critical Choices in Chaotic Environments.* McGraw-Hill: New York.

Pitcairn, H. R. and Pitcairn, S. H. 2005. *Dr. Pitcairn's New Complete Guide to Natural Health for Dogs & Cats* Rodale Press. USA.

Plotkin, S. A., Orenstein W, A., Offit, P. A. 2012. *Vaccines,* 6th Edition, Elsevier Saunders. USA.

Pretorius, J, A., 2009. *Healthcare of Wildlife*. Extracts from Postgraduate degree seminars. South African Veterinary Association Bulletin

Profetto-MacGrath, J., Polit, D. F., and Beck, C. T. 2010. *Canadian Essentials of Nursing Research,* Lippincott Williams & Wilkins. Canada.

Quak, T. 2010. *Vaccinations and their Side-effects.* www.whale.to/a/quak.html [Accessed on the 22 September 2010].

Raber, W. 2010. *Development of Contextually Adapted strategies to manage health risks related to agricultural irrigation with treated wastewater.* A case study in Magabheni, South Africa. Wageningen University [Unpublished Thesis]

Rabies Bulletin Europe. 2011. *Rabies Information System of the WHO Collaboration Centre for Rabies Surveillance and Research. Volume 35. No 4.* Wusterhausen, Germany

Rabies Grips KZN Midlands, Fears Grow. (2012, June 10). Sunday Tribune, p. 1.

Reay, D. 1996. *Insider Perspective of Stealing the words out of Women's mouth: Interpretation in the Research Process in Feminist Review*, 53.

Reay, D. 1996a. *Dealing with Difficult Differences: Reflexivity and Social Class in Feminist Research*; Feminist and Psychology, Vol. 6(3): pp. 443-456

Recuerico, S. Cherry, B. and Edson, M. 2007. *Potential Cost Saving with Terrestrial Rabies Control,* Published Online 2007 April 2. [Accessed on 11 September 2010].

Reuters. 2009. *Rand Steadies on News of Output Data*. The Natal Mercury September 21.

Richard, B., Kathleen, M. M., Algeo, T. P. and Slate, D. 1997. *Oral Rabies Vaccination in North America: Opportunities, Complexities and Challenges.* USD/APHIS/Wildlife Services, Natural Rabies Management Program, Concord. New Hampshire: USA.

Rogers, E. 2003. *Diffusion of Innovations*. Fifth edition. Free Press: New York.

Rolando, S. C. 1990. *Natal Veterinary Services, 1874 – 1912,* University of KwaZulu-Natal: South Africa (Unpublished Thesis).

Robbins, L. E. 2001. *Louis Pasteur and the Hidden World of Microbes,* Oxford University Press: New York.

Rubin, A., Babbie, E. R., 2011. *Essential Research Methods*, Brooks/Cole Empowerment Series

Rupprecht, C. E., Hanlon, C. A. and Hemachudha, T. 2002. *Rabies re-examined*. Lancet Infectious Diseases Vol 2 (6): 327-43..

Rupprecht, C. E. and Shlim, D. R. 2004. *Infectious Diseases Related to Travel,* Centre for Disease Control and Prevention, Atlanta.

Russel, J. F. A. 1985. *Extension strategies involving local groups and their participation and role of this approach in facilitating local development.* The World Bank. Washington D.C. Conference Paper 2.

Sabeta, C. T., Weyer, J., Geertsman, P., Mohale, D., Miyen, J., Blumberg, L. H., Leman, P. A., Phahladira,B., Shumba, W., Walters, J., and Paweska, J. T. 2013. *Emergence of Rabies in the Gauteng Province, South Africa: 2010 – 2011,* J. S. Afr. Vet Assoc. 2013 April 26, 84 (1): E 1 – 5.(PubMed – indexed for MEDLINE)

Schoenstadt, A. 2008 *"Rabies Symptoms"*. eMedTV. http:// rabies.emedtv.com/ rabies/ rabies - symptoms .html. [Retrieved 2010-01-30].

Schoones, I. and Thompson, J. 1994. *Beyond Farmers First: Rural Peoples' Knowledge, Agricultural Research and Extension,* Intermediate Technology Publication: London.

