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SOCIO-ECONOMIC IMPACT ANALYSIS OF LIVESTOCK DISEASE CONTROL PROGRAMMES WITH SPECIAL REFERENCE TO TICKS AND TICK-BORNE DISEASES

by

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Submitted in partial fulfilment of the requirements for the degree:

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DEDICATION

This study is dedicated in memory of my late father Mr Nndanganeni Johannes Randela whose untimely death on 10 July 1995 nearly made the furthering of my studies impossible. I will always miss him

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Rendani Randela

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Degree	:	**MSc (Agric)**
Department	:	**Agricultural Economics, Extension and Rural Development**
Supervisor	:	**Professor J.F. Kirsten**
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ABSTRACT

The outbreak of East Coast fever in the beginning of the century lead to the introduction of the plunge dip system to control the disease. This approach focused on eradicating the vectors (i.e. ticks) that transmitted the disease. The successful eradication of the disease in 1954 was mainly through the intensive use of acaricides. The fundamental objectives of this study is to determine whether there is continued justification for controlling ticks and tick-borne diseases through dipping, as well as identifying the impact of tick control to the rural household.

The study was conducted in two veterinary zones located in the Venda region of the Northern Province, namely the Yellow Line and the Open area. A sample of 125 respondents was taken from livestock farmers in the selected areas within the aforementioned zones. Data was accumulated by the use of a structured questionnaire, observations, as well as discussions with farmers.

Cattle dipping is performed to achieve both the economic, cultural and the social role with the majority of respondents (97%) farming with cattle both for commercial and subsistence purposes. The value of cattle has been estimated to be R1 152. A number of criteria have been used to estimate this value. These are the value of sales, milk, draught power and manure, and are quantified using the replacement value method. Eleven percent of the respondents expressed some dissatisfaction with the classical tick control method (plunge dip). The development of tick resistance to successive acaricide compounds is a major problem stated by 79% of the dissatisfied farmers. As a result, most of the respondents (61%) supplement dipping with either modern or traditional tick control measures such as hand picking.

The surveys amongst rural households show a 3% mortality rate in spite of the existence of the programme. It is estimated that the mortality rate would have been 4% without the control programme. Cost-benefit analysis revealed a benefit-cost ratio of 0.8 (i.e.<1) indicating that the control of ticks and tick-borne diseases by the government is not economically justified. However, because of the economic nature of the service it provides (public good), the dipping of cattle still deserves government support. In addition, the provision of tick control services by the government leads to a socially optimal level of supply. The sensitivity analysis gives the benefit-cost ratio of 1.2 when the mortality rate is assumed to would have been 10% without the control programme.

The results of both the logistic regression model and the multivariate regression analysis revealed that the structure of production (e.g. breed of cattle kept), as well as human resource factors (e.g. educational qualification) influences the demand for tick control service and farmers' willingness-to-pay for such a service significantly. In addition, there is also a slight indication of regional differences with regard to the demand for dipping and willingness-to-pay for the service by farmers.

The manner in which cattle dipping should be continued by the government, however, needs some alterations. The currently envisioned tick control strategy is based on integrated tick management system where acaricides will be strategically applied. This strategy will reduce the costs of tick control thereby improving the benefit-cost ratio. However, there is no easy and straightforward solution on the frequency of cattle dipping. A multi-disciplinary study needs to be conducted to ensure an optimal tick control strategy compatible with the needs of the resource poor farmers.

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SOSIO-EKONOMIESE IMPAK ANALISE VAN VEESIEKTE BEHEER MET SPESIFIEKE VERWYSING NA BOSLUISE EN BOSLUIS GEDRAAGDE SIEKTES.

Deur

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UITTREKSEL

Die uitbreek van Ooskuskoors aan die begin van die eeu het gelei tot die implementering van die dompeldip stelsel ten einde die siekete te beheer. Die benadering fokus op die uitwissing van die vektore (bosluise) wat die siektes oordra. Die suksesvolle uitwissing van die siekte teen 1954 was hoofsaaklik die gevolg van intensiewe aanwending van akarisiede. Die fundamentele doelwitte van dië studie is om te bepaal of daar volgehoue motivering vir die beheer van bosluise en buisluis gedraagde siektes is deur middel van dip, sowel as die identifisering van die impak van bosluisbeheer op die landelike huishoudings.

Die studie is gedoen in twee veeartsenykundige gebiede geleë in die Venda streek van die Noor Provinsie, naamlik die Geel lyn en Oop gebied. 'n Steekproef van 125 respondente is geneem onder veeboere in geselekteerde gebiede binne die genoemde gebiede. Data is versamel deur middel van 'n vraelys, waarneming en gesprekke met produsente.

Die dip van beeste word gedoen ter bereiking van beide ekonomiese, kulturele en sosiale funksies deur die meerderheid van die produsente (97%) wat boer met vee vir beide kommersiële en bestaansredes. Die waarde van beeste word geraam op R1 152. 'n Aantal kriteria is gebruik om in die raming. Dit is die waarde van verkope, melk, trekkrag en mis en is gekwantifiseer op basis van die vervangingswaarde metode. Elf persent van die respondente het 'n mate van ontevredenheid uitgespreek met die klassieke bosluis beheer metode (dompeldip). Die ontwikkeling van weerstand deur bosluise teen opeenvolgende akariside samestelling is a groot probleem, soos aangetoon deur 79% van die produsente wat hul ontevredenheid aangetoon het. Gevolglik vul die meeste van die respondente (61%) die dipstelsel aan met of moderne of tradisionele bosluis beheer meganismes soos die verwydering daarvan met die hand.

Die opnames onder landelike huishoudings toon 'n 3% mortaliteit ten spyte van die bestaan van die program. Dit word geraam dat mortaliteit 4% sou beloop in die afwesigheid van die program. Koste-voordeel analise toon 'n voordeel-koste verhouding van 0.8 (<1) wat daarop dui dat dat die beheer van bosluise en bosluisgedraagde siektes deur die regering nie ekonomies geregverdig is nie. In die lig van die ekonomiese aard van die diens wat die regering verskaf (openbare goedere) verdien die dip van beeste egter steeds owerheidsteun. Die verskaffing van bosluisbeheer dienste deur die regering lei voorts ook tot 'n sosio-optimale vlak van aanbod. Die sensitiwiteitsanalise toon 'n voordeel-koste verhouding van 1.2 aan indien die mortaliteit 10% sou beloop in die afwesigheid van die program.

Die resultate van beide die logistiese regressie model en die multivariansie regressie analise toon dat die struktuur van produksie (bv. ras aangehou), sowel as menslike hulpbron faktore (bv. opvoedkundige kwalifikasie) 'n beduidende invloed het op die vraag na die bosluisbeheer diens en die bereidheid om te betaal vir die diens deur die produsent.

Die wyse waarop beeste gedip word behoort voortgesit te word deur die regering, maar sal egter aanpaasing moet geniet. Die huidig voorsiene bosluis beheerstrategie is gebaseer op 'n geintegreerde bosluis bestuurstelsel, waar akarisiedes strategies aangewend word.

Hierdie strategie sal die koste van bosluis beheer verlaag en sodoende die voordeel-koste verhouding verbeter. Daar is egter nie 'n maklike en eenvoudige oplossing ten opsigte van die dip frekwensie nie. 'n Multi-dissiplinere studie moet uitgevoer word om 'n optimale bosluis beheerstrategie versoenbaar met die behoeftes van die hulpbron behoeftige produsente te verseker.

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CHAPTER 1

INTRODUCTION

1.1 Background

" The tragedy is that multitudes of the livestock of the world which could supply the animal protein so urgently needed by mankind are themselves suffering from malnutrition and diseases" (Cuthbertson, 1970: 91, cited by Schwabe, 1974)

It is estimated that in 1986 there were approximately 177 million cattle in Africa (Scholtz *et al.*, 1991). However, one of the most important constraints over livestock production is disease. It is estimated that a 6 percent reduction in disease loss would provide food for an additional 250 million people (Schwabe, 1974: 90).

Food shortages are most serious in the developing countries where 75 percent of the world's population lives. Again, it is estimated that 65 to 70 percent of the world's livestock resources exist in these regions, yet they account for only 30 percent of the world's meat output (Murray and Gray, 1984: 24). Moreover, animal protein production is lower in Africa than in any other country.

The causes of this serious situation are complex but one significant factor is the prevalence of diseases that afflict the livestock industry resulting in serious socio-economic consequences. According to Scholtz *et al.* (1991) a large number of these animals are frequently treated with acaricides in an attempt to contain ticks and tick-borne diseases on the general assumption that the numerous tick species causes losses in productivity. The diseases treated include African trypanosomiasis, East Coast fever, heartwater, redwater, anaplasmosis, *etc.* It can therefore be argued that the control of these diseases is an essential component of an economically rational approach to sustainable livestock production.

In the Socialist Republic of Romania, for example, animal health protection is a national concern, representing a permanent obligation for all state bodies and other organisations, and a duty for inhabitants throughout the country (Dida, 1983). However, in most developing countries where livestock industry is managed in the traditional way, animal disease control is still considered as part of routine government services rather than as a specific capital investment. Moreover, livestock owners under-invest in control of animal diseases either because they are inadequately informed of what represent the economically optimal level of control for a particular disease or because such information does not exist. Hence, they adopt a cautious approach and spend only small sums on disease control since the improved financial return is not direct and obvious.

Disease control programmes nevertheless are a form of investment that needs to be seriously promoted and legally enforced as a means of up-lifting the socio-economic status particularly of the rural poor, since livestock will continue to provide a vital and irreplaceable source of human food.

1.2 Problem Statement

In predominantly rural societies in underdeveloped countries, 98 percent of the large animals, such as cattle in certain African nations are raised on small-scale family farms. Livestock has a social, cultural and financial role. Despite all these roles, developing countries, including South Africa's developing areas, have a series of livestock production problems with ticks and tick-borne diseases being a significant problem. Ticks are important ectoparasites of livestock and tick-borne diseases are the most vector-borne afflictions of ruminants. Various tick control programmes have been put in place in South African developing areas to alleviate the problem. Nevertheless, cattle losses due to ticks and tick-borne diseases are still experienced. The existence of a dual economy within the agricultural sector exacerbates the problem. The small-scale, particularly black farmers who aim to increase livestock production face many problems not experienced by the white farmers. For example, in the control of livestock ectoparasites, research and extension services largely addressed problems experienced by the commercial farmers that can afford the effective and expensive acaricides, as well as the facilities needed to use them. As a result agricultural development lagged behind the progress made in the so-called high potential areas (Botha, 1994).

African agriculture according to Macgrecor (1990) does not receive the government support it deserves. For instance, in most developing countries the health budget showed a rising trend in the past years, the veterinary budget did not follow the same trend, although the veterinary services are strongly linked with human health in the broadest World Health Organisation (WHO) meaning (Bellani and Mantovani, 1983). Therefore, considering the substantial cuts in financial support that have affected veterinary services in the past and the probable resultant of under-investment in disease control in most of the Third World countries, it is rather cynical to dismiss the subject with the following questions. Is there going to be a future? Can rates of growth in animal production be successful in meeting the needs of a fast growing human population thereby improving the conditions of life of poor people throughout the world?

Currently the Directorate of Animal Health seems to be reluctant to fund animal health services. This is probably due to the government failure to realise the value to the country of the veterinary service or failure to foresee the consequences to society if such a service is not provided. In South Africa's developing areas, dipping forms an integral part of a properly orchestrated disease control programme through disease diagnostics and surveillance. A fundamental requirement for the national and international control of animal diseases is the provision of a comprehensive system of disease surveillance and disease reporting. Information from the disease diagnostic and surveillance programme benefits the whole economy and cannot be appropriated. Therefore, government intervention is necessary to ensure early warning and control of disease outbreaks.

On the other hand one of the major preoccupations of the government is to ensure sufficient supplies of food products of animal origin to meet the requirements of a balanced diet, which are ever increasing as a result of improvement in the living standards of the population. The continual threat posed by animal diseases can render the aforementioned objective null and void.

1.3 Objectives of the Study

The specific objectives of this study are to:

- Describe the current ticks and tick-borne diseases management practices of small-scale farmers in less developed areas.
- Assess the socio-economic impact of ticks and tick-borne diseases control programmes at farm level.
- Examine the links between ticks and tick-borne diseases control programmes and farmer development.
- Identify policy issues for reducing tick-borne diseases occurrence in resource limited communities.

1.4 Justification of the Study

"In most of the developing countries the death or illness of even a single work animal may be a tragedy for a family ... an epidemic among such animals may be a national catastrophe" (Macpherson, 1995: 37).

The livestock sector plays a crucial role in the economies of many developing countries by producing protein rich food supplies, generating vital income and employment, and earning much-valued foreign exchange. Cattle are the most important livestock species in Africa and account for approximately 70 percent of its domestic stock (Scholtz *et al.*, 1991). For many farmers in the developing world, their animals are also a form of stored wealth, a cushion against starvation when food is scarce, a source of fertiliser, a means of transportation and a source of traction in crop production (Umali *et al.*, 1994). However, the availability and quality of animal health service heavily influence the attainment of the full productive potential of livestock.

In the past most studies have focused attention on those producers who experience losses due to animal diseases (Kryder, 1983). Little attention has been given to those producers who are spared the effects of the disease. Also ignored has been the impact on consumers of the product that are affected by the disease. Recent studies have taken a broader approach and have estimated the impact of diseases on the total economy. For instance, in Sub-Saharan Africa, losses from all disease induced deaths and lower meat and milk production in livestock amount to an estimated $2 billion dollars a year (FAO 1985, cited in Umali *et al.*, 1994). Changes taking place in many countries demand a revised approach to meet broad national development requirements in terms of socio-economics.

Apart from having effects on public health and animal welfare, animal diseases also have economic implications, this is true for livestock which is kept for economic purposes. According to Renkema (1983: 47) a quantitative insight into the economic impact of diseases and disease control in livestock can be used for, *inter alia*:

- Assistance in indicating the lines on which veterinary research should develop by providing economic criteria.
- Supporting livestock owners' policy with respect to animal production and animal health.
- Broadening the basis for decisions where a choice must be made from alternative preventative and control procedures.
- Economic considerations are important in so far as they contribute towards policies with regard to animal diseases.
- To assess the long-term consequences of removing or reducing the constraints of ticks and tick-borne diseases from the farming system.

All the action undertaken in the field of animal health has been principally designed to obtain the highest possible level of profitability of animal husbandry resources while at the same time reducing costs, through the eradication or control of infectious or parasitic diseases which have a negative impact on such costs, as a result of either mortality, decreased production, or shortening of the average life span of the animals. Studies conducted in Australia and elsewhere on animal health programmes indicated that the return on invested funds was commonly as large as 500 to 1500 percent (Morris, 1983: 60). Morris (1983) further argues that these returns are so much higher than those from most other investments in livestock that the matter deserves investigation.

A potential benefit on disease control programmes usually results in a reduction of physical losses, increased supply and a decrease in prices to consumers in general. The overall effects according to Kryder (1983) is to reduce the benefits of producers and shift them to consumers. The opposite effect occurs when a devastating animal disease strikes the livestock population and results in reduced supply. In this case consumers are forced to pay more for the products and the net benefits accrue to the producers having little or no disease amongst their stock. These benefits would, however, depend on the relative elasticities of demand and supply.

Moreover, the national economy suffers a loss through animal diseases because resources are being used less efficiently. Additional resources at costs are required (e.g. labour, vaccine, *etc*) that could have been employed alternatively. If these costs could be reduced there will be two effects possible; either the same output can be produced more cheaply or the savings can be converted into increases in output.

It is evident that animal health and economics cannot be studied in isolation. Economic studies and the information derived from them become a basic element for a rational deployment of the technical, economic and financial resources at a national level. A key question that should be at the forefront in the thinking of any research institution should be economic. What research is worth doing?

1.5 METHODOLOGY

1.5.1 Socio-Economic Impact Assessment Technique

The study will be conducted within a Cost-Benefit Analysis approach because it provides a strong theoretical framework for analysing the economic and social impacts of research and development activities. Cost-Benefit Analysis has come to be used as a general technique for the assessment of the benefits and costs of large-scale projects (Roe, 1980). An *ex-post* view will be taken into account with the aim of establishing whether or not various ticks and tick borne diseases control interventions are producing their intended effects. Data on costs that cannot be derived from the farm level will be complemented by data derived from the veterinary service dip records. However, it is acknowledged that certain factors cannot be easily assessed quantitatively. For instance, the role of cattle in marriage contracts, prestige and ceremonial activities cannot be assessed in terms of a quantitative comparison, but should not be ignored. The "with" and "without" programme scenario will be modelled into the analysis to provide a basis for Cost-Benefit Analysis.

1.5.2 Questionnaires

Due to time limitations and financial constraints, this study makes use of the questionnaire as a tool through which information can be elicited from the farmers. The questionnaire can be used in three different ways, *viz*. for personal interviews, telephonic and mail interviews. In this study it was decided to conduct personal interviews because of the following advantages:

- The interviewer has control over question order and can ensure that the respondent does not answer the questions out of order.
- The interviewer can ensure that all of the questions are answered.
- The respondent is unable to cheat by receiving answers from others, or by having others complete the entire questionnaire for them.
- The interviewer can observe behaviour that the questionnaire is not designed to detect.

After completing the construction of the questionnaire a pilot survey was done to pre-test the questionnaire. Only a few changes were done especially with the phrasing of questions that appeared to be sensitive. The required ranking of answers in order of importance was also abandoned. Personal interviews supplemented with informal conversational interviews were conducted with the assistance of an animal health extension officer in charge of a selected diptank and a graduate diploma student in animal production. Their proven competence and enthusiasm minimised the need for training. Most of the interviews were carried out at the diptank to avoid lengthy and time-consuming journeys on foot to find homesteads. In addition, direct observation allowed the collection of data that could not have been revealed by the questionnaire, such as name of acaricides used and the type of the cattle breed kept.

1.5.3 Secondary Data Review

Data that has been acquired by other people before, published or unpublished is also considered useful in this study especially to avoid time wasted in repeating studies. However, it will be used with care to avoid using information that was done to suit a particular place and achieving some personal objectives. These will include books, journals, magazines, *etc.*

1.6 The Study Area

The differences in areas pose a problem to researchers of how to choose an appropriate study area. Moreover, there is always a problem when the researcher has to make a decision as to whether a single site or several sites will be sufficient to give a better picture of the study. For both economic reasons (resources) and the prevailing status of ticks and tick-borne diseases the former Venda homeland was chosen as a study area.

With the new political dispensation Venda now forms part of a larger regional government, in this case the Northern Province. The former Venda homeland lies between 20°45 and 24°45s and 29°50 and 3130E, and is bordered by former Gazankulu in the south-east, and the Kruger National Park in the west. A narrow strip of South Africa separates its northern border from Zimbabwe.

Agriculture is regarded as a cornerstone of the region's economic development strategy. Of the total land area of 649 240 ha in Venda, only 9% of the total area have been identified as dryland while 0.4% have been identified as under irrigation. About 86% of the total area in Venda is identified as potential grazing land. The total number of cattle as estimated by Booysen (undated) was 85 480 followed by goats (74 021) and lastly by sheep (1 516).

Venda is divided into three veterinary zones, namely the Red Line, Yellow Line and Open area (see Figure 1.1). After the presentation of a brief research proposal, on the advice of the former Venda Department of Agriculture (Veterinary Services Division) it was decided that the survey be conducted in all the veterinary zones. However, because of socio-political reasons, surveys could not be conducted in the Red Line area. The two areas surveyed (Yellow Line and the Open area) are generally known as non Foot-and-mouth disease areas. In comparison, however, the Open area is known as a low tick prevalent area and the Yellow Line as a high tick prevalent area.

Because of time constraint and a limited number of enumerators available, as well as very large numbers of cattle owners in Venda and spatial dispersion into widely scattered and sometimes small geographic areas three diptanks from each area were chosen for surveys. Within the Yellow Line area the following diptanks were chosen, namely Tshifudi, Malongana and Matshena. And within the Open area Vyeboom, Guyuni and Dzanani (see Figure 1.1). Factors such as cattle owners and the extension officer's co-operation, dipping attendance and ease of access to transport played a major role in the selection of diptanks.

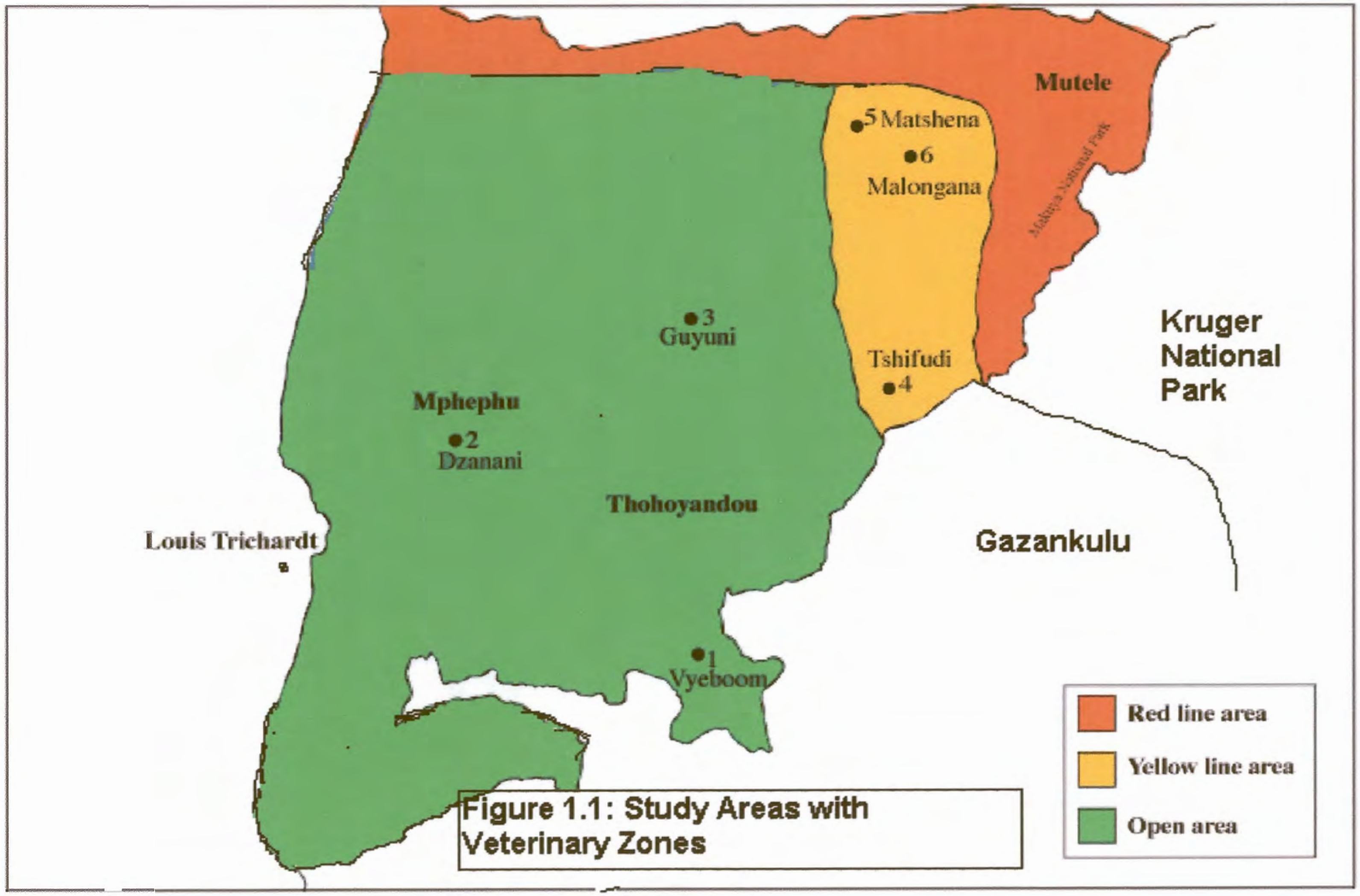

Figure 1.1: Study Areas with Veterinary Zones

1.7 Sampling Procedure and the Sample Size

It is difficult to give precise rules on what sample size is suitable. The suitable sample does not depend on the size of the population nor does it have to include a minimum percentage of that population. However, Bless and Achola (1995) argue that one of the major issues in sampling is to determine samples that best represent a population so as to allow for an accurate generalisation of results.