Schwartz, M. W. 2008. *The 5-Minute Pediatric Consult*, 6th Edition, Lippincott Williams and Wilkins. Philadelphia

Sekokotla, M. J. 2005. *Assessing Implementation of Veterinary Extension on control of cattle parasites, in Moretele District, Northwest Province.* University of Pretoria: South Africa (Unpublished PhD Thesis).

Sherman, D. M. 2002. *Tending Animals in the Global Village: A Guide to International Veterinary Medicine***,** Wiley Blackwell: Maryland.

Sid Ahmed Sayied, A. R. 2004. *Wild Animal Diseases in Africa,* University of Juba. South Sudan.

Sokoya, G. O. 2006. *Pattern of Utilization of Rural Public Health Facilities in Ogun State of Nigeria: A Gender Perspective.* University of KwaZulu-Natal, Discipline of Humanities: South Africa (Unpublished thesis).

Stafford, K. 2006. *The Welfare of Dogs*. Springer. The Netherlands

Subair, S. K. 1994. *Bridging the Gap between Extension Research through On-Farm Adaptive Research (OFAR) philosophy*. SACCAR Newsletter No 28 December 1994.

Swanepoel, R., Barnard, B. J., Meredith, C. P., Bishop, G. C., Bruckner, R. K., Fogging, C. M., and Hubschle, O. J. 1993. *Rabies in Southern Africa*, Onderstepoort J Vet. South Africa.

Taylor, W. J. and Watling, T. F. 1970. *Successful Project Management*. Business Books Limited: London. Thabethe, M. P. 1996. *Options for non-formal education/training on farm practices.* Proceedings of the 30th Conference of the South African Society for Agricultural Extension 10th – 12th April 1997.

Thabethe, M., and Uzodike, U. O. 2013 *Participation of Women in Agriculture: Reality or Rhetoric?* AlternatioN Journal 20,2 (2013) 294-316 ISSN 1023-1757

Pakree, S. *Rabies: Worst in 30 Years,* September 21, 2009, The Natal Mercury.

Thomas, H. S. 2009 *The Cattle Health Handbook,* Versa Press. USA.

van Sittert, S. J., Raath, J., Akol, G. W., Miyen, J. M., Mlahlwa, B., and Sabeta, C. T. 2010. *Rabies in the Eastern Cape Province of South Africa – Where we are going wrong?* Journal of the South African Veterinary Association. Vol. 81 No. 4 Pretoria.

van Nes, F., Abma, T., Johnsson, H., and Deeg, D. 2010. *Language Differences in Qualitative Research: Is Meaning Lost in Translation?* Springer, European Journal of Ageing. Vol. 7 (4): 313-316.

van Teijlingen, E. R., and Hundley, V. 2001. *The importance of Pilot Studies*, Sociology at Surrey. University of Surrey.

Waldan, P. 2010. *Animal Rights: What everyone needs to know?* Oxford University Press, New York.

Wasik, B., and Murphy, M. 2012. *A Cultural History of the World's Most Diabolical Virus*, Penguin Group. USA.

Warren, D. M. 2002. *Small Animal Care and Management*, Delma Thomson Learning. New York. USA.

Weathington, B. L., Cunningham, C. J. L., Pittenger, D. J. 2012. *Understanding Business Research,* John Wiley & Sons, Inc. New Jersey.

Webber, R. 2009. *Communicable Disease Epidemiology and Control: A Global Perspective,* CAB International. Cambridge. USA.

Weingart, S. and Wyer, P. 2006. *Emergency Medicine Decision Making: Critical Issues in Chaotic Environment*. McGraw-Hill: New York.

West, G. P. 1973. *Rabies in Animal & Man*, Arco Publishing Company. New York.

Weyer, J., Szmyd-Potapczuk, A.V., Blumberg, H., Leman, P.A., Markotter, W., Swanepoel, R. 2011. *Epidemiology of human rabies in South Africa, 1983–2007,* Virus Research 155, 283–290. http://dx.doi.org/10.1016/j.viruses.2010.10.023, PMid: 21036195

Willis, J. W. 2011. *Foundation of Qualitative Research: Interpretive and Critical Approaches,* Cambridge University Press. UK.

Willoughby, R. E. 2009. *Are we getting closer to the treatment of rabies? Medical benchmarks***.** MedScape.

Wilson, S. J., Obiola, V. O. 2003. *Standards and Global Trade: A Voice for Africa,* The World Bank. Washington DC

World Bank, 1986. *Population growth and policies in Sub-Saharan Africa.* Washington D.C., World Bank.

WHO. 2013. *Expert Consultation on Rabies Second report,* World Health Organization. Geneva.

WHO. 1984. *Guideline for dog rabies control* (VPH/83.43), World Health Organization, Geneva.

Woolson, R. F., and Clarke, W. R. 2011. *Statistical Methods for the Analysis of Biomedical Data,* 2nd Edition, A John Wiley and Sons, Inc., Publication. USA.

World Health Organization. 2010. *Working to Overcome Global Impact of Neglected Tropical Disease,* WHO Library Cataloguing-in-Publication Data

World Health Organisation. 1987. *Emerging and other Communicable Diseases Surveillance and Control.* WHO. Geneva, 1987

World Health Organization Expert Consultation on Rabies, First Report, 5-8 October 2004 TRS 931 WHO: Geneva 2005.

World Health Organization Expert Consultation on rabies: first report. WHO technical report series 931, WHO: Geneva 2004.

World Health Organization. 1998. *Expert Consultation on rabies: first report.* WHO technical report series 931, WHO: Geneva 1998.

World Health Organisation. 2012. *Strategic Framework for Elimination of Human Rabies Transmitted By Dogs in the South-East Asia Region,* WHO Library Cataloguing-in-Publication Data. South-East Asia Region.

Worth, S. H. 2008. *An Assessment of the Appropriateness of Agricultural Extension Education in South Africa.* University of KwaZulu-Natal, Discipline of Agriculture: South Africa (Unpublished PhD Thesis).

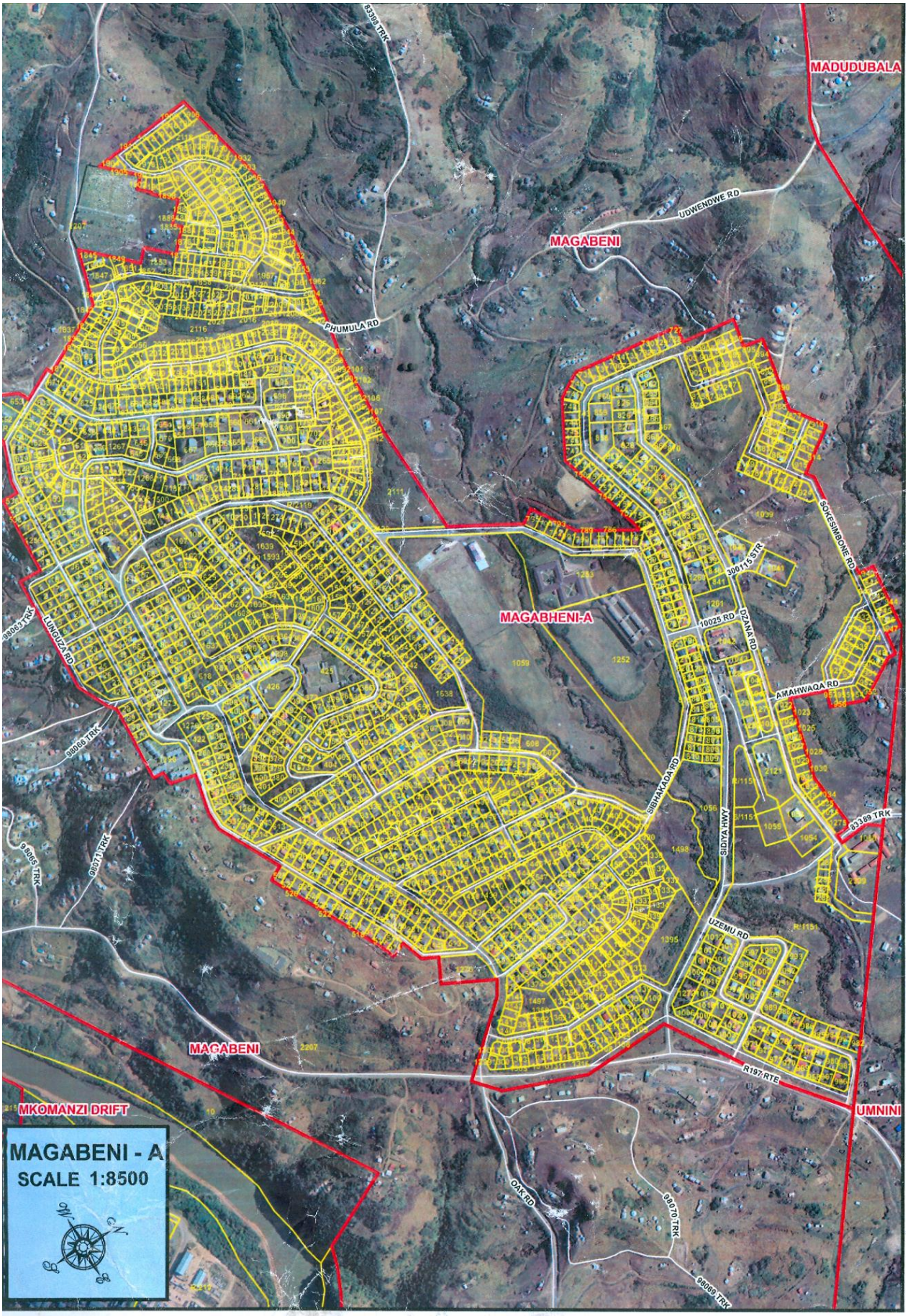
Wright, E., McNabb, S., Goddard, T., Horton, D. L., Lembo, T., Nel, L. H., Weiss, R. A., Cleaveland, S., and Fooks, A. R. 2009. *A robust lentiviral pseudotype neutralisation assay for in-field serosurveillance of rabies and lyssaviruses in Africa*, Elsevier; Vol. 27(1):152–160