A very important issue in sampling is to determine the most adequate size of the sample. The major criterion to use when deciding on the sample size is the extent to which the sample's size is representative of the population. Two-stage sampling was performed in this study. Firstly, three diptanks were chosen within each area. Secondly, cattle within each diptank were stratified by number of cattle, namely 1-10 heads of cattle, 11-20; 21-30 and more than 30 heads of cattle representing the categories of stratification. Prior to sampling a list of cattle numbers for all cattle owners was made available by the extension officers in charge of the respective diptanks. Then, within each stratum, a simple random sampling was performed using random number tables. From each diptank, it was targeted that 25 respondents should be obtained using the following formula:

$$(n/N) * 25$$

n= number of cattle owners within each stratum

N= total number of cattle owners in a diptank

1.8 Research Design and Implementation.

The Group for Development Impact Assessment of the Agricultural Research Council (ARC-DIA) requested the Directorate of Veterinary Services of the Department of Agriculture for the participation and collaboration with regard to the project surveys. This was followed by a visit to Tshifudi diptank on a dipping day. After explaining the purpose of the project to cattle owners a group interview was conducted after dipping of the cattle using a structured questionnaire. Cattle owners were notified of the researchers return to conduct personal interviews with sampled cattle owners. A meeting was later held at Sibasa state veterinary office with the chief animal health extension officers of the sampled diptanks to explain the focus of the study, particularly its objectives. A draft questionnaire was also discussed and modifications were made.

Table 1.1: The Size and Distribution of the Cattle Farmer Surveys

Area	Number of farmers actually interviewed	Minimum number of cattle/surveyed area	Maximum number of cattle/surveyed area	Average number of cattle/surveyed area
Vyeboom	17	3	52	23
Malongana	23	2	55	19
Guyuni	23	3	42	15
Matshena	23	2	98	16
Dzanani	22	2	35	13
Tshifudi	17	3	39	13
Total	125	2	98	17

Prior to the conduction of personal interview, it was learnt that children or herdboys bring some of the cattle herds to the diptank. Sampled farmers were then notified about the planned interviews a week in advance of the dipping day. The actual number of farmers who participated in the surveys is, however, less than the targeted number of 150 as indicated in Table 1.1. This can be ascribed to poor dipping attendance (caused by rain and other urgent commitments) and uncooperative behaviour by some cattle owners. This reduced the number of actual respondents to 125. This sample is about 80 percent of the targeted sample, and is considered large enough to be representative. The surveys were conducted from September to mid-December 1997.

1.9 Definition of Terms

In order to examine the socio-economic impact of disease control programmes it is necessary to briefly examine the definitions and context of this area of investigation. The prefix "socio" refers to the whole society or individuals. Sociology includes the study of customs, traditions, pattern of historical development and institution that have evolved within societies. Moreover, it examines the diverse groups within a society, such as women, ethnic groups, poverty, *etc.* Socio-economics refers to both social status and economic position.

Impact assessment according to Anandajayasekeram, Martella and Rukuni (1996: 39) is a special form of evaluation that deals with the effects of the project output on the target beneficiaries. It normally focuses on how well a programme meets its stated objectives and therefore, often deals with the direct output of the activity.
Finally, the other term that will be used throughout the study is disease - which is defined as an unhealthy condition caused by infection.

1.10 Outline of the Study

To achieve the study's objectives, the study begins in Chapter 2 with an economic assessment of the value of livestock to rural community. This chapter provides both qualitative and quantitative information on the value of livestock. Chapter 3 focuses on the emergence, spread and the control of ticks and tick-borne diseases in South Africa. To some extent this provides the basis for future planning with regard to ticks and tick-borne diseases control. Chapter 4 focuses on the control strategies for ticks and tick-borne diseases. More emphasis will be given to the classical ticks and tick-borne diseases control based on acaricides application.

Given the importance of livestock to the rural communities and the imposing threat of diseases in the climate of declining research budget, the costs and benefits of tick control strategies will be highlighted in Chapter 5. Attention will be given to the two scenarios, namely the "with" and "without" dipping scenarios. A comparison will then be made between the two scenarios so as to provide any economic justification for the implementation of the dipping programme. Chapter 6 provides an analysis of the demand for livestock tick control service. It puts more emphasis on those factors influencing farmers' willingness-to-pay and the revealed demand for dipping. Given factors influencing farmers' decisions to adopt tick control strategies, Chapter 7 deals with some future strategies for ticks and tick-borne diseases control based on an integrated system of tick management and pays attention to policy proposals emanating from the study. Finally, Chapter 8 conclude by providing the summary of the results together with future challenges that need further investigation.

CHAPTER 2

AN ECONOMIC ASSESSMENT OF THE VALUE OF LIVESTOCK TO THE RURAL COMMUNITY

2.1 Introduction

An economic assessment of the value of livestock must take into account the range of factors that determine value to local farmers (Scoones, 1992). This chapter attempts to determine the value of cattle to the rural community both quantitatively and qualitatively. In doing so an effort is made to capture all the benefits of cattle within the economy of the rural community. A quantitative valuation of livestock in particular is important in indicating the degree of impact of cattle mortalities to the livelihood of the rural households. It again offers important guidelines for farmers' compensation by the government should a disaster occur.

Unless otherwise specified, the analysis is based on the survey of a sample of 125 households. A common approach used to determine the economic value of cattle production is the sales criteria or production trait approach (Scoones, 1992: 340; Upton, 1993: 463). This approach is based on the assumption that the prices received from cattle sales reflect its value. It does, however, undervalue the other productive roles of livestock.

2.2 Measuring the Economic Value

In estimating the economic value of cattle the several uses of cattle must be considered, as listed below:

- Biological productivity
- Off-take/sales
- Value of milk production
- Value of cattle draught power, this solely include ploughing.
- Value of manure use

The first two criteria are known as the natural rate of increase and the latter three as yield as advocated by Upton (1993). These criteria are evidently representative of the input and output function performed by livestock. These methods are not optimising models but do provide a useful method for estimating the value of livestock for small household herds. A further value of cattle is derived from the ceremonial activities (funerals, wedding) as well as wealth, which could not be easily quantified.

2.3 Reasons for Keeping Livestock: Theoretical Underpinnings

The sampled farmers were questioned on their reasons for keeping livestock. The intention was, *inter alia*, to identify those household that farm for subsistence reasons from those that farm for commercial purposes. To achieve this the sampled farmers were requested to rank in order of importance their reasons for keeping livestock. In general, economists identify commercial livestock production with high rates of animal sales (or rental values) and subsistence production with low rates of sales. This approach is misleading because rates of sale provide no indication of the reasons for sale. In Venda one producer might sell under duress; the other producer may raise cattle in order to profit from their sales. Despite their different levels of commitment to commercial involvement, the live animals' sales rate of the two producers may be remarkably similar under certain circumstances. In this survey attempts to clearly identify the orientation of farmers were disappointing. Failure to determine the respondents' orientation made it difficult to classify with any certainty whether surveyed farmers were subsistence or commercially oriented. However, although the results were inconclusive, it still offered enough information for one to broadly infer the motive.

Survey results shows that the livestock sector plays an important social, economic and cultural role in the economies of the surveyed areas. These roles have been documented over many years (for example in Doran *et al.*, 1979; Feuerstein *et al.*, 1987; Aaker, 1994). The social and cultural role of cattle in less developed countries led to the generally accepted cattle complex myth (Van Rooyen *et al.*, 1981). This myth is based on the assumption that black small-scale farmers were incapable of responding rationally to the market signals. According to this myth, peasant farmers would not sell cattle because their economic concern is overlaid by mystical and ritual devotion to their stock, and by the desire to accumulate cattle merely for prestige and wealth. Doran *et al.* (1979: 42) in this regard defines wealth as the accumulation of assets which confer among other things security, prestige and status, while income provides the means of attaining wealth and supporting current consumption. The essence of this view is that producers may occasionally sell a few animals, but they also strive to maintain surplus animals as an end in itself in order to fulfil traditional social needs. If one subscribes to this view, at least 15% of the sampled farmers keep cattle for the aforementioned purpose.

The view of Doran *et al.* (1979) suggest that one should expect to find an inordinate number of animals which are suitable for sale, but unsold, a sort of 'on the hoof bank account' (as Behnke, 1987 puts it) directly convertible to social status or emotional satisfaction on the part of the owner. This implies that traditional farmers might have their own minimum reference number of animals that they would like to posses. Bembridge (1987: 75) estimated that in subsistence oriented agriculture at least eight animals are needed to meet the many primary and social needs before any secondary or developmental needs could be met. Moreover, some researchers maintain that as many as eighteen head are necessary for primary needs (Tapson and Rose, 1984). Behnke (1987) argues that herds which declines beneath a certain number of animals can inherently be unstable and prone to losses and eventual extinction because of the high demand placed on them for milk, traction and animal sales. The smallholder is therefore not trying to avoid market involvement; he is simply building to a point where such involvement will serve as an asset rather than a drain on his resources.

The survey results (see Table 2.1) reveals that Venda cattle herds produce a wide array of useful goods and services including meat, milk, traction power and donations to the community. These goods and services have a use value in the domestic setting, but have a low or unrealisable cash value. All sampled farmers do sell cattle to meet their cash needs. In addition, the majority of the sampled farmers (97%) simultaneously keep cattle for both subsistence and commercial purposes. These farmers represent the household of

Table 2.1: Respondents' Reasons for Keeping Livestock

Area	Sell	Milk	Lobola	Wealth	Meat	Prestige	Plough	Donation
	% of respondents							
Vyeboom	100	59	-	100	94	-	6	-
Malongana	100	87	-	65	78	-	-	4
Guyuni	100	13	4	57	57	-	17	-
Matshena	100	78	-	78	78	-	-	-
Dzanani	100	18	-	91	41	-	-	-
Tshifudi	100	29	-	100	76	12	35	-
Total number of respondents	125	60	1	100	87	2	11	1

classic micro economic analysis in which rural farm households are dual-purpose institutions.

Of the 125, at least 4 households (3%) in Malongana, Guyuni and Matshena keep cattle solely for commercial purposes with an average herd size of 35 cattle. One can infer that cattle owners with a relatively large herd size approach cattle raising with a different goal in mind – the profitable production of animals for sale.

The survey results show cattle keeping as an alternative system of capital investment with dividends in milk, manure, traction power, *etc.* Thus, farmers have a preference for banking in livestock as it is a self-generating investment. This is evident when taking into consideration one of the respondents answer in vernacular on the reasons for cattle keeping; *kholomo ndi yone bannga yanga* (meaning cattle is my bank). This was also confirmed by 88% of the sampled farmers when asked about any best investment option available besides cattle farming. Investment in cattle is regarded as the best long-term economic option open to many rural households.

It is evident from Table 2.1 that the financial role outweighs both the social and cultural role performed by the cattle. The most important reason for keeping cattle is selling as expressed by all respondents, followed by wealth (100 respondents), meat (87) and milk (60). Reasons for keeping livestock varies within a region. For instance, within Vyeboom, all respondents (17) keep cattle for wealth, followed by meat (16), milk (10) and lastly ploughing as indicated by only one of the respondents. In addition, reasons for keeping livestock also vary amongst regions. For instance, the reason for keeping livestock as a source of milk vary widely from 87% in Malongana to 13% of the respondents in Guyuni as shown in Table 2.1.

The role of the cattle is also determined partly by their importance in religious observances, most of which involve supplication to the spirit of ancestors. This indicate that cattle serve as sacrificial goods and the best means by which the goodwill of ones' ancestors may be won and ones prosperity ensured. The survey results support a study by Düvel and Affull (1996) in which it was indicated that amongst Vendas, the patrilineal male ancestors are usually embodied in a black bull as confirmed by at least 2 % of the respondents. However, the religious and ritual importance of cattle that dominated an old pattern of consumption is changing in the face of the increasing monetary value of cattle, making it difficult for an ordinary man to buy and then dispose the cattle in offerings to the spirit. Moreover, exposure to western culture especially amongst young people, is changing their attitudes and are therefore critical in changing the use of cattle.

It is evident from these results that the objectives and reasons for keeping livestock varies amongst herd owners to the extent that the control of ticks and tick-borne diseases may or may not be a high priority for them.

2.4 A Quantitative Assessment of the Value of Livestock to the Rural Community: A Micro Perspective

This section provides an analysis of data derived from the questionnaire to give an indication of the importance of cattle in milk production, cattle sales, manure and the work of cattle. An animal's value and usefulness influences the owners' attitude towards and time spent on the animal's welfare which in turn affects its health care. In addition, costs of control are limited by the economic value of the animals. In the following section, an analysis of data derived from the questionnaire gives an indication of the importance of cattle in terms of milk production, cattle sales, manure and work of cattle.

2.4.1 Milk Production

Data were collected from farmers on milk production, own consumption and sales of milk, including the average price per litre of milk sold. The results are shown in Table 2.2 in terms of the averages for the different areas under consideration. Average daily consumption per farming family ranged from 2 litres to about 4 litres, while average daily production for all milked cows in the survey area ranged from 1.5 litres to 5 litres. The average daily consumption per family is influenced by the size of the household, number of children, *etc*, while average daily production of milk is dependent upon breed type, number of lactating cows, season and the farmer's objectives. Similarly, milk is only produced by breeding females with calves, so output depends upon the average calving interval, as well as the milk off-take per lactation. It should be noted that the Nguni breed which is most prevalent in these areas, do not produce as much milk as exotic dairy breeds.

Table 2.2: The Value of Milk Production

Area	Average consumption (l/day/ farmer)	Average production (l/day/ farmer)	Average number of cows milked/day	Percentage of farmers who sold milk (%)	Average price (R/ L)	Value of milk production/ cow/year (R)
Vyeboom	3.0	4.0	5	14	7.00	1022
Malongana	4.0	5.0	5	50	4.35	793
Guyuni	2.0	2.0	3	-	3.00	365
Matshena	4.0	5.0	6	21	3.50	532
Dzanani	3.0	1.5	4	20	3.50	240
Tshifudi	2.0	1.5	4	-	3.00	205
Average	3.1	3.2	4.5	18	4.00	526

Note:The value of milk per cow per year was calculated as follows. (Production / no. of cows) * duration of milking (days) * average price. Using the first row as an example: (4/5)*(365*6/12)*7 = 1022

The number of cows milked per farming household was obtained from the number of calves that were available in the herd, *ceteris paribus*. Furthermore, the average milking period of each cow was assumed to be 6 months. This is compatible with the average milking duration obtained through informal interviews after the field survey. At least 40% of the surveyed farmers milk their cows. The majority (60%) of the farmers did not milk largely due to the breed type kept and insufficient grazing (33%). At least 30% of those who milk do sell with the largest percentage in Malongana (50%), Matshena (21%) and

Dzanani (20%). This indicates a fairly active market for milk. The selling market price for milk was used for the farmers who did not sell milk. The average selling price of milk by farmers ranged from R3.00 per litre in Tshifudi and Guyuni to R7.00 per litre in Vyeboom. The former two areas with the highest selling percentage are located in remote areas. A general observation is that as one moves from the Yellow Line to the Open area the percentage of surveyed farmers who milk tend to decline. For some unknown reasons Guyuni appears to be the exception to this rule.

The last column of Table 2.2 gives the average value of milk production per cow per year. This value ranges from R205.00 in Tshifudi to R1022.00 in Vyeboom. These values also represent the value of home consumption since the selling price for milk is also the buying price in the surveyed areas. In addition, the trading of milk takes place amongst community members. The value of milk production is influenced by the selling price, number of farmers selling milk and the average number of lactating cows.

2.4.2 The Value of Cattle Sales

Table 2.3 shows cattle sales and slaughter from which the value per cow can be derived. At least 64% of the surveyed cattle owners sold their cattle with about 58% and 28% of the animals sold being oxen and cows respectively. A relatively insignificant number of bulls (10%) and heifers (5%) are also marketed. Breeding animals decline in value or depreciate as they age and eventually must be disposed. In the same way cows are usually sold when they are no longer productive in the surveyed areas of Venda. Heifers are rarely sold because they form the cornerstone of the future benefit stream. Sampled farmers' responses as to why they sold their animals were household related reasons, such as to buy food, pay school fees and taxes or to meet miscellaneous domestic expenses. Sales percentages (calculated as the number of farmers who sold cattle/total number of farmers in a particular area * 100) ranges from 52% in Tshifudi to 71% in Vyeboom. A possible explanation for such a high sales percentage in Vyeboom is social risk e.g. theft is said to be rife in that area. It is alleged that butchery owners steal cattle, predominantly bulls and oxen.

Table 2.3: The Value of Cattle Sales

Area	Respondents selling cattle (%)	Average number of cattle sold/year	Farmers selling oxen	Farmers selling bulls	Farmers selling heifers	Farmers selling cows	Farmers who slaughtered	Off-take	Price per animal (R)		Average value of sales per cow (A)	Meat value for home consumption per cow (B)	Total value Per cow (A + B)
			%						Auction	Other	R		
Vyeboom	71	2	53	6	6	29	18	13	-	1640	207	128	335
Malongana	59	3	61	13	4	17	4	15	1900	2105	318	128	446
Guyuni	61	2	17	22	9	41	26	15	-	1650	248	128	376
Matshena	61	3	52	9	-	22	4	14	1900	1785	246	128	374
Dzanani	59	2	41	9	5	27	14	11	-	1710	188	128	316
Tshifudi	52	1	24	12	2	29	12	8	-	1811	145	128	273
Average	60	2	42	12	4	27	13	3	950	1784	225	128	353

Note: The average value of sales per animal (R) was calculated as follows: Average price * off-take. Using the second row as an example. ((1900*29) (see Table 2.4) + (2105*71))/100* 0.15=318. Livestock markets were grouped into two categories (auction and others) in such a way that percentages of other markets were added together.

The value of beef for home consumption was calculated based on the 1997 national per capita beef consumption figure due to a lack of data in rural areas. Such a value amounts to 12.82 kg (Abstract of Agricultural Statistics, 1999) and it was multiplied by the beef price of R10/kg.

From Table 2.3 it is interesting to observe that animal off-take is often concentrated on a particular sex and age group. The off-take percentage ranges from 8% in Tshifudi to 15% in Malongana and Guyuni as shown in Table 2.3. There is generally a larger off-take of oxen in surveyed areas indicating that oxen are the preferred animals for sale. It is important to note that, *inter alia*, off-take is largely influenced by mortality which again affect herd population structure. If mortality savings (deaths prevented) are high and the herd is expanding, a higher off-take is possible. With this in mind, the possible presence of a relatively large number of matured oxen especially in big herds leads one to infer that their primary purpose is to maintain (by non-commercial means) the security, prestige or status of their owners (Upton, 1993). However, this statement does not usually hold when one takes into consideration certain market imperfections within the system. For instance, disease quarantine practices applied to cattle within the Yellow Line area makes it difficult for cattle owners to sell their animals at precisely the optimal moment. The marketing problems especially in Malongana and Matshena are expected to worsen due to an indefinite closure of auction venues observed during the survey period.

As shown in Table 2.4, 15% and 29% of the sales made in Matshena and Malongana respectively were done through the use of auction venues as part of the marketing channels respectively. This is because the two areas surveyed are quite remote and situated closer to the Red Line area (Foot-and-mouth disease area). Cattle within the Yellow Line and the Red Line area have to undergo the quarantine process for 21 days before being moved to other places. Therefore auction venues form part of that process as a disease control measure. Moreover, survey results indicate sales to butcheries as the most active market with respondents' percentage range of 29% in Dzanani and 67% in Vyeboom as indicated by Table 2.4. A possible explanation for such a high sales rate is because these markets are easily accessible. The butcheries referred to here are registered meat businesses that perform the retail function. Unfortunately, the survey did not collect data that actually show the different prices received from these markets. For the calculation of the value of cattle sales (see Table 2.3) the different livestock markets were classified into two categories - auction and others. The auction price was collected through discussions with auction participants and this price was representative of both Malongana and Matshena since they both use the same auction venues. Prices received from other livestock markets were a function of the sampled farmers' willingness to sell, *ceteris paribus*.

The percentage of the sampled farmers that slaughter is far lower than the percentage of farmers that actually sell. The slaughtering percentage ranges from 4% in both Malongana and Matshena to 26% in Guyuni. Cattle slaughtering are rare today and restricted to occasions, such as weddings, religious ceremonies or to instances where the animal is about to die. The decision to slaughter seems likely to be influenced or regulated by the need to satisfy a ceremonial demand. From Table 2.3 one would notice that the Open area is leading with regard to the percentage of farmers who slaughtered. This could possibly be explained by, *inter alia,* a lack of reliable formal marketing channels in the area. Thus, some farmers would prefer to slaughter and sell on their own at an average price of five rand per kilogram.

Table 2.4: Various Marketing Channels Used by the Respondents.

Area	Auction	Butchery	Friends	Butchery and Auctions	Auction and friends	Butchery and friends	Informal traders
	%						
Vyeboom	-	67	33	-	-	-	-
Malongana	29	41	6	24	-	-	-
Guyuni	-	57	36	-	-	-	7
Matshena	15	39	15	15	8	8	-
Dzanani	-	29	50	-	-	7	14
Tshifudi	-	50	20	-	-	30	-
Average	22	47	27	20	8	15	11

In comparison, a study by Nkosi (1994) on marketing of livestock in Lebowa revealed a higher respondents percentage of 44% selling to the private buyers. Nkosi (1994) defined private buyers as any household acquiring animals for different social activities. Private sales are important to farmers as they are in a position to determine the prices for their animals. Private sales were followed by auctions (15%) in spite of the low prices received as expressed by 42% of the respondents. It is therefore imperative that the aforementioned market outlets available in developing areas need to be developed and precede production.

2.4.3 The Value of Manure

Manure has other uses besides being an input to agriculture. Manure is used both for decoration and as crop fertilizer as shown in Table 2.5. There is a relatively insignificant use of manure as a crop fertilizer indicating that respondents rate the manure value for decoration higher than its fertiliser value. All sampled farmers use livestock droppings (traditional polish as farmers put it) for decoration purposes. The use of kraal manure as a crop fertilizer ranges from 4% in Malongana to 83% in Guyuni. This percentage difference may be a result of differences in the prevalence of crop farming amongst the regions. With the exception of Matshena, sampled farmers household in other surveyed areas neither sold the traditional polish nor manure for land fertilisation.

Attaching an exact economic value of manure to these communities was a complex problem since kraal manure is freely available. At least 17% of the sampled farmers in Matshena sell the traditional polish at R1.00 a tin (about 20 litres), and only 9% sell manure for crop fertilization at an average price of R265/bakkie (about a ton). To calculate the value of manure for both the aforementioned purposes one would have to make estimates of the portion of manure collected. Moreover, the economic value of kraal manure to a farming household is obtained by multiplying the selling price by the quantity used usually on a yearly basis. An estimation of the quantities of the traditional polish used in particular was a very difficult measurement to make. It should be acknowledged that the use of the traditional polish is the task solely done by women. Therefore, estimation of the quantity of the traditional polish was done by some women and they estimated that about 250 kg (about 10 bucket on average) are used per year. However, the use of the traditional polish is influenced by two factors namely:

- Season of the year. The use of the traditional polish is lower during the rainy season .
- Effects of special days e.g. Prior to Christmas and Good Friday demand for the traditional polish increases.

Table 2.5: The Use of Manure

Area	Respondents using manure for decoration (e.g. floor preparation)	Manure for land fertilisation	Farmers selling for decoration	Selling price for decorat-ion manure	Farmers selling manure for crop fertilisat-ion.	Selling price for soil fertilisation	Average quantity used		Value		Aggregate value of manure (R/animal)
							Decoration	Fertilis-ation	Decora-tion	land fertilisa-tion	
	%	%	%	R/tin	%	R/ton	Kg/animal		R/animal		R
Vyeboom	100	65	-	-	-	-	11	44	1	9	10
Malongana	100	4	-	-	-	-	13	53	1	11	12
Guyuni	100	83	-	-	-	-	18	67	1	13	15
Matshena	100	39	17	1.00	9	265	16	63	1	13	14
Dzanani	100	77	-	-	-	-	19	77	2	15	17
Tshifudi	100	82	-	-	-	-	19	77	2	15	17
Average	100	58	17	1	9	265	16	63	1	13	14

Note: Using Vyeboom as an example, the value of manure for decoration was calculated as follows, (R20/250kg*11kg/animal) = 1

And the value of manure for land fertilisation was calculated as follows (R200/1000kg*44kg/animal) = 9

The survey has shown that the observed selling price for the traditional polish in Matshena, is below the average price of R2.00/tin prevailing in non-sampled areas. This price was adopted as a standard for all the surveyed areas instead. The economic value of the traditional polish used per cow was thus estimated at R20.00 per year. The average quantity of the traditional polish used per cow reported in Table 2.5 was calculated as the total amount used (250kg) divided by the average number of cattle per farmer. The average value per animal was derived by multiplying the price per kg (R20/250 kg) by the average quantity used per cow.

Some farmers, with the assistance of agricultural officials indicated that about 1000kg of manure per household are used at an estimated cost of R200/ton. Again, R200/ton was used as a standard price for all the surveyed areas. The calculation of the average value for manure (land fertilisation) per animal was done similar to the average value for the traditional polish. The aggregate value for manure shown in Table 2.5 ranges between R9.60/kg in Vyeboom and R16.80/kg in Dzanani.

2.4.4 Work (Labour Value) of Cattle

In developing countries animal draught power represents a major output from the livestock sector. In Africa, animals provide 9% of the use of power for agricultural production. Moreover, ploughing accounts for 90% of animal power usage in primary cultivation (Feuerstein *et al.*, 1987: 178). A survey done by Simalenga and Joubert (1997) in 1994 established that in the rural areas of South Africa 40 to 80 percent of the sampled smallholder farmers were using animal power for transport and cultivation. Oxen represent the most powerful draught animals currently used in South Africa.

Data on the use of cattle for ploughing and transport were collected. As expected the use of cattle as a mode of transport no longer applies in the survey areas and consequently was not included in the valuation. Of the sampled households at least 13% of the respondents in Guyuni and 24% in Tshifudi reported the use of cattle for cultivation purposes. The use of cattle for ploughing is limited, largely due to the availability of tractors (71%) and damage that ploughing causes to the animals (9%).

The survey results on the availability of draught power confirm the observation that there is still a countrywide shortage of draught animals. Only a limited market exists for hired spans and the price charged by those who hired span is estimated to be R110/hectare for a span of 4 oxen. This translate to a cost of at least R28/ hectare/ox. This was considered to be a standard price for all the surveyed areas in this study.

Secondary sources indicate that a span of 4 cattle takes 6 hours to cultivate half a hectare (Simalenga and Joubert, 1997: 17). It was assumed that this translates to 12 hours for the same span to cultivate a hectare, *ceteris paribus*. A study by Rocha *et al.*, (1991) in Mozambique showed that oxen worked an average of 62 days in a year and this figure was found to be comparable with figures reported from other countries in Sub-Saharan Africa. In Venda, however, a span of 4 oxen takes 10 hours to cultivate a hectare working for an average of 50 days in a year (Lubbe, 1998). The number of animals' working days is largely influenced by rainfall availability and soil depth. For example, more land will be cultivated during good rainfall years leading to an increase in the number of animal working days.

Table 2.6: The Value of the Work of Cattle

Area	Use of cattle (days/year) plough	Cost (R/ animal/day)	Probability of using draught power	Value of ploughing activity (R / animal)
Guyuni	50	28	0.13	182
Tshifudi	50	28	0.24	336
Average	50	28	0.32	259

Note: The value of the work of an animal was calculated as follows, using the second row as an example: (50*28)*0.13 = 182.00. Probabilities were derived from the survey data.

The average value of ploughing activity per cow per year is estimated to be R259.00 as indicated in Table 2.6. This value can be increased only if animal traction can be seen to have clear social and economic benefits. There is, however, a need for greater government support in terms of a definite animal traction policy as well as training, research, development and extension.

An initiative by the new South African government which introduced a policy that focuses on the needs of the community, as emphasised in the Reconstruction and Development Programme, could perhaps stimulate the use of traction animals to collect water, food, fuel and for transportation, agriculture, as well as the lot of women in rural areas, thereby helping to address gender issues.

2.4.5 Biological Productivity

Table 2.7 shows the average number of cattle and calving rates per farmer by area. Upton (1993: 464) defined calving rate as..."the number of calves born per year as a percentage of the number of cows". Due to paucity of data, calving rate calculations in this study was based on the number of cows and calves available at the end of the year (1996). This was considered as an appropriate period because it largely forms part of the calving season. This period coincide with heavy rains resulting in sufficient feed availability. A calf is defined as animals of both genders less than six month of age and cows as any female with at least one parturition. The minimum herd size was 2 in Malongana, Matshena and Dzanani and the maximum number held by a household was as high as 98 in Matshena. With the exception of Matshena, herd size in other surveyed areas is almost similarly spread. For instance, Vyeboom had a minimum and maximum level of 3 and 52 respectively, while in Malongana these statistics are 2 and 55 respectively. Slightly different to this are Dzanani and Tshifudi with a minimum of 2 and 3 and a maximum of 35 and 39 respectively.

The average cattle ownership by a farmer ranges from 13 in Dzanani and Tshifudi to 23 in Vyeboom. Average values, however, are influenced by extreme values, hence the additional use of the other measures of central tendency (median and mode). The median is the middle value of the observed measurements when arranged from the smallest herd to the largest while the mode indicates the observation (Cattle herd) with the largest relative frequency. From Table 2.7 it appears that both the median and mode values on herd size is smaller than the average, with Guyuni being the only exception. In general, farmers in the surveyed areas mostly have a herd of 10 cattle, although this vary from a minimum of 2 or 3 to as high as 98 in limited cases.

Table 2.7. Cattle Number Per Farmer and Calving Percentage

Area	Cattle per farmer					Calving rate (%)			
	Min	Max	Average	Median	Mode	≤50	51-70	71-90	100
Vyeboom	3	52	23	15	12	64	12	6	18
Malongana	2	55	19	14	-	60	-	10	30
Guyuni	3	42	15	15.5	16	63	14	9	14
Matshena	2	98	16	11.5	13	50	-	5	45
Dzanani	2	35	13	11	6	35	15	10	40
Tshifudi	3	39	13	10	12	76	6	-	18
Total	2	98	17	13	10	58	8	7	28

Table 2.7 shows that at least 28% of the sampled farmers maintain a calving percentage of 100%, whereas the majority (58%) have a calving percentage that is below 50%. Although causality between the low calving percentage and the factors leading to it have not been tested in this survey, it is known that it is caused by factors such as mating rates, poor nutritional status and/or poor health (Herman *et al.*, 1989). More specifically, the incidence of diseases can in many cases quite substantially reduce the general productivity of animals at a loss to the society. Some of the factors can be directly influenced or controlled by farmers in order to avoid high calf and adult cattle mortality and, hence, increase the biological productivity of the herd.

However, factors such as drought are beyond the control of the farmer and one can at best try to limit the effects if the means to implement alternatives are available and affordable. Since biological productivity is usually linked to the number of mature females in the herd, an improvement in the calving rate could be tantamount to an improvement in the return on the investment in cattle. Tick-borne diseases result in death of breeding stock, infertility or abortion, thus effectively destroying the capital stock of the production base.

Against this background and given the large proportion of farmers in Venda who experience a low calving percentage it should be clear that a need exists to improve the biological productivity of the regions' herds. Naturally this would call for sustainable production practices in the broader economic and environmental context of the region.

2.5 Integrated Crop-Livestock System

Crop production and cattle rearing are the dominant economic activities of the area surveyed. The majority of the sampled farmers (86%) practice crop farming largely under dryland conditions. Maize is the main crop, being intercropped with groundnuts, millet, watermelons, *etc*. Ploughing is by far the most common operation for which draught animals are employed in integrated farming. This survey did not collect data that would allow a quantitative relationship to be established between animal traction, area cultivated and total production. Research done in countries like Togo, Sierra Leone, Burkina Faso, Ghana, Zambia and Mali, however, revealed a positive relationship between area cultivated and the utilisation of animal power and overall quantities of crops being produced (Rocha *et al.*, 1991).

The integration of crop and livestock farming promotes the division of labour within a household by age and gender in the interest of optimal resource utilisation. For example, clearing the land for crop production, and then ploughing it with cattle, is work mainly done by men. Women have the responsibility for planting and weeding. Grazing cattle are often supervised by children, although this activity may conflict with school attendance.

During work peaks (such as harvesting time) however, all the available family members work in the fields. The areas of interaction in the livestock-crop system are both complementary and competitive. The following sub-section deals with the areas of interaction.

2.5.1 A Competitive Relationship in Livestock-Crop Integrated Farming

Fertile grazing land competes with the cropping land especially during summer. Farmers devote their land to production in accordance to food needs and economic benefits. Labour requirements for both enterprises differ with respect to different seasons of the year to the extent that, depending on the season, the relationship might be complementary or competitive. As the level of farm activities increase during summer time, the demand for labour also increases. The two enterprises compete for the labour input and for funds available for the purchase of inputs. Labour for herding is employed by 11% of the sampled farmers, but these labourers also work in the crop enterprise. The integration of livestock with crop farming require practices that optimise on human resource utilisation. The nature of livestock production further intensifies competition since it is a long-term investment in contrast to annual/seasonal crops. This competition is very evident during summer time when the increase in tick availability coincides with the cropping season and this exacerbates competition for the purchase of both enterprises inputs.

Competitive relationships between the two enterprises also manifest itself with regard to government policies. Historically government policies have been biased towards crop production to solve food shortages. For example, although the qualification of animal health and crop extension officers are identical; more extension work has been devoted towards crop production. This became evident when respondents were asked whether they normally have animal health based outreach programmes such as farmers days? The response of some of the sampled farmers was yes, referring to crop based outreach programmes. Moreover, some of the respondents expressed that such ventures are rarely done for the livestock sector.

2.5.2 Complementary Contributions of Crops and Livestock to the Welfare of Farmers

In the past when a food shortage problem was addressed it used to automatically refer to food crops. However, crops and livestock complement each other in providing a balanced diet. The other area of complementarity is with regard to employment. Both crops and livestock provide employment at the household level and at times hired labour is used. The use of hired labour is justified in viable enterprises only (Mgheni *et al.*, 1992). Generally income from crops is seasonal while those from livestock are more evenly distributed throughout the year. Crop seasonality creates the existence of a lag between the decision to produce and the decision to sell the surplus produced. Farmers usually prefer a regular source of income that will support them when the need arises. More importantly the existence of the lag, however, depends on the stages of farming development. For instance, its only when one has a well established herd that one can even out the income stream. The most important advantage of introducing livestock into crop farming enterprises and *vice versa* is the reduction of risk through diversification.

Certain outputs from both livestock and crop enterprises serve as inputs for each other. Some of the respondents (58%) use kraal manure to enrich and improve soil productivity on the general assumption that this lead to increased production. Crop residues are fed to the cattle of 73% of the sampled farmers. These residues otherwise have had to be removed by using human labour. It can equally be argued that crop residues provide feed for livestock especially in dry season. Either livestock or crop products can be sold to raise income for the purchase of inputs e.g. acaricides and fertilisers.

The determination of the economic value a rational farmer would place on the home produced inputs under a crop-livestock integrated system is not different from determining the cash value of subsistence consumables. In all cases the appropriate value of subsistence input is the cash cost of purchasing its replacement i.e. the cash cost of purchasing fertiliser to replace manure.

2.6 The Value of Livestock to the Sampled Household Farmers in Venda: A Comparison.

Table 2.8 shows a summary of the results of the value of cattle to the sampled cattle farmers in Venda. These results are compared with similar results of the studies done by Townsend and Sigwele (1997) in the Ngamiland region of Botswana and Scoones (1992) in southern region of Zimbabwe. The results of these studies are presented in Table 2.9 and 2.10. The comparison is done to establish or identify the most important value of cattle, as well as determining the differences that exist amongst the regions thereof. Comparison is done in percentages terms and not in monetary values. This is because of differences in currencies (Rand, Pula and Zimbabwean Dollars) amongst the countries.

There are variations in cattle values amongst Venda regions. For instance, in Vyeboom milk contributes at least 32% of the total value (R3157.00). The percentage contribution of milk value to the total milk value of the survey areas ranges from 32% in Vyeboom to 6% in Tshifudi. In addition, there is no any single cattle value that dominates all the cattle values across all the regions. For instance, in Vyeboom milk contribute the highest percentage (75%) of the total average cattle value (R1367.00) in that region. Whereas in Dzanani sales contribute the highest percentage (55%) of the total average cattle value (R573).

Table 2.8: The Value of Cattle to a Rural Household in the Sampled Areas of Venda (R/animal)

Area	Milk	Sales	Manure	Work of cattle	Total value per animal
Vyeboom	1022	335	10	-	1367
Malongana	793	446	12	-	1251
Guyuni	365	376	15	182	938
Matshena	532	374	14	-	920
Dzanani	240	316	17	-	573
Tshifudi	205	273	17	336	831
Total	3157	2120	85	518	5880
Average	526	353	14	259	1152
	Comparison within and amongst regions (%)				
Vyeboom	32 (75)	16 (25)	13 (1)	-	23 (100)
Malongana	25 (63)	21 (36)	15 (1)	-	21 (100)
Guyuni	12 (39)	18 (40)	19 (2)	35 (19)	16 (100)
Matshena	17 (58)	18 (41)	18 (2)	-	16 (100)
Dzanani	8 (42)	15 (55)	21 (3)	-	10 (100)
Tshifudi	6 (25)	13 (33)	18 (2)	65 (41)	14 (100)
Total	100(54)	100(36)	100(1)	100 (9)	100 (100)
% contribution	46	31	1	23	100

Note: Figures in parenthesis deal with a comparison within a region and those outside deal with comparison amongst regions. All figures are in percentages.

Table 2.9: The Value of Cattle to a Rural Household in Ngamiland, Botswana (P/animal)

	Milk	Sales	Manure	Work of Cattle	Total Value per Animal
Total	2922	513	5	10 430	13 869
Average	244	43	-	869	1156
% contribution	21	4	-	75	100

Source: Townsend and Sigwele (1998)

Table 2.10: The Value of Cattle to a Rural Household in Zimbabwe (Z$) (1987)

	Milk	Sales	Manure	Work of cattle	Total value per animal/year
Average	187	15	26	593	821
% contribution	23	2	3	72	100

Source: Scoones (1992)

Of the total average value of an animal (R1152) in Venda, milk contribute the greatest percentage (46%) followed by sales (31%), work of cattle (23%) and finally manure (1%). However, the results of the study done in Botswana (Ngamiland) and Zimbabwe almost show the same order pattern of cattle values, but there exist a slight difference amongst all the countries. Of the total average value of cattle in Botswana work of cattle contributes the highest percentage (75%) followed by milk (21%), sales (4%) and lastly manure (0%). In Zimbabwe work of cattle also contributes the highest percentage (72%) followed by milk (23%), manure (3%) and lastly sales (2%). This comparative analysis seems to show milk as the most common important cattle value in all the countries under review. Differences that exist in cattle values within various regions in Venda, as well as amongst different countries probably depends upon how respondents value their cattle or cattle product. This valuation is influenced largely by the market forces.

2.7 Conclusion

This chapter attempted to determine the value of cattle in the surveyed areas in Venda using several criteria. The rationale for undertaking this analysis was to show the importance of cattle and the impact which mortalities could have to the surveyed rural household. A quantitative valuation of cattle is done because it forms the basis for cost-benefit analysis. In addition, it assists both farmers and the government in assessing the extent of the impact that cattle mortalities have to the rural household. The criteria used for valuation are the sales value, milk, manure and ploughing which were quantified using the replacement value method. Table 2.8 shows a summary of the results by area. More importantly, the values expressed should be viewed as an opportunity cost of the cattle.

Benefits derived from integrated crop-livestock farming are not quantified due to paucity of data and as a result are not included in the summary Table 2.8. In the past many policy proclamations have decreed the low productivity of the livestock system in small-scale farming areas. This was because the productivity of the system was being measured according to a single criterion – the sales value. The average total value is R1 152 per animal and this value represents the value of an adult cow. Depending on the age, sex and the condition of an animal, *etc.*, this value can be low or high.

CHAPTER 3

THE EMERGENCE AND SPREAD OF TICK-BORNE DISEASES AND THEIR CONTROL IN SOUTH AFRICA

3.1 Introduction

Ticks and tick-borne diseases constitute one of the principal threats to the livestock industry in Africa. The most serious tick-borne disease problems of the 19th century were the spread of heartwater disease through the coastal areas of the Eastern Cape Province due to the spread of the tick vector, *Amblyomma Hebraeum* (Norval, 1994). The literature suggests that tick-borne diseases were not a major problem in the indigenous cattle breeds prior to the introduction of the exotic breeds. Due to heavy stock losses in the face of the rinderpest disease, exotic breeds were introduced in an attempt to re-establish the herd.

This chapter examines the occurrence and spread of tick-borne diseases in South Africa from a historical perspective. It then focuses on the epidemiology of tick-borne diseases. This is followed by a review of past options for tick control, which then form the basis for future tick control strategies.

3.2 Historical Occurrence and Spread of Tick-borne Diseases in South Africa

3.2.1 Heartwater

Addressing parasitologists in a meeting held at Onderstepoort on the 15th January 1975, Theiler (1975: 303) indicated that ticks have been with us since the beginning of time. Tick-borne diseases of major economic importance that affect cattle are heartwater, redwater and gallsickness. Heartwater is generally the most prevalent and the first to be established tick-borne disease of cattle in Africa (Lawrence *et al.*, 1994). According to Neitz (1968, cited in Provost and Bezuidenhout, 1987:165), the first record of what probably could have been heartwater was made in South Africa by the Voortrekker pioneer, Louis Trichardt in 1838. He mentioned a fatal disease "nintas" following on a massive tick infestation amongst his sheep.

In 1888, a disease that was apparently known as heartwater was reported to the Cattle and Sheep Disease Commission in Grahamstown by a farmer, John Webb. He was of the opinion that the disease was introduced into the Eastern Cape from a cow that was imported from Zululand in approximately 1837. Subsequently, the disease was reported from various parts of South Africa. This confusion makes the information regarding the incidence of heartwater unreliable.

Gray and Robertson first described heartwater in 1902 following its introduction into Zimbabwe and it was named Rhodesian redwater. It was introduced into Zimbabwe by cattle that were imported from Kenya and Tanzania during 1901 to 1903 for the purpose of restocking the region after the ravages of the rinderpest epidemic of 1896. Except in Zimbabwe, the disease was later called African Coast fever. The causal organism was named *Theileria parva parva* to distinguish it from other members of the *parva* complex that causes diseases.

The disease spread southward along the East Coast of southern Africa through Mozambique, Swaziland, Natal, Transkei and the Cape Province. Between the period 1901-1914, the disease was estimated to have killed one and a quarter million of the four million cattle that were present in the affected territories. In South Africa, losses attributable to ticks and tick-borne diseases have been estimated to be between 70 and 200 million rand annually. On a worldwide basis, losses estimated to amount to hundred of millions dollars (Bigalke, 1980 cited in Soll, 1989).

However, there seem to be no definite answer as to whether heartwater is an indigenous disease of Africa. In their overview of the history of tick-borne diseases, Lawrence *et al.* (1994) seem to suggest that heartwater is a disease indigenous to Africa. No conclusive evidence is, however, put forward in their study to support this suggested conclusion.

The southward advance was halted in the East London region, and the disease was subsequently eradicated by a prolonged campaign consisting of movement control, tick control, quarantine procedures, destocking of infected pastures, slaughter and dipping in arsenic solutions. The disease was eradicated in South Africa by 1954. Such a breakthrough with regard to the control can be attributed to a blood vaccine that was developed at Onderstepoort Veterinary Institute in 1945 after several unsuccessful attempts of proper vaccine development by an eminent microbiologist Robert Koch and Sir Arnold Theiler.

3.2.2 Redwater

Henning (1949) argues that redwater has been known to exist in some parts of the southern states of North America for a very long time. The first record of the disease dates back to 1796 when an outbreak of Texas fever occurred amongst the local cattle breeds in the state of Pennsylvania soon after the introduction of a herd of cattle from South Carolina. The disease was first noticed in South Africa in 1870 along the Natal Coast. In South Africa redwater is transmitted by *Boophilus decoloratus* (the blue tick). The manner in which the infection was introduced into South Africa has not yet been definitely cleared up (Henning, 1949: 372). Three probable sources of infection have been suggested:

- Since the first outbreak of redwater occurred shortly after the importation of a number of cattle from Madagascar, the introduction of the infection into Natal has been ascribed to these cattle.
- While investigating Texas fever (redwater) in east Africa in 1897, Koch obtained information indicating that the disease had been existing enzootically for a long time on the island of Mafia and along the East Coast of Africa. The possibility that the infection extended southwards from east Africa until it finally reaches Natal cannot be excluded.
- The possibility exists that cattle that were imported introduced the infection from Australia or America.

Soon after the disease was first identified it became established along the coastal regions of Natal from where it was carried inland by means of transport oxen returning from the coast.

From Natal, redwater spread both into Transvaal and the Cape Colony reaching both provinces at about the same time: 1873 is the date given by Henning (1949). Due to the non-existence of any restrictions imposed on the movements of cattle in the Transvaal, the greater part of South Africa became infected within a short time and the locally bred cattle acquired immunity against the infection. By 1883 the disease had established itself in almost all the provinces.

3.2.3 Gallsickness (Anaplasmosis)

Finally, the other tick-borne disease of great importance is gallsickness (anaplasmosis). It is believed that gallsickness may have existed in South Africa possibly before the appearance of redwater, but it was commonly confused with redwater (Henning, 1949). What is probably the first description of gallsickness in South Africa was given by Hutcheon as "Jaundice or Biliary fever" in his annual report for 1897[1]. According to the report the disease was first observed by Spreull in the Barkly East district, where it appeared amongst several cattle inoculated with defibrinated blood obtained from bovines immune of rinderpest. An outbreak of a similar disease was also reported in Robben Island, which again occurred amongst cattle inoculated against rinderpest. In 1898 a similar disease was reported amongst cattle inoculated against rinderpest in Kimberly. Gallsickness is caused by an endoglobular parasite, *Anaplasma marginale* belonging to the protozoa.

3.3 Epidemiology of Tick-borne Diseases of Cattle

The epidemiology of tick-borne diseases of cattle has been studied intensively and is well documented in the literature (see for example Coetzer *et al.* (1994) and Lawrence, 1996). Although each disease has its own special characteristics, they share many features, which makes it possible to discuss their epidemiology in general terms.

The presence of tick-borne diseases exists in one of two epidemiological states, endemic or epidemic (Bezuidenhout *et al.*, 1994; Lawrence, 1996). An endemic state is one in which the disease is constantly present at a predictable level that causes only a minimal effect to cattle production. Where hosts, haemoparasite and vector coexist in a stable environment with a virtual absence of clinical disease, the state is regarded as one of endemic stability.

[1] Hutcheon was one of the veterinarians in South Africa located in the Cape Province. He was also one of the veterinarians in South Africa who were successful in eradicating the tick that caused East Coast fever through regular dipping.

Where clinical disease occurs in an endemic situation, the epidemiological state is regarded as endemically unstable. In contrast, an epidemic state is one in which the disease occurs at a rate above the expected level, particularly where the disease has not been present previously. It occurs where infection is introduced into a previously disease-free area with a fully susceptible cattle population (Lawrence *et al.*, 1994).

The epidemiological status of disease depends mainly on the status of the ticks and of the cattle that they feed on. Both factors are dynamic. Changes in climate, vegetation, as influenced by changes in land use and climate, and in methods of tick control have major effects on the abundance of the tick population in an area (Lawrence, 1996: 179). In addition, Bezuidenhout *et al.* (1994) argue that the transmission of tick-borne diseases does not solely depend on tick vector competence, but also on their distribution and the adaptations of domestic stock, their activity and abundance being influenced by temperature and humidity. On the other hand changes in cattle production systems resulting mainly from movements of human population, economic factors and diseases have major effects on the abundance and breeds of cattle in an area. For these reasons, the epidemiological status of an area may change rapidly, from disease free to epidemics or from endemic stability to instability, and vice versa (Lawrence, 1996).