Yin, R. K. 2009. *Case Study Research: Design and Methods*, 4th Edition, SAGE Ltd. London. UK.

Zuckerman, J. N. 2013. *Principle and Practice of Travel Medicine*, Wily Blackwell, West Sussex. UK.

Mandiwana, G. 2006. *Rabies outbreak causes concern at rural villages,* Zounet 2006, June 09

ANNEXURE 1: MAGABHENI SITE MAP



ANNEXURE 2: HOUSEHOLDS RESEARCH QUESTIONNAIRE

1. **To respond to these questionnaires is voluntary; the respondent may or may not answer the whole or some questions.**
2. **The name of respondent is and will remain confidential.**
3. **Your co-operation in answering these questionnaires will be highly appreciated.**

1. **Do you know about rabies disease? Yes ☐ No ☐**
2. **How many dogs do you have? 0 ☐ 1-3 ☐ >4 ☐**
3. **Is there any difficulty in handling your dogs? Yes ☐ No ☐**
4. **How did you know about this vaccination? Loud hailing ☐ Radio ☐ Newspaper ☐ Friend ☐**
5. **Which mode of advertising do you prefer? Loud hailing ☐ Radio ☐ Newspaper ☐ Other ☐**
6. **Is there any outbreak of rabies you are aware of? Yes ☐ No ☐ if yes…What do you remember?**
7. **Do you prefer this system of house-to-house vaccination compared to clinic service?**
8. **If not, what system do you prefer?**
9. **What can we do to improve this service?**
10. **Do you know any other government service which is similar to this one?**
11. **Do you have any dogs? Yes ☐ No ☐ If yes go to the next question**

12. **Number of dogs per household Male ☐ Female ☐**
13. **Number of dogs that was not vaccinated Male ☐ Female ☐**
14. **TOTAL DOGS VACCINATED 0 ☐ 1-3 ☐ >4 ☐**

NB. For dogs that were not vaccinated please fill in HOSEHOLDS NON-VACCIANTION DOG SURVEY.

ANNEXURE 3: ANIMAL HEALTH TECHNICIANS RESEARCH QUESTIONNAIRES

- These questionnaires will only take 5 minutes of your time.
- Your name will not be divulged to anybody.
- You have a right not to answer some or the whole questionnaire but your co-operation in answering these questionnaires will be highly appreciated.

Semi-structured Interview Schedule

1.0 Definition

There are five definitions of house-to-house methods of rabies vaccination. Which one you think is the best?