It is believed that Africa was generally endemically stable for tick-borne diseases among cattle until European colonists began to introduce European breeds to the local cattle herds in 1901/02. The resistance of local breeds e.g. Nguni was probably due to an inherited resistance acquired through years of natural selection. This resistance does not prevent the establishment of infection, but reduces the severity of clinical diseases (Vos and Potgieter, 1994). Lawrence (1994) attributes the indigenous breeds' resistance to ticks and a tolerance for tick-borne diseases to genetic factors that they evolved.
European colonists introduced their own breed of cattle that were perceived to be much more productive than the indigenous breeds of Africa. With no resistance to ticks or a tolerance for tick-borne diseases and no previous exposure to develop immunity, these cattle were highly susceptible to tick-borne diseases and their introduction led to epidemics of all the tick-borne diseases. The colonists introduced the use of acaricides in an attempt to control the tick vectors. The use of acaricides has become increasingly

less efficient for a variety of reasons (Lawrence, 1996). As a result tick-borne diseases has assumed a more important role as a limiting factor in the improvement of animal production in Africa.

3.4 Previous Control Strategies for Ticks and Tick-borne Diseases.

Various governments and individuals widely adopted a practical and economical approach of controlling tick-borne diseases through tick control. Although vaccination or immunization forms part of the control strategies, the two are beyond the scope of this discussion since they appear to be too specific for a particular tick-borne disease, hence, making it impossible to discuss them in general terms. Some of the strategies discussed here are no longer practiced today particularly in the communal farming areas where communal grazing is the custom.

The emergence of East Coast fever left South Africa with only two control options, namely: to control or not to control. However, perhaps for economic reasons South Africa opted for the former that largely depended upon dipping. As a result in 1901 the first diptank was constructed in South Africa. The first acaricides of importance in Africa was arsenious oxide that was in wide use from the early part of the century until the 1960s and 1970s. Since then a succession of acaricides (e.g. organophosphates, carbamates, amidines and synthetic pyrethroids) has been marketed (Norval *et al.*, 1992). Animals were dipped at three, five or seven day intervals in the first half of the century to control East Coast fever (de Vos and Potgieter, 1994). However, short interval dipping failed to eradicate the infection. In affected areas all cattle which died had a spleen smear prepared and the smears were sent to an examination centre.

In addition, cattle on the infected farms and also on the first and second contact farms were kept in quarantine for at least 18 month and acaricides application carried out on a 5-5-4 day basis in an effort to destroy infected ticks. The essence of this strategy was to control all stages of tick development throughout the year, a strategy known as intensive tick control. This practice spread rapidly throughout Africa following the introduction of exotic breeds (Pegram *et al.*, 1993).

According to Young *et al.* (1988) such a policy succeeded in reducing the number of outbreaks, but failed to eradicate East Coast fever. From 1948 onwards all cattle on infected farms were slaughtered and the farms were kept clear of cattle for 15 to 18 months, a practice known as destocking. Stocks, such as sheep and goats not susceptible to East Coast fever were introduced to clean the *T. Parva* infection from ticks. All fences on the infected farms were officially inspected and maintained. This method was used effectively in southern Africa (Lawrence *et al.*, 1994). However, this technique fell into disuse as the cattle population grew and vacant clean pastures became more difficult to locate. Closely related to destocking is isolation. Susceptible cattle are maintained as a closed herd on properly fenced pastures. In situations where fencing is not practicable, zero grazing can be practised. Isolation as a technique is too prone to breakdown to be relied upon as a sole method of tick control. Therefore, it is closely applied in conjunction with acaricides.

In many areas of Africa the co-existence of wildlife with cattle compounds the problems of control and it maintains tick-borne diseases and their tick vector. No control measure other than slaughter can be implemented for these populations (Young *et al.*, 1988). The slaughter policy is impracticable and probably undesirable, therefore many areas of Africa will have to continue living with ticks and tick-borne diseases. Without any doubt complete ticks and tick-borne diseases eradication is prohibitively expensive and probably impossible. Current thought dictates that an integrated control strategy has to be found which will allow cattle to live in reasonable harmony with tick-borne diseases. This implies the control of ticks in such a way that natural infection of livestock at an early age is possible, while there is also subsequent regular exposure to ticks so that high levels of immunity is maintained.

3.5 Conclusion

This chapter attempted to examine the occurrence and spread of tick-borne diseases and their control in South Africa. The first tick-borne disease of economic importance to be established in southern Africa is heartwater. It invaded South Africa from Zimbabwe moving along the coastal regions. Various ticks and tick-borne diseases control measures have been applied. Short interval cattle dipping in acaricides proved to be the most successful tick control measure. The efficacy of such acaricides manifested themselves by eradicating East Coast fever in 1954 in South Africa. Despite this success, cattle dipping continued to be applied to reduce the outbreak of other major tick-borne diseases such as gallsickness and redwater.

However, it is believed that short interval dipping cannot be economically justified, particularly in the case of the indigenous African breeds. In endemic areas cattle lose their immunity to all tick-borne diseases because of the lack of natural challenge. It is on this account that experts are in favour of a strategic tick control strategy. It should be acknowledged that control strategies and the intensity of application vary greatly among different countries and geographic regions due to variations in ecological conditions. Therefore, it is not possible to advocate a single control strategy.

CHAPTER 4

TICKS AND TICK-BORNE DISEASES CONTROL STRATEGIES.

4.1 Introduction

Ticks are among the most important parasitic vectors of cattle diseases in South Africa and through their blood sucking activity, they also have a devastating effect on their hosts, unless measures are applied to reduce their numbers (Howell *et al.*, 1981). Veterinarians and farmers believe that the control of ticks is of importance in maintaining the health and productivity of cattle. Hence a variety of control measures, conventional and traditional are currently employed to control tick numbers. Chemicals form an important part of most of the currently used tick control measures, of which the classical plunge dip system is the most widely used.

The use of this system is not a function of personal choice, but it is compulsory by law. The plunge dip system also forms part of a comprehensive strategy of disease surveillance. In the Venda region, disease surveillance is a public good primarily monitored by the animal health extension officer and the state veterinarian. The duties of the animal health extension officer are to inspect, count, dip, educate and immunize cattle against notifiable diseases like brucellosis and anthrax. The state veterinarian performs disease diagnosis and control, and provide clinical services and do the regulatory work.

The objective of this chapter is to describe various ticks and tick-borne diseases control measures employed by small-scale farmers surveyed under the communal grazing system. By necessity cattle dipping in acaricides remains the prime method for controlling ticks in South Africa. Other tick control measures have largely been left to the skills of the stock farmers who mostly apply them in the traditional manner. Lacking the basic scientific knowledge of either the parasites or the remedies involved, and since the degree of tick control obtained was generally satisfactory the tradition is still in operation.

4.2 The Classical Ticks and Tick-borne Diseases Control Strategy in Venda

Control measures against ticks and tick-borne diseases were applied on a large scale in Southern Africa following the spread of East Coast fever from East Africa (Norval, 1994). Prior to that, tick-borne diseases had not been reported as problematic in indigenous African breeds. *As a result of a 95 percent mortality rate caused by East Coast fever during the period 1901-02 in southern Africa, a considerable effort was therefore devoted to the development of control measures.*

Early attempts at vaccination by Robert Koch and later by sir Arnold Theiler were largely unsuccessful. However, the knowledge about the tick responsible for the disease transmission (brown ear tick) led to more successful control measures which were based on tick control, quarantine procedures, pasture spelling, slaughter and dipping in arsenic solutions. Dipping proved to be the most practical and effective measure, which then became a compulsory mainstay of tick control. This occurred after East Coast fever was brought under control and its complete eradication in 1960.

After the eradication of East Coast fever two options were essentially open to southern African countries; they could either control the remaining major tick-borne diseases (babesiosis, anaplasmosis and heartwater) by vaccination and move towards reduced tick control and endemic stability, or they could continue to control the diseases by intensive dipping. It was established that the most efficient and economical manner for tick control was to target treatment at the parasitic stage, and short interval dipping of livestock became the standard method of tick control. This method promotes endemic stability so that infection is universal but there are no losses.

In South Africa compulsory dipping was abolished and the choice was left to individual farmers (Norval, 1994). However, in some of the autonomous South African homelands compulsory dipping carried out by government on communal grazing continued to be enforced through legislation. Although indirectly stated this was also the case in Venda as was stipulated in the Venda government gazette which state that, "By law a stockowner is now compelled to produce his cattle for inspection and tally recording by a stock inspector at the stock inspection point (diptanks) at least every 14 days" (Republic of

Venda, 1984: 2), and this practice is still in operation today. Cattle are brought to the diptank for the aforementioned two purposes to be immersed at the expense of acaricides. According to Lawrence (1996), there is no justification in insisting that every animal be produced every week and immersed at considerable expense in a tank for other disease control purposes. Compulsory dipping may at one time have been thought to be leading towards eventual tick eradication, which would have provided a possible case for public funding, but today the perception is gaining that eradication is an unlikely prospect.

Presently there are 127 diptanks in Venda of which some were initially erected in the mid 1920s (Neluvhalani, 1997). Cattle are either dipped on a weekly or fortnightly cycle depending on the tick challenge of a particular area, although Bachmann (1992) argues that less than 10% of the cattle in Africa are dipped with any regularity. There is a large variety of acaricides to choose from, each having its own application and management system (Dipping Policy Survey, 1997). The commonly used acaricides are Grenade, Triatix and Clout (pour-on). Pour-on is used in cases where there is a shortage of dipping water with a heavy tick infestation and when cattle are not in a good enough condition capable of swimming. Unlike Grenade and Triatix provided by the government, Hoechst as part of the Reconstruction and Development Programme package donated Clout. It is a worrying fact that cases of resistance by ticks to the available acaricides is on the increase. The increase of tick resistance to acaricides and the rapidly rising costs of running dipping services lead to doubts as to whether the Northern Province will be able to sustain effective tick control.

4.3 Purpose of the Dipping Venues (diptanks)

The assessment of any programme is done against its intended objectives or purpose. Unless the programme has achieved its primary objectives, it is hard to defend its continuation.

The main reason for the construction of diptanks was because of the outbreak of East Coast fever whose control was dependent on the control of the tick vector, as previously discussed. Once East Coast fever was brought under control, it was apparent that dipping was beneficial to the farmer, as well as to the veterinary services. The gathering of animals at dipping venues offers opportunities to veterinary services to perform the following important functions:

- Diseases surveillance
  - The physical concentration of cattle at diptanks is used by the state to perform compulsory cattle inspection. This inspection is in respect of controlled diseases such as Foot-and-mouth disease. Surveillance of Foot-and-mouth disease is a function of international, national, provincial and local importance based on compulsory inspection at various intervals and movement control (through quarantines) of various intensities in the whole of the Foot-and-mouth disease controlled area. However, the danger associated with communal diptanks is that they can act as centres for disease transmission.
  - The surveillance of the status of animals with respect to condition, general health, production and reproduction, as well as monitoring of mortalities is also made possible by the communal cattle dipping system. Finally, it is hardly possible to perform diagnostic testing in respect of controlled diseases such as brucellosis in the absence of the communal cattle dipping set up.

- Extension
  - Dipping at communal diptanks is also seen as an opportunity for effective extension, education, training, practical demonstration and the collection of census data. Similarly, dipping attendance, *inter alia*, is an important forum for interface between cattle owners and government veterinary officials where cattle statistics are collected and movements permits authorised, *etc*. Under this system the farmer is obliged to explain the whereabouts of absent cattle. The costs of performing extension as effectively without this opportunity would be enormous, rendering extension unaffordable and unachievable.

Finally, dipping venues also offer some unintended services. It was observed that nowadays it also serves as a slaughterhouse for private buyers. Private buyers e.g. butchers use diptanks as a place where they can get animals for slaughtering, negotiate terms of trade and conclude the transaction only if the buyer and the seller satisfactorily agree on the price. However, the cattle owner priorities and the objectives of keeping the cattle, play a significant role on the decision to sell. It can be argued that dipping venues provide place utility to buyers and sellers. Thus, the advantage of reducing the transaction costs to both buyers and sellers (farmers). Fortunately, because of lack of formal reliable market both farmers and private buyers sometimes find themselves in a coincidence of needs situation.

4.4 Limitations of the Existing Ticks and Tick-Borne Diseases Control Measures

Tick-borne diseases can be effectively controlled by the control of the vector ticks with acaricides. The widespread application of acaricides does, however, have certain limitations. The classical method of controlling ticks on cattle is by dipping in acaricides. Cattle are passed through the plunge dip where complete immersion of cattle is attained to kill the attached ticks. This method has certain flaws and limitations[2]. Eleven percent (14) of the 125 sampled farmers expressed some dissatisfaction with the classical control method and with the majority of these (8%) being Dzanani cattle owners. The development of tick resistance to successive acaricides compounds is a major problem stated by 79% of the dissatisfied cattle owners. This problem ranges from 9% of the dissatisfied respondent in Vyeboom to 91% in Dzanani as shown in Table 4.1. The problem of tick resistance can be attributed to incorrect use of acaricides (Dipping Policy Survey, 1997). However, the exact extent of acaricides resistance is not yet known (Oberem and Schroder, 1994).

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[2] The problem of the classical tick control method forms part of a complex problem limiting cattle production in Venda. See figure 1 (Appendix 1) for a diagrammatical outlay of the problems confronting respondents.

Table 4.1: **Limitations Associated with the Classical Tick Control Measure as identified by the Sampled Farmers**

	Tick resistance	Lack of dipping water supply	Incorrect use of acaricides	Total number of respondents
		%		
Vyeboom	9	-	-	1
Malongana	-	-	-	-
Guyuni	-	-	-	-
Matshena	-	-	100	1
Dzanani	91	-	-	10
Tshifudi	-	100	-	2
Total number of respondents	11	2	1	14
Percentages	79	14	7	100

Note: Values are calculated as a percentage of the total number of dissatisfied farmers and not the total number of the respondents (125)

As resistance to one compound builds up new acaricides are developed, but its effectiveness does not last and it must eventually be replaced by newer and different compounds. Thus, the use of acaricides demands continuous checks on the development of acaricides. The resistance problem has been exacerbated by the increasing costs of acaricides and poor management by the farmers. The increasing costs of acaricides coincide with year-on-year cuts in the veterinary budget.

Other considerations which have rendered acaricides application a less reliable method include shortages of water for public dips and incorrect use of acaricides. Respectively, an insignificant number of the dissatisfied cattle owners 14% and 7% expressed lack of dipping water supply and wrong use of acaricides as some of the major problems experienced. Lack of water renders diptanks non-operational especially during drought years. For instance, the devastating drought of 1983 made all the diptanks in Venda non-operational. Furthermore, this method is not applicable during drought times because of the weak condition of cattle. Another complication associated with the use of acaricides is that they are environmental pollutants and contaminate meat and milk and may endanger human health. This arises from direct contact, spilled or misused acaricides and from the consumption of products derived from treated animals.

Finally the use of communal diptanks put a large demand on human labour for trekking animals to and from diptanks. Losses are also incurred whilst driving animals through diptanks as it creates stress induced abortions, drowning and physical injury (Mukhebi and Perry, 1992). In addition, the constant trekking of animals to and from diptanks often creates gullies and the frequent concentration around the tanks lead to overgrazing both of which cause erosion and environmental degradation. The limitations associated with the current methods of ticks and tick-borne diseases control are prompting a search for new, safer, cheaper, more effective, environmentally friendly and sustainable control.

4.5 Alternative Tick Control Measures Used by the Sampled Farmers

It has been acknowledged that of all the ectoparasites, ticks cause the greatest economical losses in livestock production (Okello-Onen *et al.*, 1992). And as a result tick control is perceived by cattle owners as an important aspect of animal husbandry. In the past tick control largely carried out by the plunge dip used to be viewed as part of the government routine services. However, this view no longer hold to all cattle owners surveyed.

Some of the sampled farmers (61%) supplement dipping with other individual organised tick control methods to control high tick burdens on their cattle as shown by Table 4.2. The term dipping in the sense of tick control applies to all forms of chemical usage on cattle i.e. plunge dipping, handdressing, mechanical spraying and the use of pour-on. For the purpose of this section dipping refers to the use of plunge dip only. Table 4.2 reveals that 49 (39%) of the respondents solely use the plunge dip as a tick control measure. The plunge dip is good and is the cheapest method as far as communal dips are concerned (Wamukoya, 1992). The majority of sole plunge dip users (78%) are situated within the Yellow Line area. Table 4.2 also shows that as one moves from the Yellow Line to the Open area the number of sole plunge dip users decreases. Three possible explanations can be advanced for this. Firstly, Malongana and Matshena diptanks in particular are remotely located leaving cattle owners with slim opportunities for other income sources to be able to apply other control measures. Secondly, there might be a lower tick challenge within the area. Thirdly, past application of home-made plant preparations had a negative impact on the health of livestock (plant poisoning effects) to the extent that cattle losses were even experienced.

Dipping is supplemented with one or more combinations of other tick control strategies. Such strategies involve the use of engine-oil, handpicking, handdressing, *etc.* The frequency of the type of treatment highly preferred is handdressing followed by engine-oil both with a frequency of thirty seven and twenty two respectively as shown in Table 4.2. Because of the respondents low socio-economic status one could infer that the frequency of the type of treatment most preferred is a function of its cheapness i.e. the higher the frequency of the type of treatment the lower the cost of treatment of that particular tick control method. The frequency of the type of treatment, handdressing, is almost similar amongst regions compared to engine-oil. In addition, there are also variations within a region with regard to the frequency of the type of treatment. In Vyeboom, for example, engine-oil is preferred to other tick control strategies.

Table 4.2: Number of Respondents and the Frequency of the Type of Treatment

		Number of respondents applying dip with:			Type of treatment					
Areas	Sole dip users	One combination	Two combination	Three or more combination	Engine -oil	Handpicking	Biological control	Handspraying	Pour-on	Handdressing
Vyeboom	1	3	13	-	9	-	-	4	1	7
Malongana	14	4	5	-	1	-	-	-	4	4
Guyuni	9	7	7	-	-	-	-	1	8	7
Matshena	14	-	9	-	2	-	-	1	-	7
Dzanani	1	6	11	4	9	7	2	7	6	8
Tshifudi	10	2	5	-	1	-	-	1	1	4
Total	49	22	50	4	22	7	2	14	20	37

Table 4.3: Various Ticks and Tick-Borne Diseases Strategies Used by the Sampled Farmers

	Engine-oil and handdressing	Pour -on	Hand-spraying	Pour-on and Handdressing	Engine-oil, handpicking and Pour-on	Hand-picking	Hand-picking and pour-on	Hand-spraying and pour-on	Engine-oil, hand-picking and handdressing	Engine-oil and handspraying	Handspraying and handdressing
Vyeboom	11	1	2	-	-	-	-	-	-	2	-
Malongana	5	4	-	-	-	-	-	-	-	-	-
Guyuni	2	7	-	4	-	-	-	-	-	-	1
Matshena	8	-	-	-	-	-	-	-	-	-	1
Dzanani	6	-	5	1	2	1	2	1	2	1	-
Tshifudi	5	1	1	-	-	-	-	-	-	-	-
Total	37	13	8	5	2	1	2	1	2	3	2
Percentage	30	10	6	4	2	1	2	1	2	2	2

The majority of respondents (30%) uses engine-oil and handdressing (sometimes with household insecticides e.g. Doom, paraffin, *etc*) to supplement dipping as shown in Table 4.3. This combination is most preferred in Vyeboom, with eleven respondents, followed by Matshena with eight respondents. With the exception of Guyuni, this combination is the most preferred choice of all other control strategies or combination of strategies as indicated in Table 4.3. Handdressing although laborious, is highly recommended and particularly valuable in the control of various ticks species in those body areas vulnerable to tick infestation such as the udder, ear, scrotum and the tail.

Both Table 4.2 and 4.3 show that handpicking is only done in Dzanani. Handpicking saves time and can be carried out at anytime and in conjunction with other husbandry practices such as milking. It is flawed because it is directed at engorging female ticks thereby leaving off the larvae and nymphs which are usually minute in size, but capable of transmitting a good number of tick-borne diseases (Fasanmi and Onyima, 1992). However, its success depends upon light tick infestation. This practice has limited impact on ticks but it still forms part of animal husbandry practices for resource poor farmers.

Other widely used methods of acaricides application involve pour-on and handspraying using various types of small pumps. Handspraying seldom achieve complete wetting and so usually results in poor tick control. It also tends to be very uneconomical since the excess acaricides solution, which drips off animals, is not recovered. Nevertheless, if used sensibly, it offers the small farmer with the means to control excessive tick numbers on the udder and scrotum (Norval *et al.*, 1992). On the other hand, pour-on seem to hold better prospects for tick control since one application along the dorsal line of the animal effectively eliminates ticks (Fasanmi and Onyima, 1992). Pour-on are proving to be popular as shown by a treatment frequency of 20 respondents (see Table 4.2) coupled with at least 10% of the respondents utilising it to supplement dipping (see Table 4.3).

Table 4.4 shows the various reasons advanced by the respondents for the use of several tick control methods, as well as, the number of respondents selecting a certain reason. Most respondents (39%) use various alternative combinations of tick control strategies because of the low cost involved and ease of use. The second most important reason advanced is because of limited knowledge about husbandry practices and options available as indicated by 36 respondents. This problem is most prevalent in the Malongana, Matshena and Guyuni areas with thirteen, ten and eight respondents per region, respectively. This shows some variation in the effectiveness of the extension services between the regions. To some extent, these reasons gives an indication on the type of the livestock technology transfer strategy to be used for increased livestock production. Thus, before any livestock programme is introduced, it is important for any institution to be sure of the farmers' resources since they have an effect on farmers' behaviour.

Table 4.4: Various Reasons for the Utilisation of Various Tick Control Measures

Areas	Cheap and easy to use	Reliable	Communal	Effective in control	Western contacts	Control ticks when I feel like	Limited knowledge and options	Tradition
Vyeboom	13	5	3	7	-	-	1	-
Malongana	7	1	3	2	1	2	13	-
Guyuni	2	-	2	9	1	-	8	-
Matshena	10	6	2	1	-	-	10	-
Dzanani	12	6	2	10	-	1	3	-
Tshifudi	5	2	7	4	-	-	1	5
Total	49	20	19	33	2	3	36	5

Note: Numbers do not add-up because some respondents have more than one reason for the use of a particular tick control strategy.

Farmers claim that traditional methods do effectively kill the ticks on their livestock. A study by Dreyer (1997: 155) on the efficacy of engine oil in some parts of Free State Province revealed a 38% engine oil efficacy that does not compare very well to the efficacy of commercial acaricides of at least 95%. The efficacy of any tick control method depends entirely on its ability to prevent female ticks from feeding and reaching the egg laying stage (Owen, 1985). Norval *et al.* (1992) argues that tick control using acaricides has proved to be a simple and effective veterinary tick control procedure. He further argued that acaricides may cause epidemiological problems and are becoming increasingly costly. The development of alternative approaches, such as the use of tick resistant cattle and the possibility of effective immunisation against tick-borne diseases, has thus given rise to a mounting debate about the future role of acaricides in ticks and tick-borne diseases control in southern Africa.

Judging from the results in Table 4.3 the available options for tick control in Venda indicates that reliance on one method of control would not be particularly effective in alleviating the various tick problems to be discussed below.

4.6 Tick Problems and Reasons for Tick Control

Ticks and the diseases they transmit are present throughout the world, but they are most prevalent and numerous and exert their greatest impact in the tropical and sub-tropical regions (Mukhebi, 1992). They are the major health impediment to the development and improvement of the livestock industry. Tick control according to Norval *et al.* (1992) provide a means of preventing direct tick damage and associated production losses, as well as secondary infestation with screw worm fly larvae, hide damage and tick associated paralysis.

The effects of tick infestation on animals may be direct or indirect (Soll, 1989: 1 and Oberem and Schroder, 1993: 334). The direct effects include:

- Anaemia from blood sucking
- Damage to skins and hides with subsequent quality losses to the leather industry
- Irritation leading to biting, licking and scratching

- Toxins produced in the saliva of ticks, which causes paralysis, bacterial, fungal and other parasitic infections of bite wounds with resultant abscessation, mastitis or loss of teats and udder quarters
- Restlessness which hampers productive grazing due to discomfort

A total of 94% of the sampled farmers viewed ticks and tick-borne diseases as a serious problem in the surveyed areas. Damages afflicted on cattle are serious enough to justify appropriate tick control. To the animal producer, ticks are destructive blood sucking parasites that are capable of causing spectacular physical damage to the animals on which they live and feed. The majority of the respondents (70%) indicated tick wounds and tick damage (teat loss) as the most common tick problem amongst their livestock. This problem ranges from 53 % in Tshifudi to 83% of the respondents in Malongana and Guyuni as shown in Table 4.5. Young *et al.* (1988) argue that ticks with large mouth parts, such as *Amblyomma* species, are capable of damaging udders and teats of cows to such an extent that they become non-functional. At least 13% of the respondents viewed tick worry, tick wounds and tick damage as the second biggest problem caused by ticks.