House-to-house Rabies Vaccination Definition		
Definition A	**House-to-house rabies vaccination is the method that is used to move from house-to house vaccinating dogs and cats**	
Definition B	**House-to-house rabies vaccination is the method that is used to drive along the street and call dog owners to bring their pets for vaccination**	
Definition C	**House-to-house rabies vaccination is the method whereby the community bring dogs to certain spots on the road so as to have their pets vaccinated**	
Definition D	**House-to-house rabies vaccination is whereby the technicians initiate the methods to be done in order to have maximum number of dogs vaccinated that may include even to walk on foot to the houses that have dogs**	
Definition E	**All/None of the above**	

1.2 Why do you think this is a good definition?

……
……
……
……
……

2.1 Which of the following two reasons for practising house-to-house is the most important?

Service effectiveness	
Community empowerment **Optimal results** **Cost effectiveness** **All/none of the above**	

2.2 Why do you think you have made that choice?

……
……
……
……

3.0 Benefits

3.1 The focus group identified four main benefits of practising house-to-house rabies vaccination method. Which one of the four do you think is the primary benefit?

1. Establishment of joint working relationship	
2. Eradication of rabies disease	
3. Community development	
4. Provision of effective veterinary services	
5. None of the above	

3.2 If you answer is 5 why do you think this is the primary benefit?

……
……

……
……

4.1 Difficulties

Which one of the following is the main hindrance of house-to-house vaccination?

1. Community resistant towards rabies vaccination	
2. Fatigue which accompanies long hours of work	
3. Lack of commitment from the community	
4. Repetitive nature of house-to-house rabies vaccination	
5. None of the above	

4.2 If your answer is 5 what do you think is the primary difficulty?

7.1 In your opinion what is the best rabies strategy for the rural community?

(a) Large-scale vaccination	
(b) Cordon vaccination	
(c) Ring vaccination	
(d) House-to-house (HH) vaccination	
(e) Central-point (CP) vaccination	

7.2 Additional comments. If any.

ANNEXURE 4: CORRESPONDENCE TO THE STATE VET REGARDING COST OF EQUIPMENTS

KZN Agriculture and Environmental Affairs
UmNyango WezoLimo NezeMvelo
isiFundazwe SakwaZulu-Natali

INTERNAL MEMORANDUM

TO/IYA KU: **CAHT - J.C Peens** **Veterinarian – Dr S. Dahnilall**	**FROM/IPHUMA KU:** **Telephone**: **Ucingo**: 031 – 332 6731 **Enquiries:** **Imibuzo:** Michael Mtshali **Ref:** **Inkomba:** **Date**: **Usuku: 14/07/2009**

Total Cost of HH Rabies Vaccination

I humbly ask you to compile for me the total cost of HH Rabies vaccination for the financial year 2009. This will help me in completing MAgric research. The costs breakdown are as follows;