Table 4.5: Common Tick Problems Experienced by the Sampled Farmers (n=118)

Tick Problems	Vyeboom	Malongana	Guyuni	Matshena	Dzanani	Tshifudi	Respondents (total)
	(%)						
Tick worry	-	6	-	-	-	6	2
Tick wounds	6	6	-	5	-	18	6
Tick damage	-	6	17	5	-	6	7
Tick wounds and tick damage	82	83	83	76	64	53	87
Tick worry, tick wounds and damage	12	-	-	14	36	18	16
Respondents (total)	17	18	23	21	22	17	118

The occurrence of ticks and their control is a cause for concern (tick worry) to 2% of the sampled farmers. These farmers incidentally represent those farmers with a relatively large herd size of 45 on average. Tick worry refers to a situation where the incidence or number of ticks in the herd is above a certain subjective minimum beyond which they are capable of causing physical damage. As a result the farmer becomes concerned, even though this level is highly subjective. Typically these farmers tend to apply more acaricidal treatment which leads to higher control costs. As indicated in Table 4.6, farmers' positive attitude towards tick control is done predominantly to avoid wounds, diseases and stock losses. This problem ranges from 18% in Tshifudi to 77% in Dzanani.

Table 4.6: Sampled Farmers' Reasons for Tick Control

Reasons	Vyeboom	Malongana	Guyuni	Matshena	Dzanani	Tshifudi	Total
	(%)						
Avoid teat loss and skin damage	-	4	13	4	-	6	6
Avoid diseases and death	35	17	22	44	-	18	28
Avoid wounds and teat losses	-	17	30	4	23	18	20
Avoid wounds, diseases and death	47	56	35	30	77	18	56
Avoid teat losses and diseases	18	4	-	17	-	41	15
Respondents (Total)	17	23	23	23	22	17	125

Disease transmission is the single most important indirect effect of tick infestation, which if untreated can cause heavy mortalities especially among susceptible breeds of cattle. Should the animal survive the effects of the disease, there is still a loss of productivity of milk or meat, *etc.* during the recovery period.

4.7 Cattle Dipping Frequency

The practice of intensive dipping of cattle is still widely practiced throughout the East Coast fever endemic areas. With certain reservations the same can be said for the surveyed areas putting indigenous breed at risk. Due to a high tick challenge, cattle in Vyeboom and Tshifudi are dipped once per week in summer, whereas in the other surveyed areas they are dipped once every two weeks. However, weekly dipping can be extended to once every two weeks in winter. Because of natural immunity, regular dipping of particularly the indigenous breed cattle at even once every two weeks is too costly, inefficient in controlling diseases and ecologically undesirable (Fasanmi and Onyima, 1991).

The frequency of acaricides application depends on the area, the tick challenge, breed of cattle and the level of control required (Norval *et al.*, 1992). Due to communal farming complexities, dipping frequency in the surveyed areas seem to be influenced solely by the level of tick challenge because in the dry season when the tick challenge is low, fortnightly dipping can be adopted in those areas that normally uses weekly dipping. However, it remains essential to monitor cattle carefully during the dry season, since the immature ticks are most active during this period (Oberem and Schroder, 1994). Therefore, under certain circumstances weekly dipping in the dry season can be used subject to a joint agreement between cattle owners and the general assistant animal health officers. Again, acaricides in the surveyed areas have been applied indiscriminately in all breeds of cattle.

Strict acaricides application results in a highly susceptible cattle population, because cattle are not exposed to the parasites; when tick control breaks down due to, for example civil unrest, enormous losses can occur (Latif, 1992). An extreme example was the break down of dipping infrastructure during the pre-independence war (1972-1980) in Zimbabwe where compulsory-dipping policy had been in force since 1914. This resulted in approximately one million cattle deaths from tick-borne diseases (Norval *et al.*, 1984). Literature indicates that Venda has been following a pattern of chronological usage of acaricides similar to that of Zimbabwe and other southern African countries. Thus, creating the same vulnerability to a breakdown in tick control programmes.

Production losses due to tick infestation *per se*, are too small to justify intensive tick acaricides application on economic grounds. This is especially so in the case of indigenous breeds (Mukhebi and Perry, 1992). The dipping frequency can be linked primarily to the farmer's reasons for his/her involvement with farming. Under certain circumstances intensive tick control is not cost effective and is often required only for valuable exotic breeds. Apparently, it is assumed that indigenous livestock requires the same degree of control as exotic stock. The consequence of this is that indigenous resistant cattle have been dipped regularly for the sake of a small proportion of susceptible exotic breeds, leading to the loss of both resistance to ticks and enzootic stability to tick-borne diseases amongst indigenous breeds (Pegram *et al.*, 1993). Thus, in evaluating the need for intensive tick control, the primary issue is not whether tick infestation leads to any losses in productivity, but whether such losses are sufficient to justify the expenditure on tick control.

4.8 Conclusion

This chapter described various ticks and tick-borne diseases control strategies. It seems that successful tick control is possible if the various tick control strategies complement each other. For various reasons, farmers complement cattle dipping in acaricides with other traditional and modern tick control methods such as pour-on. The socio-economic status seems to be an important determinant of the adoption of other optional alternative ticks and tick-borne diseases control measures. The traditional acaricides seem to have a low efficacy rate. In addition, being compulsory by law, dipping in acaricides have been intensively applied, either on weekly or fortnightly basis.

Production losses caused by ticks and tick-borne diseases are probably less important than previously believed and may perhaps not justify intensive tick control programmes. There is also no an economic justification for continuing with short interval dipping among the indigenous African breeds. Therefore, there may be a need to revise ticks and tick-borne diseases control policies if profitable animal production is to keep up with the increasing demand for animal products by a growing population.

The limitation associated with the current control methods of ticks and tick-borne diseases and the opportunities for reliance on intensive acaricides use in the area surveyed calls for a search for a new, safer, cheaper and more sustainable control strategies depending on thorough knowledge of the cattle type, tick ecology and epidemiology.

CHAPTER 5

COST-BENEFIT ANALYSIS OF TICKS AND TICK-BORNE DISEASES CONTROL

5.1 Introduction

Various techniques are available to assess the impact of agricultural research and development and are well documented in Anandajayasekeram *et al.* (1996: 83) and in Marasas (1999: 61). The techniques included are, namely modified peer review, user surveys, benefit-cost method, cost effectiveness analysis, partial indicators, patent analysis, case studies, mathematical programming and econometric methods. The choice of method is primarily dictated by the problem under evaluation. Benefit-cost method is, however, much more appropriate for past research projects than for ongoing or future research, hence the adoption of the benefit-cost method in this study. In addition, the main value of benefit-cost analysis in research and development impact assessment is that it offers a systematic framework for identifying the costs, benefits and wider implications of research and development.

Using the cattle values discussed in Chapter 2 as a point of departure, this chapter examines the costs and benefits of tick control at the farm level. The "with" and "without" dipping scenario will be incorporated into the analysis to provide a basis for cost-benefit analysis. The "without" scenario analysis is based on secondary data whereas the "with" scenario uses survey data. The (potential) benefits for the "without" dipping scenario are dealt with in the first half of this chapter assuming no dipping was pursued. The costs and benefits for each strategy will be compared to determine whether it is economically justified to control ticks and tick-borne diseases.

5.2 The Socio-Economic Value for the "With" and "Without" Dipping Scenario

The socio-economic values for the aforementioned scenarios are related to the different products or benefits obtained from the control of ticks and tick-borne diseases.

Furthermore, the socio-economic value to be derived from each strategy is largely the direct opposite of the other. The "with" scenario results in increased agricultural production through decreased morbidity and mortality rates. The mortality savings (deaths prevented) directly affect total off-take per time horizon and herd population structure. If mortality savings are high and the herd expanding, higher off-take rates are possible. This contributes towards an increase in human wellbeing through increased farm income and food availability. Under these circumstances of increased production, elementary economics suggests a decrease in the price of the products thereby enhancing food affordability, *ceteris paribus*.

Other aspects of the livestock production process in which parasites may influence the income from livestock is with regard to product quality. There are two principal mechanisms through which parasite affects product quality as suggested by Morris and Meek (1980: 171). Firstly, it may influence product characteristics including composition so that the consumer obtains less value from its use. In some cases the market price of the product in monetary terms is lower leaving less income available for household expenses e.g. school fees. Secondly the occurrence of ticks and tick-borne diseases (parasitism) influences the marketability of products. Examples of the consequences of such problems include the downgrading of the hide with a lower price due to evidence of tick damage. The attainment of the full productive potential of livestock is according to Umali *et al.* (1994) influenced by the availability and quality of animal health services. However, the benefits to be derived from the "with" scenario are constrained by the following factors such as the purchasing power, access to credit, extension services, adequate market infrastructure, *etc.* Apparently the socio-economic value for the "with" scenario, in particular, significantly contributes towards food security and therefore needs further exploration.

5.3 The Financial Burden of Dipping

In several countries in southern Africa, government veterinary services have a special role in ticks and tick-borne diseases control, being responsible for funding and implementation of extensive rural dipping programmes for peasant farming communities (Norval *et al.*, 1992). Venda too is a region where public sector involvement in rural communal dipping is substantial. The government maintains a network of some 127 cattle diptanks which at present serves 104 778 head of cattle owned by communal farmers.

The control of ticks and tick-borne diseases is inexpensive only if ticks are effectively controlled. However, it becomes expensive to farmers if tick-borne diseases emerge and farmers have to buy their own medicines usually from farmer's co-operatives. The cost of acaricides alone in the control of ticks amounted to R80 million in 1994 (Onderstepoort Veterinary Institute, 1997). Government also spends considerable amounts of money annually on research, training and extension services related to the control of ticks and tick-borne diseases. Parastatals (e.g. Agricultural Research Council–Onderstepoort Veterinary Institute) and international organization (e.g. Food and Agriculture Organization) also spend large sums of money on research aimed at developing improved control methods. Ticks cost South African agriculture more than R500 million per annum in direct and indirect losses (Farmers Weekly, 1998: 47).

As in Zambia and Kenya, the dipping of cattle in Venda is provided at heavily subsidised rates to the communal cattle owners. Subsidisation of the veterinary services in many developing countries has according to Umali *et al.* (1994) resulted in trade-offs between quantity and quality. In addition, Mukhebi and Perry (1992) argue that in recent times the budget of governments in most of the African countries have shrunk and the scarcity of foreign exchange for imports has grown more acute. As a result, the competition for limited government resources from other pressing national social development needs have heightened and the quantity and quality of animal health services and infrastructure has consequently declined considerably.

The justification for public sector funding of veterinary services for peasant farmers in southern Africa according to Norval *et al.* (1992) is a thorny issue. In the present economic climate in Africa, Lawrence (1996) predicts that there is unlikely to be any improvement in the government dipping services, and tick control will fall more and more into the hands of the cattle owners themselves. Therefore, it is sensible to expect that in the situation where acaricides cost is recovered, rural farmers will welcome the end of compulsory intensive dipping where it is recognised to be unnecessary in favour of strategic tick control strategy. This is more applicable to the situation where dipping frequency is linked to the costs of dipping. The practical scope for moving away from intensive dipping of cattle seem to be of urgent interest and obviously will benefit the farmers.

As previously mentioned, it currently costs communal farmers in Venda R1 and government R12 to dip a head of cattle each year. However, there is a group of commercial farmers that bears the full cost of controlling ticks and tick-borne diseases in their own herds. Depending on the frequency of application, annual costs of acaricides to these farmers who bear the full cost of control can range from US$ 2 to US$ 20 per animal as estimated by Mukhebi (1992). The current cost of acaricides to the government escalates with the worsening dollar exchange rate and inflation (Dipping survey, 1997). In order to choose the optimal level of treatment, Norval *et al.* (1992) argue that one must be able to model the impact of different scenarios of intervention upon tick infestation, tick population dynamics, breed susceptibility to tick infestation and damage coefficients.

5.4 Farmer's Costs of Production.

Although dipping and other veterinary services for cattle are provided by the government in the communal areas, farmers also incur other production costs (see Table 5.1). The main cost to household of maintaining livestock is herding labour. At least 11% of the respondents use hired labour for herding. Labour is hired at an average salary of R2066.00 per year. For cattle owners there are a number of different options for mobilising herding labour. Co-operative arrangements between or amongst households are popular where 2 to 5 relatively small herds are combined and the households rotate the responsibility for payment as a way of reducing costs. Hired labour is only an option open to those households with sufficient cash. The first option is the use of own household labour. It is only in Dzanani where hired labour is not employed. The use of hired labour gives an indication that the day to day management of the cattle is in the hired labourer's hands leaving more chances for disease occurrence. This is especially true in those cases where the cattle owners are not resident in the communal grazing areas.

Table 5.1: Farmers' Economic Costs of Livestock Services.

Area	Purchased worm remedies	Labour for herding	Vaccination	Tickicides	Medicines
			R/year		
Vyeboom	104	2040	66	146	35
Malongana	148	2600	155	124	128
Guyuni	101	3513	105	79	175
Matshena	117	2100	19	33	39
Dzanani	47	-	55	154	70
Tshifudi	104	2040	66	146	35
Average	104	2066	79	110	85

The second largest cost item to the farmer is that of tickicides at an average cost of R110/year. With the probable exception of labour, the cost of the other cost items is indicative of the priority the farmers attach in their husbandry practices to the severity of the problem. In addition, the cost of tickicides may indicate the level of tick challenge of a particular area, *ceteris paribus*. The Open area thus has a higher tick challenge than the Yellow Line area as revealed by their respective tickicides costs, the only exception being Tshifudi in the Yellow Line area. Other costs incurred include the costs of vaccination, worm remedies and other medicines for both endo and ectoparasites.

5.5 Costs and Benefits of Alternative Control Programmes

The outbreak of East Coast fever in the early nineteenth century presented the Venda government (then the South African Government) with only two basic options, namely to control or not to control. The assessment of an animal health project takes into account the incidence of disease outbreaks before and after the project, as well as the losses which would result from failure to implement the project (Sidibe, 1981). This section examines those two options/scenarios herein referred to as:

- A 'do nothing' strategy ("without" dipping scenario)
- A control strategy ("with" dipping scenario)

Emphasis will be given to the comparison of the costs and benefits of each strategy at the household level had the strategy been adopted.

5.5.1 Estimations of Economic Costs and Benefits of Disease Control Programmes

Knowledge of factors relating to costs incurred and benefits accrued is important when dealing with the appraisal of alternative control strategies. These factors are important because they enable one to differentiate between the various alternative control programmes. Establishing standard methods to measure both costs and benefits in order to determine the cost-benefit ratio is not possible, since this differs in terms of the disease, the species affected and their levels of production (Paniagua Arellano and Diaz Yubero, 1983). Perry and Mukhebi (1995) also admit that the quantification of output losses (costs) is not a simple task. They argue that there are often problems in separating these losses from the effects of confounding factors such as other diseases and production constraints. Accurate measurement of the level of diseases and their effects on productivity requires intensive record keeping, which are often nonexistent or unavailable, or requires time consuming and expensive field surveys and monitoring studies to be conducted. The determination of the cost-benefit ratio requires the following evaluation of costs (Denes, 1983: 306; Paniagua Arellano and Diaz Yubero, 1983: 350)

- The mortality and morbidity rate[4].
- Losses in meat, milk, *etc.*
- Infertility and abortion.
- Treatment (acaricides).
- Other potential losses (expenses resulting from the closing of domestic and export markets).

[4] Mortality rate refers to death and morbidity refers to the loss in the productive performance of an animal

The following benefits will be gained from the control of these negative factors:

- A reduction in the mortality and morbidity rate.
- Increase in the production of meat, milk, hides, *etc.*
- Increase in the fertility and birth rates.
- Other potential benefits (i.e. the opening up of markets, the improved sanitary quality of the products and thus a higher sales price).
- The relief from socio-psychological embarrassment borne by the animal owner and his neighbours as a result of the disease.
- Avoidance of permanent loss of value, which include short, and long term irrecoverable losses with secondary multiplier effects.

There are costs which must be incurred in order to achieve these benefits and such costs can be grouped into:

- Direct costs, including investment and salaries.
- Indirect costs, including improved standard of hygiene in the animal husbandry facilities.

It must be stressed that it is not always possible to evaluate the above mentioned losses since some cannot be quantitatively assessed, and the system available for this purpose is sometimes nonexistence. To calculate losses or benefits the following are mostly used: statistics, estimates by experts, actual verification based on research or survey data, observations made while programmes are put into practice and findings from comparative studies.

Once these physical output losses or benefits have been quantified, they must be valued in monetary terms to reduce them to a common unit of measurement before they can be aggregated. This requires the use of appropriate prices for valuation, which are not often obvious. Quantification of economic losses and benefit of a disease is of value in demonstrating the magnitude of the economic impact caused by the disease, particularly to those who make decisions affecting financial allocations for disease control programmes (Perry and Mukhebi, 1995).

Indirect losses are even more complex and difficult to quantify meaningfully, but they should not be ignored in order to provide a more comprehensive assessment of the impact of the disease.

5.5.2 A 'Do Nothing' Strategy

The introduction of exotic breeds made Africa vulnerable to tick-borne diseases as mentioned before. Due to breed susceptibility, it would probably have been irrational at the time to adopt this strategy for economic reasons. Had this strategy been adopted, tick-borne diseases would have been an epidemic in the continent, but as time progresses cattle would have adapted and there would have been a move to enzootic stability (Spickett, 1998). The existence of enzootic stability implies that control could have been selective, strategic and focused only on susceptible target cattle populations.

A 'do nothing' strategy would have incurred no additional government expenditure and farmers would have maintained the use of their cattle, although the cattle would not have performed as efficiently as before the introduction of the disease. In addition, the income forgone from cattle products would have been higher relative to the income forgone under the control strategy discussed below. This is because of the high morbidity and mortality rate estimated to be 4 percent. Although this strategy was not adopted, an effort should be made to estimate the losses in the absence of control and then estimate the extent to which these losses will be reduced by the strategy followed.

5.5.3 A Control Strategy

One of the most significant consequences of the East Coast fever control programmes was the introduction of compulsory dipping in acaricides throughout the infected areas. Whether eradication of East Coast fever can be attributed entirely to the dipping programme and the other control measures that were applied, or whether climatic changes brought this about, or at least facilitated the elimination of a specific population of ticks responsible for transmission of East Coast fever is open to speculation (Norval, 1992).

The benefits derived under this strategy are higher than the benefits derived under the aforementioned strategy. This is because of a relatively low morbidity and mortality rate of 3% in the sampled region. Most developing regions were left with a tradition of short interval dipping which has persisted to the present day. If properly applied dipping provides very good control of all tick-borne diseases.

5.6 Derivation of Costs and Benefits Estimates

5.6.1 The "Without" Dipping Scenario

One of the most important components in a cost-benefit analysis of the disease control programmes is the estimation of losses per animal from disease. The estimation of physical losses for individual animals is always a problem (Beal, 1981). This problem is worse in a situation without a control programme, because dipping has been in operation comprehensively since the start of the century. Moreover, it is difficult, if not impossible, to have access to data from the period before the dipping programme. This lack of data resulted in one major problem; the accurate determination of the effects to be assessed, the costs and benefits and the exact method to be used to measure these effects. It was decided to assess only direct benefits that appear at the farm level in terms of milk and meat production gains/losses, low productivity due to longer calving interval and impacts on draught power.

The derivation of benefits for the "without" scenario was performed on the basis of various estimates through making use of the Delphi technique. Experimental data comparing the effect of ticks and tick-borne diseases on livestock productivity between tick free and tick infested herds is unavailable for South Africa. Estimates of impact on productivity done by the Food and Agriculture Organization in Zambia were used with minor adjustments (Pegram *et al*., 1993).

Table 5.2 presents various figures used for the estimation of costs and benefits for both milk and meat (beef). Based on the income from milk production as reported in Table 5.2, the impact on morbidity and mortality was calculated for the without situation as follows (i.e. income gained from milk production):

Morbidity = 326 (sampled average herd size) * 38% (cows percentage) * 405 (value per year)

Mortality = 326 (sampled average herd size) * 4% (mortality rate) * 38% (cows percentage) * 405 (value per year)

Table 5.2: Values for the Possible Calculation of Milk and Meat Benefits

Dipping scenarios	Average live-body weight (Kg)	Beef price/ kilogram* (R)	Average herd size	Cows herd composition (%)	Mortality rate (%)	Value of milk/ year (R)	Value of a cow/ year (R)
"With"	241	5	329	39	3	526	1152
"Without"	234	5	326	38	4	405	1036

*Source: Own survey data

It was estimated that on average the mortality rate would have stabilised at 4% without the control programme (Spickett, 1998). However, the initial mortality rate would have been 10% without dipping at the beginning of the century. This possible decline in mortality is based on the assumption that breeds with a strong immune system (predominantly the Nguni breed) would have survived better and on the basis of the "survival of the fittest" would have dominated the national herd.

Income gained from beef production is calculated as follows:

Morbidity = 57 (average number of cattle sold) * 234kg (weight) * R5 (price per kilogram)

Mortality = 326 (sampled average herd size) * 4% (mortality rate) * 234kg (weight) * R5 (price per kilogram).

For a small-scale traditional farmer the selling price of a live cow is not a function of weight. However, it is assumed that price is a function of weight in this analysis so that the price of beef per kilogram can be multiplied by the total weight of an animal. Moreover, the traditional farmer sometimes salvages a sick animal for meat. In this analysis all reported deaths are considered to be unsalvaged.

With regard to draught power, two significant assumptions had to be made to perform the analysis, namely:

- Only oxen are used for ploughing.
- Infected oxen are entirely incapable of ploughing.

Oxen were grouped into two breed categories, indigenous and exotic breed, so as to attach the infection probability for each group. Grouping of breeds was done using the sampled breed percentage composition. Nguni constitute 65% of the sampled herd and it was assumed that Nguni is the only indigenous breed. Again it was assumed that both breeds have an equal infection probability of 25% without dipping. The value of oxen indicated in Table 5.3 is for an average herd of 18 oxen after taking into consideration the infection probability. The average number of oxen for the sampled herd is 24.

.Ticks may be responsible for loss in udder quarters and may increase the calving interval. The latter is the most significant parameter in determining herd productivity and, hence profitability. This type of loss is better estimated on a survey basis (Pegram *et al.*, 1993). Low productivity in milk production due to a longer calving interval for the infected cow is estimated as follows (i.e. forgone income due to longer calving interval):

> Productivity = 61 (number of calves in a year) *12.5% (probability of losing a calf per cow in a year) *1 036 (average value of cattle).

5.6.2 The "With" Dipping Scenario

The derivation of benefits for this scenario is similar to the "without" scenario. Unlike the "without" scenario, this scenario relies on the survey results. Survey results reveals the mortality rate as 3%. Mortality rates exhibit a strong seasonal pattern that closely parallels the rainy season when ticks are most active. No attempt was made here to differentiate the various mortality rates for the different seasons of the year. To measure the mortality rate, sampled farmers were asked about the number of cattle deaths caused by tick-borne diseases. This relies only on the farmers' diagnosis and it is acknowledged that the reliance on farmer diagnosis has a potential for error depending on, *inter alia*, familiarity with the disease, memory and the desire to attract veterinary attention. In communal areas mortalities are not always reported, or if reported, seldomly investigated. Moreover, disease reporting in general in South Africa is unsatisfactory, and results in underreporting of most diseases and causing unreliable statistics (National Department of Agriculture, 1996/7). Although these limitations render the estimations less reliable and accurate, they serve as the only basis on which the analysis can be built. Both milk and meat production incomes can be obtained using the values in Table 5.2.

For a small-scale traditional farmer the costs of tick control can be divided into two categories, namely:

- Those that the government incurs.
- And those incurred by stockowners.

Data on government expenditure for ticks and tick-borne diseases control was obtained from the government veterinary budget, reports and records in the Department of Veterinary services. Costs incurred by the government includes costs of vehicle maintenance, insurance and allowances, stationery, dip maintenance and heavy machinery for water provision. The cost of water provision is low because the location of many diptanks was determined by the available water sources. Costs of ticks and tick-borne diseases control to individual farmers are fairly straight forward and are based upon expenses for animal treatment and acaricides application. Treatment costs largely include cost of purchased drugs, *etc*. These costs were obtained from sampled farmers' interviews and are shown in Table 5.3. Treatment of the disease is regarded as an *ex post* use of resources to restore animal performance to its previous level of health before the disease occurred back towards its previous healthy level when a disease has occurred. Whether it is worth doing, as opposed to accepting the reduced productivity or even culling the animal, is an economic decision.