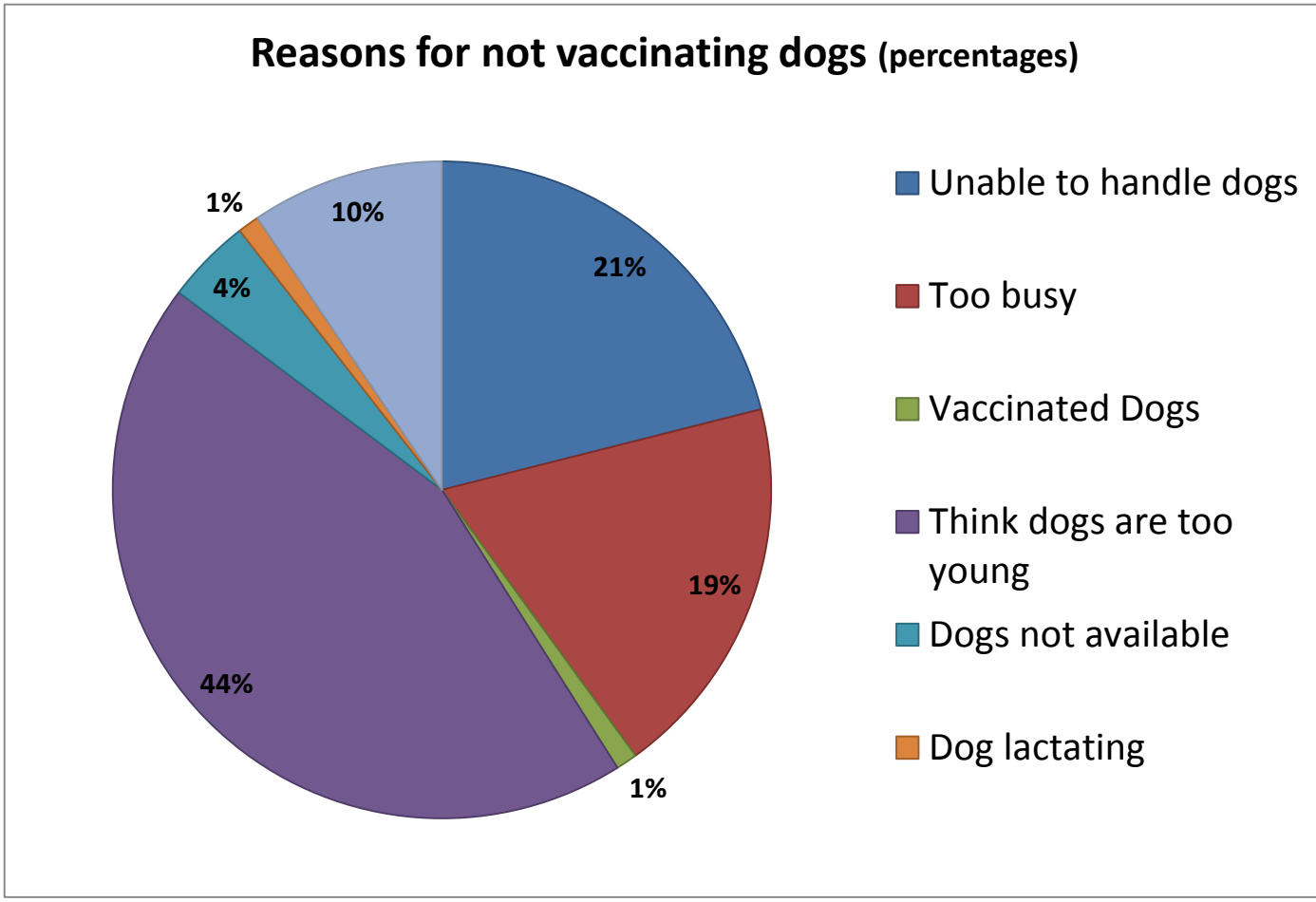
Disposables (a) Syringes		
(b) Needles		
© Certificates		
(d) Diaries		
Fuel		
Allowances		
Vaccine		

Vehicle Maintenance		
Capital Cost (Vehicle, Fridges, Straining Equipment & PA System		

Your cooperation will be highly appreciated

M. M. MTSHALI
SENIOR ANIMAL HEALTH TECHNICIAN-DURBAN

ANNEXURE 5: GRAPH FOR THE REASONS OF NON-VACCINATION



ANNEXURE 6: NON-VACCINATION SPREAD SHEET

HOUSEHOLDS	Unable to handle the dogs	Households were too busy or engaged	Dogs have already been vaccinated recently	Thought their dogs were too young	Non-availability at the time of vaccination	Dog lactating	Mistrust of government vets	Feral dogs (Stray Dogs)	TOTAL
1				3					3
2	1								1
3								1	1
4	1								1
5			1						1
6	1								1
7	2								2
8		2							2
9					1				1
10							2		2
11				2					2
12		1							1
13				4					4
14								1	1
15	4								4
16				3					3
17					1				1
18							3		3
19		5							5
20				5					5
21	1								1
22				2					2
23							2		2
24								1	1
25	1								1
26	2								2
27	1								1
28				4					4
29								1	1
30	1								1
31				3					3
32						1			1
33							1		1

34					1				1
35		3							3
36	1								1
37				4					4
38					1				1
39	2								2
40				3					3
41		5							5
42	1			3					4
dogs	19	16	1	36	4	1	8	4	89
	21%	18%	1%	40%	4%	1%	9%	4%	100%
hh	13	5	1	11	4	1	4	4	
	31%	12%	2%	26%	10%	2%	10%	10%	102%