5.7 A Comparison of the "With" and "Without" Scenarios.

Project impact analysis attempt to value costs and benefits that arise with the project and compare them with the situation as it would have been without the project (Gittinger, 1982). Both costs and benefits are clearly shown in Table 5.3 with milk and beef calculated in terms of mortality and a decrease in the productivity of the herd (i.e. morbidity). The forgone income for the "without" scenario due to mortality is higher than the forgone income for the "with" scenario. The difference between the "with" dipping scenario net income and the net income balance for the "without" scenario gives an incremental net loss of R23 475 per sampled herd. This amount represents the loss in income occurred in spite of the existence of the dipping programme. Disease control is economically justified only if the estimated benefits outweigh the costs incurred, i.e. the benefit-cost ratio must be greater than or equal to one. Table 5.3 shows a benefit-cost ratio that is almost equals to one. (0.8). This ratio was calculated as:

B/C = Δ in total income for both scenario / Δ in total costs for both scenario

According to Morris and Meek (1980: 165)..."monetary values must be used with caution that the numerical values obtained in an economic analysis should be seen principally as a basis for ranking strategies, not as representing the actual benefit which will be achieved under all circumstances".

This ratio suggests that the control of ticks and tick-borne diseases by the government is not economically justified and probably need to be a private sector responsibility. However, in establishing the appropriate roles for the public and private sector in the livestock services industry, it is necessary to obtain a clear understanding of the nature of the tick control service. Not only will the economic nature of the service determine whether private delivery will be feasible, but also whether private provision will results in a socially optimal level of supply (Kirsten and Randela, 1998).

The control of ticks is a private good with externality. This implies that the control of ticks by an individual farmer also benefits other farmers by reducing tick population and the chances of other farmers from getting tick-borne diseases. Therefore due to this free rider problem associated with tick control service delivery, there will be a tendency towards under-provision or no provision of this service when the production decision is profit motivated. Thus, private firms will have no incentive to provide this service because it will not be in the interest of any individual to pay for it.

Table 5.3: Comparison of Costs and Benefits for the "With" and "Without" dipping Scenarios (1997).

"With" dipping scenario				
Costs (R)		**Income (R)**		
Government costs*		Milk: sold	67 854	
Motor transport allowance, maintenance		Mortality	-2 025	
and insurance.	11 538			65 829
Heavy machinery (water provision)	661	Meat: sold	69 890	
Stationery	236	Mortality	- 11 893	
Livestock maintenance (acaricides)	15 535			57 997
Diptank maintenance	21 000			
		Draught power		6216
Total	48 970			
Farmers costs				
Tickicides	1 164			
Purchased drugs	682			
Total	1 846			
Salary	6 341			
Total Cost	57 157	Total income		130 042
Net income		72 885		
"Without" dipping scenario				
Costs		**Income**		
		Milk: sold	50 171	
		Mortality	- 2 007	
				48 165
		Meat: sold	66 690	
		Mortality	-15 257	
				51 433
		Draught power		4662
		Total income		104 260
		Low calving productivity		- 7 900
Total income		96 360		
Benefit-Cost ratio		*0.8*		

Furthermore, although the benefit-cost ratio is slightly less than one, this ratio can be improved by reducing the costs involved. This can be done by moving from intensive dipping to a strategic acaricides application. Such a costs decrease might possibly result in two effects namely, either the same output can be produced more cheaply or the savings can be converted into increases in output. The strategic control of ticks is a strategy based on the fact that ticks exhibit seasonal cycle and that concentration of acaricides application during the peak month of tick activity will effectively interrupt tick feeding cycle, reduce tick population thereby reducing the number of engorged females which lay eggs to perpetuate the generation.

This dipping regime is possible taking into consideration that livestock owners are more particular about regular immersion of their cattle during spring/summer period (September/October – March/April) when the presence of ticks and the damage they cause are obvious, than in winter when only few or no ticks are seen. The presence of ticks on cattle in winter varies from region to region, from few to none, depending on the degree of dryness and severity of winter cold. Thus, in some areas, there may in fact be no need to dip cattle in winter instead of dipping cattle throughout the year. It appears, therefore, that if the strategic dipping regime can be adopted, there can be a significant decrease of the dipping costs and an improvement of the benefit-cost ratio. The magnitude of a decrease in dipping costs depends on the knowledge of the optimal tick control. In addition, the range and magnitude of physical losses avoided, *inter alia*, depends on the control system used, and determined by the technique of control and the success with which it is implemented.

5.8 Sensitivity Analysis

The mortality rate for the "without" dipping scenario is, however, subject to debates and is based on optimistic assumptions. Therefore, sensitivity analysis is conducted to determine the robustness of benefit-cost ratio against possible changes in the mortality rates. The sensitivity analysis presented in this section addresses the effects of changes in the mortality rate to 10% and the results are shown in Table 5.4. With a 10% mortality rate without the control programme the benefit-cost ratio increases from 0.8 to 1.2. Thus, it is evident that the benefit-cost ratio is sensitive to changes in the mortality rate. The 10% mortality rate was chosen assuming that it would have been probably the second lowest mortality rate to prevail in the absence of the control programme.

Table 5.4: Sensitivity Analysis of a Change in the Mortality Rate.

"With" dipping scenario				
Costs (R)		Income (R)		
Government costs*		Milk: sold	67 854	
Motor transport allowance, maintenance		Mortality	- 2 025	
and insurance.	11 538			65 829
Heavy machinery (water provision)	661	Meat: sold	69 890	
Stationery	236	Mortality	- 11 893	
Livestock maintenance (acaricides)	15 535			57 997
Diptank maintenance	21 000			
		Draught power		6216.00
Total	**48 970**			
Farmers costs				
Tickicides	1 164			
Purchased drugs	682			
Total	**1 846**			
Salary	**6 341**			
Total Cost	57 157	**Total income**		130 042
Net income		72 885		
"Without" dipping scenario				
Costs		**Income**		
		Milk: sold	38 418	
		Mortality	- 3 842	
				34 576
		Meat: sold	66 690	
		Mortality	-35 802	
				30 888
		Draught power		4662
		Total income		**70 126**
		Low calving productivity		- 7 900
Total income		**62 226**		
Benefit-Cost ratio		*1.2*		

The sensitivity analysis also shows an incremental net benefit of R10 658 per sampled herd. It is important to note that the incremental net benefit derived represent the loss in income which would have resulted from failure to implement the dipping programme.

Sensitivity analysis based on various mortality rates (i.e. worst case scenario) was also performed. In addition to the 4 and 10% mortality rate already analysed, Table 5.5 further shows the probability of occurrence for various mortality rates together with their respective benefit-cost ratios. It is evident from Table 5.5 that in the "without" dipping scenario, the would be mortality rate is inversely related to the probability of occurrence. This is because higher mortality rate e.g. 21% is relatively a worst case scenario that is unlikely to occur, hence the low probability of 2%. At 15% and 21% mortality rate the benefit-cost ratio is 1.5 and 2 respectively.

Table 5.5: Estimates of Mortality Rates for the "Without" Dipping Scenario

Mortality rate (%)*	Probability of occurrence (%)*	Benefit-cost ratio
4	80	0.8
10	40	1.2
15	10	1.5
21	2	2

*Source: Spickett (1998)

Attempts to supplement this analysis with other measures of project value, internal rate of return and net present value, were made. But lack of both benefit and costs series of data as well as data on initial investment costs precluded the performance of the analysis. This lack of data surely underscores the importance of institutionalising project monitoring and evaluation within the South African agricultural research system.

However, wherever programmes involve public expenditure the authorities responsible now require, *inter alia*, clear demonstration that programmes will show a net benefit and the extent of such benefits need to be indicated. In performing analyses of ongoing programmes, there has to be a comparison of projected future progress with what would happen in the future if the programme can be discontinued (Beal, 1980). Therefore, what is of relevance today is the analysis of what will happen in future if dipping can be completely discontinued. It is estimated that in the first, second and third year farmers are likely to face an average mortality rate of 10, 6, and 4 percent respectively (Spickett, 1998). Thus, it will only take 3 years for the herd to develop an acceptable immune system to the extent that the mortality rate can stabilise at 4%.

The reason for the high mortality rate in the first year is that dipping to some extent destroyed the immune system of especially the indigenous African breeds. In addition, it resulted in an interruption in the transmission of tick-borne pathogens and led to the establishment of a susceptible cattle population which was followed by the loss of the existing situation of enzootic stability. Considering a 10% mortality rate, of the total sampled herd of cattle (1976) 198 cattle are expected to die of tick-borne diseases resulting in a R228 0986 (198 * R1 152) loss to the sampled cattle owners. Obviously, dipping should continue but the manner in which it should continue would require further investigation with all participants within the livestock industry.

5.9 The Direct Economic Impact of Tick-borne Disease Mortalities at Farm Level.

Tick-borne diseases cause great economic losses to the individual farmer. Mukhebi and Perry (1992) categorised losses caused by tick-borne diseases into direct and indirect production losses, losses through costs incurred for controlling the disease and costs for providing research training and extension services pertaining to the diseases. Economic losses caused by tick-borne diseases are at present difficult to estimate accurately. Direct production losses can be attributed to the presence of the diseases in the cattle herd largely through mortality. Cattle which become severely infected die unless treated. Often it is the mortality rate and the cost of control that appears to receive the greatest attention and concern from those interested in controlling the diseases. This is due to the fact that mortality is more discernible than any tick-borne disease effects. Moreover, losses from morbidity are negligible compared with losses from mortality and may be ignored. It is for this reason that this section solely focuses on the effect mortality caused by tick-borne diseases have for the sampled small-scale cattle farmers.

A total number of 64 cattle died from tick-borne diseases as reported by 22% of the sampled farmers. Total cattle losses range from 2 in Dzanani to 16 in Guyuni. The most commonly found tick-borne diseases in the surveyed areas are redwater, heartwater and gallsickness. The majority of the respondents (71%) are farming with the Nguni breed which represent about 65% of the total sampled herd size. However, it constitute 80% and 50% of the total sampled herd in the Open and the Yellow Line area respectively (see Figure 5.1). With the exception of Tshifudi, group discussion indicates that the respondents within the Yellow Line area have always preferred cattle breeds that grow fast for commercial purposes.

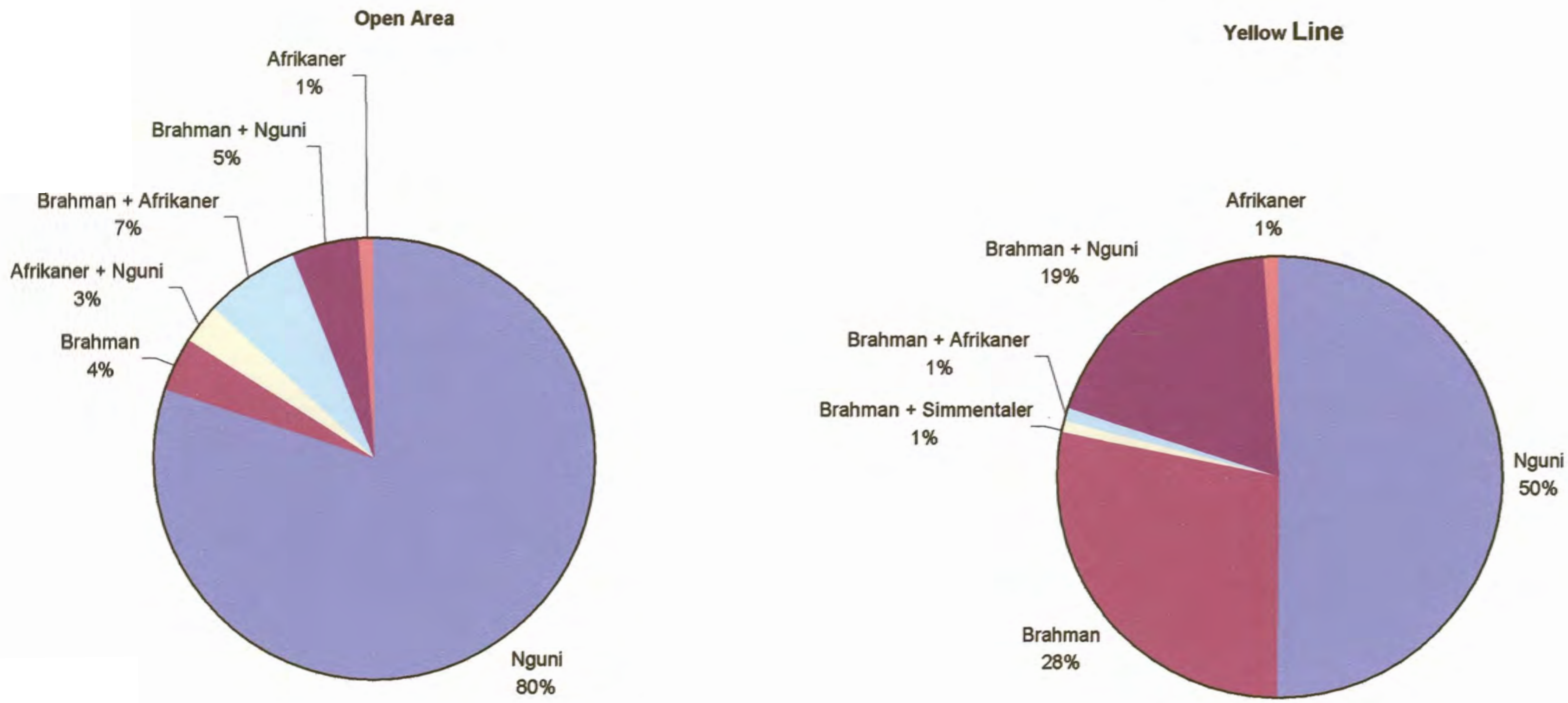

Figure 5.1: Cattle Breeds Kept by the Respondents

The Nguni breed is resistant to diseases to such an extent that little or no losses from the infection may be experienced, especially in areas where tick-borne diseases are endemically stable (Norval *et al.*, 1994). However, contrary to expectation Table 5.6 show that Nguni breed exhibited a relatively higher mortality of 2.8%, followed by the Nguni - Brahman mixed breed mortality of 0.3% in Matshena. The relatively high mortality due to tick-borne diseases in the Nguni breed can probably be ascribed to the loss of immunity caused by indiscriminatory acaricides application. More importantly, a possible explanation for this paradox could relate to poor management practices of small-scale farmers.

Evidently, tick-borne diseases hardly makes it possible for a resource poor farmer in particular to maintain the desired rate of genetic gain through selection since tick-borne diseases affect the demographic structure of the herd population. Animals which recover from tick-borne diseases may suffer from weight loss, produce low milk yields, provide less draught power and could possibly suffer from reduced fertility and delays in reaching maturity. These animals according to Lawrence (1992) remain carriers and can spread the infection, particularly heartwater.

Table 5.6: The Average Value of Cattle Lost and the Number of Cattle Deaths by Region.

Cattle breed	Vyeboom	Malongana	Guyuni	Matshena	Dzanani	Tshifudi	Mortality rate (%)
Brahman	-	0 .7 (3)	-	-	-	-	0.1
Nguni	3.4 (13)	0.7 (2)	4.9 (16)	1.9 (7)	0.69 (2)	6.5 (14)	2.8
Brahman – Nguni	-	-	-	1.7 (6)	-	-	0.2
Afrikaner – Nguni	0.3 (1)	-	-	-	-	-	0.05
Total	3.9 (14)	1.4 (5)	4.9 (16)	3.6 (13)	0.7 (2)	6.5 (14)	3.2 (64)
Total average value of cattle lost (R)	19 138	6 255	15 008	11 960	1 146	11 592	73 728

Note: Figures in parenthesis indicate the actual number of cattle mortalities whereas those outside indicate the percentage cattle mortalities.

Table 5.6 also shows the effect of mortalities in terms of the loss in income due to tick-borne diseases. The average number of cattle lost indicated in the last row/Table 5.6 represents the loss of adult cows capable of performing all the quantified values of cattle. The total average monetary value of cattle lost was estimated as follows: Taking the second column as an example:

Average value of cattle for Vyeboom	R1 367 (see Table 2.8)
Total number of cattle lost	14
Total average value of cattle lost	= R 19 138

This value reflects the cost of the loss of cattle as a result of tick-borne diseases in Vyeboom. The total average value lost ranges from R1 146 for Dzanani to R19 138 for Vyeboom. The financial loss caused by animal diseases is determined, *inter alia*, by the form of diseases. A disease can either be in an enzootic or epizootic state. The former refers to those diseases whose incidence vary from farm to farm and which the individual livestock owner can control (Dijkhuizen *et al.*, 1991: 263). Whereas epizootic diseases on the other hand are those that are usually contagious and rarely occur in certain areas and they require regional, and (inter) national control measures.

The total loss of cattle value to the surveyed areas is estimated at:

Number of cattle died * average value per cattle

64 * R 1 152 = R 73 728

The estimate indicates that the total direct loss in milk, traction, manure and sales caused by tick-borne diseases in the surveyed areas is R73 728. It is important to note that as the number of cattle death increases, the total cattle value lost also increases. From Table 2.8, it is apparent that milk production due to cattle death represent the greatest financial loss followed by meat sales, work of cattle and manure. This is slightly in contrast with a study done by Mukhebi and Perry (1992) in 11 African countries on the annual economic losses due to East Coast fever (appendix 2 Table 1) where the reduction in milk production represented the greatest financial loss followed by traction, beef and manure.

occurrence of a catastrophe in less developed regions. To avoid further cattle deaths it is important to examine the real causes influencing the occurrence of those deaths. Although cursory discussed below, all factors influencing the occurrence of diseases need further investigation.

5.10 Factors Influencing the Occurrence of Tick-borne Diseases

Socio-economic factors have a strong influence on the distribution, dynamics and significance of animal diseases, particularly in developing areas where there are wide differences in the socio-economic status of the inhabitants (Perry and Mukhebi, 1995). Socio-economic factors are generally taken to mean the non-physical properties or characteristics of human environments, which can greatly influence the natural environment.

In broader terms, the essence of these factors mean the economic status of a human population, and all the other characteristics which can be influenced by that, such as level of education, income (occupation), access to resources, including capital, land and services. Throughout the world, public health research demonstrates that people in the lowest socio-economic group experience the highest rate of livestock mortality and morbidity (Coetzer, 1995). Considering two of the most important socio economic characteristics namely, educational qualifications and residential status, the majority (52%) followed by 19% of the sampled farmers are pensioners and the unemployed respectively[5]. It is therefore not surprising that the majority of cattle owners (43%) do not have a single year of formal education.

In addition to socio economic status, disease occurrence and the resulting economic losses vary widely within and among countries due to differences in livestock production systems, cattle breeds, level of disease risk, disease control policies and programmes (Coetzer, 1995). The occurrence and prevalence of parasitic infections in a given locality

[5] See appendix 2 (Table 2) for a detailed information on socio-economic characteristics of the respondents

is a reflection of a complex interaction between the environment and the host species that are present.

The existence of dual socio-economic divisions of land use, namely the commercial farming areas and the communal land has an influence in the occurrence of certain tick-borne diseases. In commercial farming areas, for example, the relatively low cattle stocking density, high standard of pasture management and adequate tree cover ensure a near perfect environment for the tick vector *Rhipicephalus appendiculatus* that causes theileriosis. In contrast, the high population density, poor pasture management and scarcity of tree cover in the communal lands means the tick cannot survive and is absent from most of the communal lands even though they occur within a climatically suitable environment in terms of rainfall and temperature.

According to Norval *et al.* (1992) there is evidence of variation in susceptibility of different cattle types and breeds to different tick species. Improved breeds of livestock are much more susceptible to the effects of tick-borne diseases infections, and considerable investment in disease control technologies such as acaricides is required (Perry and Mukhebi, 1995). Furthermore, as farmers move up the socio-economic ladder, they wish to exploit opportunities to enhance their productivity by investing in more productive livestock. The existence of Afrikaner crosses is, *inter alia*, attributed to the Venda government breeding policy that was aimed at improving animal production. This policy resulted in the introduction of state owned Afrikaner bulls in the late 1970s. However, this venture was met with little success.

Future expectations are that the introduction of improved but susceptible breeds is likely to occur probably with an increase in the standard of living accompanied with improvements in socio-economic status. Closely related to this is a change of farmers' motive towards cattle farming from a cultural motive to a commercial one. To achieve this, respondents were asked about the preferred breed of their choice for future use. The research results (see appendix 2 Table 3) reveals that the Nguni breed is favoured by 58% of the farmers, followed by the Brahman (16%) and the Afrikaner (12%). Given that the

Nguni constitute 65% of the sampled breed, results shows a decrease of 11% in the Nguni breed in favour of more improved breeds.

5.11 Conclusion

The cost-benefit analysis of ticks and tick-borne diseases control programme was done in two scenarios, namely the "with" and "without" control scenario. Emphasis was given to the comparison of the costs and benefits of each strategy at the household level, had both strategies been adopted. The income forgone in terms of milk, meat, draught power and low productivity under the "without" scenario is larger than the income forgone under the "with" scenario.

The results of this chapter reveal a benefit-cost ratio which is less than one (0.8) using a 4% mortality rate. This ratio can possibly be improved by reducing the current dipping costs through the adoption of a strategic tick control. However, this ratio seem to be sensitive to changes in the mortality rate yielding a benefit-cost ratio of 1.2 when the mortality rate is changed from 4% to 10%. Although the benefit-cost ratio is less than one, the dipping programme still deserves government support because of the economic (public) nature of the service it provides. More importantly, in less developed areas dipping forms part of the whole veterinary surveillance programmes which in essence is a purely public good. The information from a surveillance programme benefits the whole sector and cannot be appropriated by any livestock farmer.

CHAPTER 6

DEMAND FOR LIVESTOCK TICK CONTROL SERVICE

6.1 Introduction

Animal health control services remain an important input support function for any livestock farmer, as diseases and high mortality are major constraints on livestock production in Southern Africa (Nell *et al.*, 1998). In South Africa's developing areas animal health services are provided at highly subsidised charges or "free of charge" as explained previously. It costs the government R12.00 and communal farmers R1.00 to dip a head of cattle per year. Under government service, it is compulsory for farmers to take their animals for dipping at stated intervals to achieve more effective and widespread control.

This chapter attempts to identify factors that influence farmers' willingness-to-pay, as well as the revealed preference for dipping frequency from the point of view of the respondents if dipping legislation were to be relaxed. To achieve this, a multivariate regression analysis and a logistic regression model are applied. A fundamental purpose of multivariate regression analysis is the prediction of the dependent variable with a set of independent variables. In addition, logistic regression analysis presents a unique complement to a multiple regression in its ability to utilise a binary dependent variable but also predicts the probability of an event.

Identification of factors that determine the demand for livestock services can possibly have promising and cost-saving impacts on the planning and extension of future livestock disease control programmes. In addition, the rationale for identifying those factors is important, more particularly to extension educators, technical assistants and policy makers involved in livestock development in order to target and deliver effective tick control programmes. However, due to communal farming complexities, this analysis is based on the assumption that dipping price per head of cattle per year remains fixed irrespective of dipping frequency. It is important to note that data limitations precluded the significance and inclusion of all the factors likely to influence the demand for dipping service and the willingness-to-pay for such a service.

6.2 The Respondents' Revealed Dipping Demand frequency

To determine whether farmers are in favour of the present dipping arrangements respondents were asked about dipping intervals that they prefer for future tick control should the legislation be relaxed. The majority of the respondents (51%) prefer to dip their cattle twenty six times per year (i.e. equivalent to once per week in summer). This ranges from 2% in Vyeboom to 33% both in Malongana and Matshena as indicated in Table 6.1. Secondly, 41% of the respondents prefers to dip their cattle once per week with the majority in Tshifudi (29%). Farmers' tendency towards high acaricides treatment frequency is probably indicative of high tick challenge in the region and also reflects the attitude of the majority of farmers towards intensive tick control.

The overall dipping frequency ranges from three times a week to a strategic tick control based on tick counting. Few farmers (2%) are undoubtedly in favour of an opportunistic (strategic) tick control measure based on tick counting. This means that acaricidal treatment will be applied only when there is relatively high tick numbers. Strategic tick control would make for less intensive use of expensive acaricides and would reduce (save) the cost of ticks and tick-borne diseases control. However, the costs of the method and the economics of its application will obviously vary in time and space in each region depending on the cattle type, tick ecology and epidemiology, and the prevailing level of disease risk.

Table 6.1: Revealed Dipping Demand Frequency

Frequency (times per year)	Vyeboom	Malongana	Guyuni	Matshena	Dzanani	Tshifudi	Total
	%						Number
Two	100	-	-	-	-	-	1
Twelve	-	-	-	100	-	-	1
Twenty six	2	33	23	33	9	-	64
Thirty six	-	100	-	-	-	-	1
Fifty two	26	-	16	2	28	29	51
Hundred and four	50	-	-	-	-	50	2
Hundred and fifty six	-	-	-	-	50	50	2
Tick counting matters	33	33	-	-	33	-	3

Note: Most of the farmers' responses were on weekly basis but converted to an annual basis such that:
Fifty two = once/week; Hundred and four = twice/week
Twenty six = once/two weeks; Hundred and fifty six = thrice/week
Twelve = once/month; Thirty six = thrice/month

6.3 Farmers' Willingness-To-Pay for Dipping Services

The concept of willingness-to-pay is borrowed from demand theory. It is derived from an interpretation of a point on a demand curve representing the maximum price that a customer would be willing to pay for the corresponding quantity of a particular good (Mansfield, 1975). It is used to impute the real value of a service to a customer or group of customers. The willingness-to-pay criterion is advantageous because it is a measure of farmer's response to a particular technology. Baker *et al.* (1988) argue that farmers are probably better qualified to give a broad, inclusive evaluation of the technology's value to themselves than any other group. However, the farmers' assessment of a particular technology is influenced by many factors, such as economic and social factors. In their evaluation attitude towards risk is one of the most important factors that influence the willingness-to-pay for a particular project.

Ultimately it is farmers who have to decide whether to adopt a certain technology. These decisions are based on their own perception and ability to pay for the service/technology. Therefore, this study used the willingness-to-pay approach to estimate the demand for dipping services. Each farmer was thus asked as to how much (s)he thinks it costs government to dip a head of cattle per year. The results are shown in Table 6.2.

Table 6.2: Farmers Willingness-To-Pay and Government Estimated Contribution to Dipping Services by Area

Areas	Farmers willingness-to-pay (R/head/year)		Farmers estimated government contribution (R/head/year)		Average farmers' willingness-to- pay (R/head/year)	Farmers' estimates of government contribution (R/head/year)
	Min	Max	min	max		
Vyeboom	1	30	14	500	3	257
Malongana	0.50	15	5	333	2	35
Guyuni	0.50	2	10	50	1	24
Matshena	0.50	5	10	500	2	51
Dzanani	0.50	20	0.50	1000	2	500
Tshifudi	0.50	14	1	1500	2	234
Average	0.50	30	0.50	1500	2	184

Source: Own survey data

All the sampled farmers (125) are willing to contribute to any services aimed at controlling ticks and tick-borne diseases, but the amount that they are willing to pay varies. As could be expected the majority of the sampled farmers (67%) feel that cost recovery should continue at the current cost to the farmer of R1/head/year. The minority (10%) is prepared to pay a lower price relative to the currently charged price.

At least 23% of farmers are willing to pay relatively high prices if dipping services can be guaranteed to be effective and improved. The maximum willingness-to-pay ranges from as low as R2.00 in Guyuni to a maximum of R30.00/head /year in the Vyeboom area (see Table 6.2). The findings of some recent studies (Umali *et al.*, 1994) indicate that farmers are generally willing to pay for reliable and effective services. On average sampled farmers are willing to contribute R2/head/year for dipping as shown by Table 6.2. The willingness-to-pay gives some indication of the farmer's assessment of a technology's value. Subsistence farmers in particular may find it difficult to estimate the benefits of dipping or omit important benefits thereof, especially when such benefits are not readily apparent or quickly converted into cash.

It should be noted here that the question regarding farmers' willingness-to-pay was experienced as a sensitive one. Farmers perceived it to be indicative of a new basis for future policy making with regard to ticks and tick-borne disease control. Therefore, farmers seemed to be reluctant to provide this information and the estimates are likely to be biased downwards.

With regard to the farmers' view on the estimated costs that they think the government spend per dip per cattle per year, at least 34% of the sampled farmers were able to estimate an average cost to the government of R184/head/year. However, the general feeling for those farmers that were unable to estimate the cost to the government felt that it was higher than what they are currently contributing. Since many of the cattle owners are poor and have to rely on meagre pensions for their existence, they are not in favour of an increase in dipping costs and feel that some form of subsidy on dipping costs is called for. Using both the 1996 and 1999 prices, it approximately costs the government an average amount of R12.00 and R22.00 to dip a head of cattle per year for forty dippings, respectively[6].

6.4 Factors Influencing Farmers' Demand for Veterinary Services.

Livestock owners take many things into account when deciding whether or not to make use of animal health services. Umali *et al.* (1994) identified the most important factors influencing the demand for veterinary services as:

- *The size of the herd.* The size of the herd has many ramifications for veterinary care. A general (although not infallible) rule of thumb is that, as the herd size increases the veterinary cost per animal decreases. The cost differential can become a screening device as to who can afford veterinary services, because larger farmers may be able to afford the service. Similarly, owners of small herds can still take advantage of economies of scale by becoming members of a producer association. However, producers associations are rarely being established by small or subsistence farmers. Under certain circumstances, if established, they are of a short-term nature to overcome a certain pressing problem or need.

[6] These costs include only dipping (acaricides) costs and exclude salaries, transport costs etc

- *The relation of benefit to cost.* Normally farmers demand animal health care only if the benefits of the veterinary care exceed its cost i.e. a benefit-cost ratio greater than one.
- *The nature of the disease and the economic losses associated with it.* Different diseases have different effects on livestock and the economic impact on the livestock enterprise thereof may also be different. The risk of economic losses is greater for some diseases than for others: thus if the disease is not economically threatening, a farmer may forgo veterinary care. For instance, a dairy herd owner may be more inclined to take steps to combat brucellosis than to deal with heartwater. Closely related to this, another factor that comes into play in the owners decision on how to deal with disease may be the breed of cattle involved because of differences in genetic potential or disease resistance.
- *The nature of the livestock production system.* The type of livestock production system affects the potential for disease transmission. Livestock in the extensive breeding areas have a higher risk of diseases than livestock kept under intensive farming. This can probably be ascribed to overstocking which is typical of communal grazing areas. It is expected that these farmers may have a higher demand for preventative services than farmers under intensive farming systems because the risk of disease outbreaks is higher.

6.5 Methodologies for Measuring Demand Functions

Regression analysis is the common approach taken to estimate demand or preference functions. Indeed the literature on these analyses has expanded rapidly in various direction of sophistication. Most of these studies have used time series data with continuous variables in a multivariate regression framework. A similar approach has been used with cross-section data explaining the continuous dependent 'demand' variable with independent continuous variables.

However, in analyses that use farm data from cross-sectional surveys, binary responses are often encountered because of the categorical nature of the decision. When a service is introduced a farmer is confronted with a decision to which (s)he reacts positively or negatively. Differences in such reaction result from the fact that producers do not have the same resource endowments, they have different objectives and utility preferences, and are often of different socio-economic backgrounds.

In order to account for these binary responses the regression literature has expanded to facilitate a binary dependent variable in the form of logit, tobit and probit models. This analysis will use both a multivariate as well as a logistic regression approach. These different methodologies will complement each other and enrich the analysis of the survey data.

6.5.1 Multivariate Regression Model

The multivariate regression model can be expressed as:

$$y_i = \delta_0 + \sum_{i=1}^{n} \delta_i x_i \qquad (1)$$

Y_i is the dependent variable, X_i are the explanatory variables. These can include both the dichotomous and continuous variables.

6.5.2 Logistic Regression Model

The logistic regression model can be expressed as:

$$Log\left(\frac{P_{(y=1)}}{1-P_{(y=1)}}\right) = \beta_0 + \sum_{i=1}^{n} \beta_i \chi_i \ \ or\ as\ \left(\frac{P_{(y=1)}}{1-P_{(y=1)}}\right) = e^{(\beta_0 + \sum_{i=1}^{n} \beta_i \chi_i)} \qquad (2)$$

Where P is the probability that y=1 and χ_i are the set of explanatory variables. In this analysis χ will contain both dichotomous and continuous variables as in the multivariate regression analysis in the previous section. In the second expression in equation (2) the left-hand side is an odds ratio and the right hand side gives the marginal effects of χ_i on the odds.

6.5.3 Dependant and Explanatory Variables

The multivariate regression analysis will use the price farmers are willing to pay and the frequency with which farmers would like to dip their animals as dependent variables. These are both continuous. The first variable will be transformed into binary form for the logistic regression. The price farmers are willing to pay will be 1 when the price is higher than what they are currently paying for the dipping service (i.e.>R1.00) and 0 if it is lower (i.e. ≤R1.00). This cut-off in prices was chosen primarily to determine the factors that determine whether a farmer is willing to pay more for the dipping service than (s)he is currently paying.

Several independent variables were selected to estimate the predicted values of the dependent variables. The choice of variables used is largely based on Tambi *et al.* (1999) who extensively reviewed factors influencing farmers' demand for private veterinary services. Factors that influence both the willingness-to-pay and the revealed preference for dipping services are arguably similar. Some of the variables chosen were either dichotomous or continuous and are listed in Table 6.3.

Table 6.3: Definition of Variables Influencing both Farmers' Willingness-To-Pay and the Revealed Demand for Dipping Services

Explanatory Variables	Variable description
Dichotomous variables	
Residential status	1 – if the farmer is employed 0 – if farmer is not employed
Breed composition	1 – if farming with exotic breed 0 – if farming with Nguni only
Outreach Programmes (e.g. farmers' days)	1 – if farmers have outreach programmes 0 – if farmers do not have outreach programmes
Investment	1 – if farmers have alternative investment opportunity beside cattle farming 0 – if farmers do not have alternative investment opportunities.
Crop farming	1 – if farmers also practice crop farming 0 – if farmers do not practice crop farming.
Satisfaction with the dipping programme	1 - if satisfied with the dipping programme. 0 – if not satisfied with the dipping programme.
Perception about the disease*	1 - if farmers associate ticks with diseases. 0 – if farmers do not associate ticks with diseases
Continuous Variables	
Age	Age of farmer in years
Educational qualification	The level of education in years
Farming experience	Number of years of experience with livestock farming acquired by the farmer
Value of the cattle	The value of cattle measured in monetary terms (see chapter 2)

* This variable is assumed to have no influence on the farmers' willingness-to-pay for dipping services.

These factors are hypothesized to have different impacts on the dependent variables and the rationale for including these variables in the model is as follows. Demand for the dipping service and the willingness-to-pay are hypothesised as a positive function of employment. This is attributed largely to the income (salary) received which is likely to increase farmers ability and willingness to pay a higher price and possibly demand more animal health services. As far as farmers' age is concerned the relationship may be positive or negative depending on the stages of development. Younger farmers are assumed to have relatively high socio-economic status. These farmers may recognise the importance of maintaining a healthy herd through intensive dipping and as such may be prepared to pay higher prices for dipping services probably because of their understanding of the 'paying for the service' principle. Whereas very old farmers tend to be less energetic and more relaxed about disease and pest control, obviously these farmers might not be prepared to pay higher prices for a service that they might seldom use.

Closely related with age is experience. It is hypothesized that long term farming experience is negatively related to the willingness-to-pay and positively related to the dipping frequency. Farmers with long term farming experience are generally pensioners and are traditionally not used to the payment of rising prices and are characterised by the dependency syndrome. They have traditionally also been exposed to an intensive dipping frequency at a fixed cost. Thus, the number of years in livestock farming could positively or negatively influence the willingness–to-pay depending on the farmers position in the life cycle.

The variable breed composition was included to account for the differences in responses between farmers with exotic breeds and the Nguni breed. Breed of cattle is expected to influence farmers' willingness-to-pay for dipping services, as well as the revealed preference for dipping either negatively or positively depending on the genetic potential of the breed kept. Exotic breeds are more susceptible and less tolerant to diseases than the Nguni breed. It is therefore hypothesised that farmers with exotic breeds are expected to prefer an intensive dipping programme and will be willing to pay a higher price for the service. This is because farmers with exotic breeds are likely to be those with relatively higher socio-economic status, and *vice versa* for the Nguni breed farmers.

Education and training have been shown to influence farmers' adoption and farm management behaviour (Jones *et al.*, 1989). Educated farmers tend to be more conversant with improved husbandry methods and generally recognise the importance of having a healthy herd through disease and pests control. For such farmers, demand for animal health services is high. Thus, farmers with a high level of formal education are expected to prefer an intensive dipping programme and would be willing to pay more for dipping services probably because high education level is mostly associated with higher paying jobs.

Outreach programmes (e.g. farmers' days) are expected to positively influence the willingness-to-pay and negatively influence the dipping frequency. This might probably be the result of the current emphasis on the 'paying for the service' principle and the tick control strategy advocated under the tick control programmes is one of less acaricides application (strategic dipping). In addition, outreach programmes are assumed to be more relevant and informative than formal education, *ceteris paribus*. The attendance of farmers' days by rural livestock households in less developed areas to an extent reflect the degree of farmers' involvement and commitment in livestock production. Such attendance helps them to be up-to-date and remain informed.

There seems to be a limitation of investment opportunities in rural areas with cattle being the main and better investment opportunity as expressed by 88% of the sampled farmers. Under these circumstances one would expect that farmers without better alternative investment opportunity would be willing-to-pay a higher price and would prefer an intensive dipping service. This is probably because farmers will want to ensure that their investment (livestock) is highly protected from any natural shocks e.g. diseases. Intensive dipping would therefore be preferred to maintain a good health of the animal thereby ensuring the highest possible return from the investments. Crop farming is expected to positively influence the willingness-to-pay and negatively influence the revealed demand for dipping. The positive relationship might be attributed to the income derived from both enterprises that likely increases the buying ability assuming that farmers do sell their surplus produce. The negative relationship, however, can be attributed to labour flexibility between the livestock and crop farming enterprises such that the farmer might not prefer dipping his cattle intensively, as (s)he would like to devote more time towards crop production.

Satisfaction with the programme was also included in the model to reveal farmers' attitude towards the dipping programme. Unsatisfactory services usually yield negative attitudes towards that particular service. Therefore, farmers' willingness-to-pay and the demand for dipping are hypothesized as a positive function of farmers' satisfaction with the dipping service. In addition, satisfaction with the dipping programme implies that farmers might be getting value from their contribution.

The value of the cattle expressed in monetary terms is expected to positively influence both dipping frequency and the willingness-to-pay. Similarly, farmers who highly value their livestock are expected to prefer an intensive dipping frequency. This is due to the fact that healthy animals are usually valued higher than the unhealthy ones, hence the preference of an intensive dipping frequency in order to maintain the value of an animal. If this value can actually be realised, the more farmers will be willing to pay a higher price due to higher income likely to be received. Demand for tick control services is also hypothesized as a positive function of farmers' knowledge about tick-borne diseases herein referred to as perception about the disease. Thus, if farmers associate ticks with diseases, more farmers would like to intensively control ticks so as to avoid the cause of the disease (i.e. ticks).

6.6 Empirical Results

6.6.1 Factors Influencing Farmers' Willingness-to-Pay

Empirical estimates derived from the multivariate regression analysis are presented in Table 6.4. The level of significance chosen was 15%, and it was chosen because of the limited number of usable observations from the farmers' survey in estimation. In addition, the level of statistical significance was chosen to be able to determine those variables most affecting the independent variables. The results of the multivariate regression analysis on the willingness-to-pay indicate that at least three variables are statistical significant, namely residential status (P=0.14), herd composition (P=0.11) and satisfaction with the programme (P=0.14). As expected residential status and satisfaction with the programme variables are of the hypothesized positive sign. Contrary to expectation, however, farmers with exotic breeds are not willing to pay a higher price.

This can be ascribed to the communal grazing complexities where a farmer might unintentionally end-up farming with exotic breeds as a result of his/her cattle (possibly Nguni) mating with the exotic bulls of other farmers usually of a relatively high socio-economic status. This to a certain extent indicate a need to strengthen the delivery of extension services to the study area. The extension messages should, *inter alia*, cover topics on the advantages of keeping indigenous African breeds. As such this is an added advantage for ease of implementation of strategic tick control.

Table 6.4: Multivariate and Logistic Regression for Factors Influencing the Willingness-to-Pay

Independent variable	Multivariate Regression Results		Logistic Regression Results		
	δ_i	t-value (t-Prob)	β_i	t-value (t-Prob)	Exp (β_i)
Constant	2.46	1.24 (0.21)	-0.13	-0.08 (0.93)	0.87
Human resource					
Educational qualification	0.30	0.64 (0.52)	0.31	0.88 (0.38)	1.36
Farming experience	-0.02	-0.77 (0.44)	-0.03	-1.67 (0.09)	0.97
Liquidity					
Residential status (Employment)	1.34	1.48 (0.14)	0.53	0.89 (0.37)	1.69
Structure of production					
Herd composition (Exotic/Nguni)	-1.25	-1.61 (0.11)	-1.07	-1.84 (0.07)	0.34
Value of cattle	0.01	0.49 (0.62)	0.01	0.74 (0.46)	1.01
Crop farming	1.00	1.15 (0.32)	0.37	0.47 (0.64)	1.45
Extension					
Outreach programmes	-1.07	-1.19 (0.24)	0.63	0.87 (0.38)	1.88
Attitude					
Satisfaction with dipping service	1.92	1.47 (0.14)	0.03	0.03 (0.98)	1.03
Regional differences					
Dzanani	-1.77	-1.23(0.22)	-1.55	-1.39 (0.17)	0.21
Guyuni	-3.22	-2.54 (0.01)	-2.76	-2.24 (0.27)	0.06
Matshena	-0.99	-1.05 (0.30)	-0.49	-0.75 (0.45)	0.47
Goodness of fit	0.11		0.81		

There also appears to be strong regional differences with regard to farmers willingness-to-pay. For unknown reasons, the results indicate that farmers in Guyuni are not willing to pay a higher price for dipping services. The goodness of fit is measured by R^2 and judging from the results the explanatory variables explain at least 11% of the variation in the farmers willingness to pay. In models with qualitative dependent variables, the conventionally computed R^2 is likely to be much lower than one because corresponding to a given dependent and independent variables is 0 or 1. As a result the "use of the coefficient of determination as a summary statistic should be avoided in models with qualitative dependent variables" (Gujarati, 1988: 472).

Applying the logistic regression model, at least two variables, namely farming experience (P=0.09) and herd composition (P=0.07) were significant at the 10% level of significance as indicated in Table 6.4. Farmers with a relatively long term farming experience are not willing to pay a higher price for dipping services as expected. Again, as in the multivariate regression analysis farmers with exotic breeds are not willing to pay a higher price for dipping services. There is a slight indication of regional differences in farmers' willingness-to-pay amongst Dzanani, Guyuni and Matshena. The negative sign of all the coefficient in all the aforementioned diptanks indicate that farmers in those diptanks are not willing to pay a higher price. These results are consistent with the results of the multivariate regression analysis. A possible explanation that can be advanced is that the three diptanks probably experience a low tick challenge such that farmers might not see the need for a higher price. If this explanation holds true, it therefore indicates that there are some dynamics in tick occurrence or changes in tick distribution taking place within and amongst the veterinary zones because one would expect a higher tick challenge in Matshena (Yellow Line area). The specified model provided encouraging results with a goodness of fit of 0.82.

The existence of regional differences in farmers' willingness to pay is probably an indication that financial contribution by farmers towards dipping needs to vary from a region to a region. This is sensible taking into consideration the variation in tick challenge amongst the regions. It appears irrational for farmers in different regions facing different tick challenge and different dipping frequency to contribute an equal amount of dipping costs. It seems therefore that farmers' contribution need to be closely linked with dipping frequency so as to avoid cross subsidisation.

The exponential of β_i column (Exp (β_i)) in Table 6.4 shows the odds of having an event occurring versus not occurring, per unit change in an explanatory variable. Using this interpretation, the odds for farming experience and herd composition (exotic breeds) to be willing to pay a higher price are 0.97 and 0.34 times less that of their counterparts, respectively. This means that for an additional year of farming experience gained farmers have 0.5 probability to be willing to pay a higher price for dipping, and those owning exotic breeds have a low probability (0.25) to be willing to pay a higher price i.e. exotic breed farmers have a higher probability (0.75) to be willing to pay a lower price. There also appears an indication that farmers in Dzanani, Guyuni and Matshena have a low probability (0.18 on average) to be willing to pay a higher price.

6.6.2 Factors Influencing Dipping Frequency

Unlike the analysis on the willingness-to-pay, factors influencing dipping frequency were determined using the multivariate regression analysis only. This is because of a lack of clear quantitative identification between intensive and strategic tick control dipping frequency for the survey area. The results are indicated in Table 6.5.

Table 6.5: Multivariate Regression for Factors Influencing the Dipping Frequency

Independent variable	Dipping frequency	
	Percentage of median	
	δ_1	t-value (t-Prob)
Constant	2.45	0.63 (0.53)
Human resource		
Farming experience	-0.06	-0.97 (0.33)
Liquidity		
Residential status (Employment)	37.66	13.64 (<0.001)
Structure of production		
Herd composition (Exotic/Nguni)	-1.26	-0.52 (0.61)
Value of cattle	0.01	0.88 (0.38)
Crop farming	3.70	1.15 (0.25)
Extension		
Outreach programmes	-1.80	-0.67 (0.50)
Regional differences		
Dzanani	-5.29	-1.60 (0.11)
Tshifudi	4.51	1.38 (0.17)
Goodness of fit	0.67	

At least one variable, namely employment ($P<0.001$) was the only significant variable. As expected the demand for the dipping service is of a hypothesized positive function of employment. Thus, employed farmers are prepared to adopt an intensive dipping frequency than the unemployed ones. There is also a slight indication of regional differences in dipping frequency preferences in Dzanani and Tshifudi. Sampled farmers in Dzanani do not prefer an intensive dipping whereas those in Tshifudi seem to prefer an intensive dipping frequency. This probably confirms the existence of differences in tick prevalence between the two areas, Yellow Line and the Open area, with the former considered as a high tick prevalent area. The goodness of fit as measured by R^2 is impressive since the explanatory variable explain 67% of the variation in the dipping frequency.

The results obtained from both Table 6.4 and 6.5 suggest a more significant role of human resource, liquidity, attitude and structure of production (herd composition) over other factors in affecting both the willingness-to-pay, as well as the dipping frequency.

Given that the average willingness to pay for dipping is less than the subsidised price by government, it probably indicates that in the foreseeable future subsidising the price of dipping is likely to be the norm. However, most governments according to Umali *et al* (1994) no longer have enough funds, are unable to meet the increasing needs of farmers and the availability and quality of veterinary service is rapidly declining. Therefore, information provided by the results of the study illustrate that a good understanding of those factors is necessary for those who want to get into private veterinary practice and for government wanting to privatise the delivery of veterinary services. This is because from a provider standpoint, demand must be large enough to make private practice a profitable endeavour. In addition, the results obtained have certain implications for the extension services especially towards the adoption of new practices. Prospects indicate a move from intensive acaricides application in favour of less intensive dipping based on strategic tick control. An awareness of those factors influencing the adoption of new practices is, *inter alia*, helpful to the extension agents in selecting the teaching tools to be used to yield the desired resultant end products.

An important question that one may ask is how extension agents can use the results to influence the diffusion process in adopting strategic dipping given factors influencing the willingness-to-pay and dipping frequency? The effectiveness of the extension services or method depends upon the knowledge of the target group. Thus, before strategic dipping can be implemented it is important to know the target group so that the extension method employed can be effective towards its adoption. This is crucial considering that in most cases adoption behaviour differs across socio-economic groups and overtime. From the study results, one can realise that there are various groups of farmers that can be categorised into potential adopters and non-potential adopters. In this regard, extension agents might increase their impact by co-operating with potential adopters since they tend to be people who are capable, willing and sometimes in a position to influence other farmers.

6.7 Conclusion

This chapter attempted to identify factors influencing both the demand for dipping services and farmers' willingness-to-pay using the multivariate regression and the logistic regression model. Significant factors influencing the willingness-to-pay were human resource, structure of production, and liquidity. Liquidity also influences the dipping frequency. The influence of liquidity (employment) on both the willingness to pay and the dipping frequency underscores the importance of job creation. More importantly job creation strategies in rural areas should, *inter alia*, aim at increasing the utility farmers gain from cattle by providing marketing opportunities for cattle and their products. These results are an indication that the significant possible predictor variables of adoption must be attended to when adoption policies are set for veterinary services in general.

The structure of production, herd composition in particular, provides an interesting results with both models indicating the unwillingness-to-pay a higher price for dipping services by farmers owning exotic breeds. This to an extent implies that private veterinarians intending to provide veterinary services in less developed regions need to seriously consider the structure of production in order to stimulate the demand for animal health services. On the basis of the preceding discussion, the results of the study seem to indicate that research needs to be done focussing on the effects of various breed types on the demand for animal health services.

CHAPTER 7

FUTURE STRATEGIES TO CONTROL TICKS AND TICK-BORNE DISEASES IN LESS DEVELOPED AREAS.

7.1 Introduction

The preceding chapters demonstrated that the current method of ticks and tick-borne diseases control is clearly beset with numerous limitations and is evidently inadequate and unsustainable. In tropical developing countries where problems of ticks and tick-borne diseases of livestock are the most acute, there is no longer a universal acceptance of the notion that intensive dipping in acaricides is the appropriate and desirable way to manage the problem (George, 1992). Again, experience (de Castro and Newson, 1993) has shown that the intensive use of acaricides, though beneficial in the short term if applied efficiently, soon leads to the loss of protective immunity against ticks and tick-borne diseases. Any prolonged interruption in the tick control programme leave the cattle population vulnerable to major outbreaks of tick-borne diseases or the build up of debilitatingly high tick population. Moreover, economic studies have shown that there is no justification for continuing or attempting to re-establish short interval dipping in indigenous, low producing cattle (Lawrence, 1996). As a result, the role that acaricides should play in the control or management of ticks and tick-borne diseases complex in Africa has been the subject of intensive debate in recent years, particularly in southern Africa where East Coast fever is considered to have been eradicated (Norval *et al.*, 1992).

With the above concerns in mind, there is a need to revise ticks and tick-borne diseases control practices especially in the light of current understanding of the economics of tick control. However, differences in livestock production systems and animal disease control strategy mean that individual countries will need to assess their own policy option to determine approaches compatible with optimal and sustainable application of new control strategies.

In Venda, the following strategies will be necessary to prevent future occurrence and the probable resultant of cattle mortalities caused by tick-borne diseases. In pursuing these strategies it is essential to remember that the disease does not exist in vacuum.

7.1.1 Host Resistance

Strict tick control is difficult to maintain in many less developed countries and more rigorous methods for controlling ticks and tick-borne diseases are imperative. The most important element in the control package is the use of breeds of cattle that are genetically resistant to tick infestation. In Africa, it is evident from a number of studies that indigenous breed of cattle (e.g. Nguni) are more resistance than Taurine breeds and their crosses for a variety of tick species and that there is considerable variation in individual resistance within breeds (Norval, 1992; Fasanmi and Onyima, 1992). Resistant animals have a tendency towards light tick burden and requires less dipping thereby making control relatively easy and cheaper.

Despite the increasing recognition of Nguni resistance to ticks and tick-borne diseases it is still inadequately exploited in control strategies and large number of animals in Venda are subjected to unnecessary intensive acaricides application. There is no any economic justification to intensively control ticks and tick-borne diseases for the low producing indigenous breed. However, for non-indigenous cattle with a higher production potential, short interval dipping is economically justified and it will continue to be so (Lawrence, 1996).

Failure to exploit tick resistance directly in Africa has been the result of a number of factors, foremost being the general acceptance of acaricides application as a necessity of acaricides procedure in cattle husbandry by most farmers. Linked to this is a widespread belief that even small numbers of ticks have large effects on the health and productivity of cattle. Moreover, tick control procedures were set by the requirements of the Taurine animals and the potential resistance of the indigenous breeds was ignored such that Nguni breed was intensively dipped at the expense of their immune system. Therefore wherever and whenever the control of ticks on livestock is considered worthwhile, the use of tick resistant livestock should be considered a viable option among the many factors that are weighed when devising and evaluating management strategy.

The exploitation of host resistance requires a concerted extension effort for active tick control and optimal results. Through extension services farmers should be advised and convinced to cull very susceptible animals in their herd early to upgrade the tick resistant potential of their herds by using only tick resistant cattle for breeding. However, this change is likely to be slow since some farmer's decisions on cattle breeds are deeply rooted and often driven by aesthetic, cultural, social as well as economic consideration. For a poor resource farmer like in Venda this seem to be a viable option taking into consideration that the majority of the sampled cattle owners (71%) are farming with the Nguni breed. However, host resistance to tick infestation in our local breed of cattle and the assessment of its effective role in tick control should be further investigated. And this will provide further information on the ranking of animals for tick resistance and subsequent application in livestock improvement programmes.

7.1.2 Strategic Tick Control

Strategic tick control is an attempt to control ticks and reduce losses in animal production due to tick infestation while decreasing the cost for the control. Under this strategy acaricides are applied only when it is necessary especially during period of high tick challenge. Due to low productivity of the local breed of cattle, it is difficult and virtually irrational to suggest a longer period of tick control. In addition, the increasing costs of acaricides, maintenance of the infrastructure, salaries for personnel, *etc* possibly creates a tick control programmes where the benefits may not be adequate to justify the expense. According to Norval *et al.* (1992) the other main disadvantage of acaricides have been the rate at which their costs have increased relative to the value of cattle products. Therefore, with adequate cattle owners participation and organisational support from government personnel this strategy can help to solve this economic problem. Its overall aim according Bezuidenhout and Bigalke (1987) is to:

- Reduce costs
- Decrease the tick population of an area
- Assist in increasing animal production
- Ensures that enzootic stability is maintained

However, strategic tick control is not a panacea. Practically it is a very difficult strategy to apply because (Bachmann, 1992):

- Tick numbers peak at different times for different tick species, and different stages in the life cycle of ticks.
- The times when numbers peak differ from area to area, and also possibly from year to year depending on climatic variations.
- Peaking of tick numbers might take place on other cattle breed which cannot be dipped simultaneously.
- Farmers who attempt to apply strategic dipping must be dedicated, observant and able to interprete information.

It appears possible that overtime the current benefits obtained more especially from the Nguni breed can be obtained with less cost. More importantly, it is not the total costs of the disease that is useful, but rather the avoidable costs. The economically optimal disease control policy is that which gives the lowest attainable total costs, i.e. the least-cost combination of control expenditure and losses (McInerney *et al.*, 1992).

Unfortunately, very little relevant information on exactly how to strategically control ticks is presently available (Bezuidenhout and Bigalke, 1987). The main reasons for this are a lack of knowledge on the infection rate of ticks, the factors that influence such a rate and the absence of a practical method to determine the percentage of infected ticks. It would be of great value if one could attempt to turn these limitations into opportunities for future research.

7.1.3 Integrated Tick Control Strategy

Most farmers in less developed regions are resource poor and it is therefore important that ticks and tick-borne diseases control strategies should be aimed at making control affordable and readily available to these farmers. This cannot be achieved by adopting a control strategy that is totally dependant on acaricides, but based on cheaper, safer and sustainable methods of tick control such as the use of natural pesticides in integrated tick programmes.

Current policies is to combine two or more of the available techniques for controlling ticks and tick-borne diseases to produce an integrated system of tick management. According to Mukhebi and Perry (1992) disease control in any country or area is possible only if the different measures complement each other. As the name indicates, integrated control strategies are based on the use of several different methods for the control of ticks and tick-borne diseases, as opposed to the use of a single method such as intensive acaricides application for the control of the entire ticks and tick-borne diseases complex. The philosophy is that different methods for ticks and tick-borne diseases control are complementary, economically viable and sustainable such that if one control measure breaks down a robust integrated control system still remains effective. This strategy is necessary as it is now clear that tick eradication by means of acaricides is unachievable and that the control of ticks and tick-borne diseases by intensive acaricides treatment of livestock is expensive.

The aims of integrated control strategies should be to manage tick population and tick-borne diseases within acceptable limits in which the risks of disease outbreaks are minimal (Norval *et al.*, 1992). Moreover,…"the objective of tick control should be to reduce tick population below the economic threshold so that control costs are less than the anticipated benefits, not all of which can be priced in subsistence economies" (de Castro and Newson, 1993: 13). Tick population can possibly be managed by utilising host resistance with strategic tick control measures previously discussed. Whereas tick-borne diseases can be managed by ensuring that all domestic livestock are immune to the diseases that occur there. Immunity may possibly be maintained by simply ensuring that tick numbers are high enough to perpetuate endemic stability. The essence of the integrated control programmes is to provide sufficient tick control to increase cattle productivity, while not reducing tick numbers to the extent that endemic stability is adversely affected.

Pegram *et al.* (1993: 4) mentioned some of the main essential elements of an integrated ticks and tick-borne diseases programme, namely:

- Appropriate legislation
- Correct extensive message for both disease and vector control
- Enzootic stability to tick-borne diseases
- Host resistance to ticks using the correct breed
- Appropriate strategies, such as minimal control in periods of low challenge and strategic control for seasonal challenges
- Economics and marketing, considering the costs of acaricides production and delivery and type of farming.

For resource poor farmers a policy of minimal intervention can be the best strategy. Evidently, integrated tick control strategy seems to be the best strategy to be pursued by those farmers. It costs little and does not start the dangerous course of replacing a stable system with an unstable one henceforth maintained only by expensive inputs.

In adopting this strategy, Mukhebi (1992) suggests three important factors to be taken into consideration namely: political, social and economic factors. Informed professional staff will need to convince politicians of the necessity of accelerating the revision of legislation (that makes intensive tick control obligatory) to facilitate the changes and the benefits to be gained thereof. Secondly, extension services extended to participating farmers through auxiliary fields staff will need to be given high priority. Farmers and advisers need to be educated to accept the benefits gained from boasting immunity to tick-borne diseases and achieving host resistance to ticks that would results from relaxed tick control regime. Thus, there need to be improved communication with the end users of the policies i.e. field animal health personnel and farmers. As farmers are expected to contribute the control costs of this strategy, efforts to improve available markets for livestock products will be required. For a small-scale farmer, it appears appropriate that such efforts need to be accompanied by the incentives to sell.

Given integrated control option, a sound management decision requires input based upon knowledge of the biology and ecology of the target tick species, the cost of ticks and tick-borne diseases on the productivity of the breed of livestock (George, 1992). Moreover, in animal production system one of the variable input is the cost of diseases. An integrated tick control strategy, *inter alia*, aims at decreasing the cost of diseases. If this costs can be reduced the same output can be produced more cheaply (thus efficiency) and the savings can be converted into other developmental needs such as education.

7.2 Investment in Disease Research and Development

There seem to be no animal production system without health control in its various forms. Diseases occurrence are dynamic and frequently change, new and more effective drugs, *etc* need to be developed. With this in mind, research and disease control are to be treated as productive factors that are complementary with other factors in the production sectors. It is in the long-term interest of South Africa to invest in disease research and technology. Research starts with problems, priorities, knowledge and resource base. It is therefore crucial to employ a participatory approach in all the phases of agricultural research and development. As primary beneficiaries, farmers in particular should actively be involved since they validate technology adoption.

Moreover, research and development is an important avenue of growth in the livestock sector. Recent emphasis placed on the role of the small farmer requires public sector investment to provide services that are essential if he/she is to compete with large-scale enterprises in animal production. Thus, government should play an active role in agricultural research and development with more emphasis on disease surveillance and diagnostics. A fundamental requirement for the national and international control of animal diseases is the provision of a comprehensive system of disease surveillance and disease reporting (Griffiths, 1976). There is a great need for improved disease surveillance in most of the developing countries as evidenced by the tick-borne diseases induced mortality that is unreliably high. Such a disease surveillance system should be able to answer questions such as when, where, how and why did the disease occur or spread.

7.3 The Delivery of Veterinary Services: Public versus Private Good Debate

In establishing the appropriate roles for the public and private sector in the livestock services industry, it necessary to obtain a clear understanding of the economic nature of each service. This involves the identification of various areas that constitute the veterinary services. In most production system the veterinary service cover three broad areas; animal health care, production and public health. According to Gros (1994) animal health services consists of preventative (e.g. tick control) and curative care, as well as the delivery of veterinary pharmaceuticals. Production services on the other hand, are more specifically geared to increase the product of individual animals and herds; they include such extension services as artificial insemination to achieve genetic improvements.

Animal health care delivery alone involves a wide range of activities, some of which have private good attributes, while others may best be defined as having public good ones. In the veterinary service area some aspects (i.e. curative services and drug sales) exhibit private good characteristics; thus, other things being equal, if delivered by the private sector an economically optimal quantity is likely to be provided. Curative care is, however, only an imperfect private good. It can be argued, especially where contagious diseases are involved, that all producers benefit when one of their neighbours' animal is cured of a disease. If left untreated such disease could spread to other animals. Hence there is a spill-over effects of externality in such cases.

On the other hand, other aspects such as preventative and promotive services are at best public goods which will likely be underprovided unless undertaken by an entity other than the private sector. Thus, the privatisation of public goods especially those involving preventative and public health services is likely to results in significant market failures.

The only way such goods can be optimally provided is if some kind of collectivity (e.g. the state) assumes responsibility for service delivery.

With the above in mind, it is evident that both the public and the private sector can play a complementary rather than a mutually exclusive role in certain areas. The question is not so much state or market, or private versus the public sector, but rather to what extent and in what form these institutions should participate in a given domain (Leonard, 1993; Gros, 1994). There are certain areas in which optimality is more likely to be achieved if both sectors are involved. The veterinary service delivery is thus one area in which state and private sector participation is not incompatible but complementary in the African setting.

7.4 Provision of Dipping Services

For a long time tick control has been regarded as a national concern, hence the provision of communal diptanks by government. In poor-rural areas the provision of dipping services by government is justified and as such will continue to be its responsibility to ensure food security, alleviate poverty and other social benefits. However, the provision of tick control at a highly subsidised charge places a heavy burden on government budget and usually leads to deterioration in the quality of the services. The principle of "pay for services" is a good principle, but not necessarily of first priority in the complicated field of dipping, especially in controlled areas. Fortunately, all the sampled farmers feel that cost recovery should continue with the majority (67% as previously stated) being in favour of the same price presently charged by the government. However, at least 23% of the sampled farmers are conditionally prepared to contribute a relatively high price only if dipping services can be improved. It is therefore sensible to suggest that farmers should get the best services in return to their contribution. To this end, ways of increasing the farmers' choice must be considered. Similarly, this suggests that there should be a marriage between the public and the private sector in the provision of tick control.

7.5 Formation of Farmer's Organisations

There is a window for opportunity available to all cattle owners' in the communal areas in terms of improving cattle production in general. To explore such an opportunity farmers should organise their own organisations and cooperatives to be able to address their own problems and to seek for solutions themselves. If not, farmers reliance on governmental institution will persist, as it is one of the main factors that characterises cattle owners in Venda. Effective farmers groups are the most likely channels through which to resolve deficiencies in animal production because they are able to provide benefits that are difficult to secure from individual efforts. The formation of farmers' unions could answer questions such as what will the government do for them instead of asking what will they do for their government. In addition, the formation of such unions must be viewed in the context of the whole farming system. If proved successful and effective, such a formation should coincide with the gradual handing over of some recurrent expenditures such as the provision of consumables (e.g. acaricides, vaccines, drugs, *etc*) to the communal farmers.

7.6 Improvement of Livestock Production Extension

For a successful disease control, it appears fundamental to strengthen extension activities and be given high priority. Among other things, the construction of diptanks (as previously stated) was seen as an opportunity by the government for effective extension, education, and training, practical demonstration, inspection, uptake of accurate census data and calculation of stock density. It was observed, for example, that the inspection expected to be done by the animal health extension officers is limited because their duties at the diptank is predominantly counting and recording. It is rarely possible, if not impossible, to count, record and inspect simultaneously. The expertise of any animal health extension officer is to control diseases through for example vaccination, health care (referrals to the state veterinarian) and advisory services.

At the root of many of problems of small-scale farmers lie ignorance and lack of communication. It is not, however, ignorance in a pejorative sense, but rather a lack of knowledge (Dreyer, 1997). It is therefore recommended that the major objectives of extension should be to transfer relevant knowledge and information to enhance the productive capacity of farmers. Failure in education of livestock owners and the general public have probably accounted for more problems in successful pursuit of animal disease management than any other single factor. According to Unklesbay (1992) recent research projects have shown that improvements in animal health are feasible once the stockowners receive appropriate educational information. More importantly, livestock record keeping as an integral part of disease control should be emphasized within the extension services. This will enhance farmers' data and information reliability necessary for livestock development strategy.

It is therefore important that educational ventures such as farmer's days need serious attention and be promoted 'by doing'. The implementation of such ventures should be the responsibility of everyone including high schools, universities, non-governmental organisations, various government departments, research institutions e.g. Onderstepoort Veterinary Institute, *etc*. For their success, such ventures should be planned in such a way that they are accessible to the resource poor farmers.

CHAPTER 8

SUMMARY AND CONCLUSION

8.1 Introduction

This chapter provides the summary of the study and conclusions on future action needed to maintain cattle productivity, especially with regard to the optimal control strategies for ticks and tick-borne diseases in developing areas based on the Venda region as an example.

8.2 Summary

Two veterinary zones, namely the Yellow Line and the Open area, of the Venda region in the Northern Province were surveyed in order to evaluate the justification of the ticks and tick-borne diseases control programme (i.e. dipping), as well as assessing the socio-economic impact of the programme at the farm level. In South Africa, dipping of cattle was implemented at the start of the 20^{th} century after the introduction of tick-borne diseases such as heartwater, redwater and gallsickness. However, heartwater occurs most frequently and was probably the first to be established tick-borne disease of cattle in Africa. It spread into South Africa through the coastal areas of the then Eastern Cape Province and it was eradicated in 1954. This breakthrough can be attributed to a blood vaccine which was developed at Onderstepoort Veterinary Institute.

The livestock sector plays an important social, economic and cultural role in the economies of developing areas hence the control of ticks and tick-borne diseases and the resultant eradication of East Coast fever. These roles have been analysed both in quantitative and qualitative terms. Survey results revealed that Venda cattle herds produce a wide diverse array of useful goods and services including meat, milk, traction power and some donations to the community. The majority of the sampled farmers (97%) keep cattle for both subsistence and commercial purposes. At least 3% of the respondents keep cattle solely for commercial purposes.

A quantitative assessment of the value of livestock revealed an average economic value of R1 152 using the sales criteria. Several aspects were considered to measure the economic value and those values are mainly based on the assumption that price reflect value. The aspects considered for valuation are, namely:

- Biological productivity
- Off-take
- Value of milk
- Value of draught power (ploughing)
- Value of manure use

These method are not optimising models but do provide a useful method for estimating the value of livestock for small household herds. Of the total economic value, milk contributes a relatively larger proportion of R526 followed by off-take (R353), work of cattle (R259) and lastly manure use (R14.00). However, the quantified economic value derived does not take into account the benefits derived from an integrated crop-livestock system. Under this system the areas of interaction are both complementary and competitive.

An important observation is that some values are largely performed by animals of a certain age group or sex. For instance, animal off-take and draught power is often concentrated on oxen. Butcheries and friends (i.e. private sales) are the most commonly used market outlets used by 47% and 26% of the respondents who sold their cattle, respectively. With the exception of Tshifudi, auctions venues were only used by 22% of the sampled farmers located within the Yellow Line area.

However, ticks are still the most important parasitic vector of cattle that inhibit farmers in the attainment of their farming objectives. The control of ticks and tick-borne diseases is of importance in maintaining the productivity of cattle. The classical and the most widely used ticks and tick-borne diseases control measure is the plunge dip. After the eradication of East Coast fever, short interval dipping of livestock became a standard compulsory method of tick control enforced by law. Cattle are either dipped weekly or fortnightly. The collection of cattle at diptanks presents a useful vehicle for disease surveillance and extension. Moreover, due to a lack of a reliable formal market it offers some unintended services as a place where private buyers and cattle owners can negotiate terms of trade thereby reducing the transaction costs.

The widespread application of acaricides as a tick control measure has certain flaws and limitations as expressed by 11% of the respondents. The development of tick resistance and lack of dipping water supply are the major problems advanced by 79% and 14% of the dissatisfied farmers, respectively. In addition, the use of plunge dip is not applicable during drought times due to the weak condition of the animals. Due to some of these limitations, 61% of the respondents supplement dipping with both modern and traditional tick control measures. A large number of the respondents (45%) control ticks to avoid wounds, diseases and possible deaths. The most common tick problems experienced by the respondents (70%) amongst their livestock are tick wounds and tick damage.

Intensive acaricides application cannot be justified on economic grounds in indigenous breeds when taking into consideration their inherent immune system against diseases. The frequency of acaricides application depends on the area, tick challenge, breed of cattle and the level of control required. However, in the surveyed areas dipping frequency seem to be influenced solely by the level of tick challenge. The majority of the farmers (90%) are still in favour of the intensive dipping of cattle. Intensive acaricides application results in highly susceptible cattle population because cattle are not exposed to the parasites resulting overtime in a loss of immunity.

It costs the government R12.00 and farmers only R1.00 to dip a head of cattle per year irrespective of the dipping frequency. However, governments spend a considerable sum of money annually on research, training and extension services related to the control of ticks and tick-borne diseases. Surveyed farmers spend an average annual amount of R110 on tickicides only. Surveyed farmers are willing to spend an average amount of only R2.00 to dip a head of cattle per year in spite of the higher costs borne by the government.

The "with" and "without" dipping scenarios comparison shows a benefit-cost ratio of 0.8 indicating that the provision of the dipping programme by the government is not economically justified. However, this ratio can be improved by reducing the dipping costs through strategic tick control. In addition, the government should continue providing the dipping service largely because of the economic nature of the service (public good) it provides. The benefit cost ratio is, however, sensitive to changes in the mortality rate. When the mortality rate for the "without" scenario is assumed to be 10%, the ratio increases from 0.8 to 1.2 indicating that it is worthwhile to control ticks and tick-borne diseases through dipping.

Several aspects were considered for the possible calculation of benefits, namely milk, meat and draught power. Costs of control included both government and farmers costs. The "with" and "without" dipping scenarios mortality is 3% and 4% respectively, assuming if dipping was not pursued. The difference between the "with" scenario net income and the net income balance for the without scenario gives an incremental net loss of R23 475 per sampled herd.

A 3% mortality rate for the "with" scenario results in a total average loss of R73 728 in income. A relatively higher mortality rate of 3.9% in Vyeboom makes it possible for this area to contribute a larger proportion of R19 138 to the total loss. Of the 3% mortality rate the Nguni breed contributes 2.8% in spite of its resistance to diseases. Two possible reasons can be advanced for this. Firstly, this is probably due to a loss of immunity caused by intensive acaricides application; secondly, this could be related to poor cattle management practices by the sample farmers. With a mortality rate of 4%, the "without" scenario results in a total average potential loss of R211 344 to all the farmers in the surveyed areas, *ceteris paribus*.

Using the dipping programme as an example, it is important to know various significant factors influencing the demand, as well as farmers' willingness-to-pay for veterinary services before any alternative options aiming at improving animal health can be introduced. This was done by applying both the logistic regression model, as well as a multivariate regression analysis. The results of the multivariate regression analysis revealed that satisfaction with the dipping programme and employment positively influence the willingness to pay whereas farmers owning exotic breeds are willing to pay less for dipping services. This can be ascribed to the communal grazing complexities where a farmer might unintentionally end up farming with exotic breeds as a result of his/her cattle (possibly Nguni) mating with exotic bulls of other farmers.

Applying the logit model, the results further indicate that farmers with long term farming experience are not willing to pay a higher price. This is probably because farmers with long term farming experience are generally pensioners and have been 'spoiled' by state provision of (almost) free veterinary services. Thus, such farmers are not used to the payment of rising prices. As far as dipping frequency is concerned, the results of the multivariate regression analysis shows that employed farmers prefer an intensive dipping frequency. This can be attributed largely to the income (salary) received which likely increase farmers' ability to pay and possibly demand more animal health service.

Finally, the results of the study show a need to revise ticks and tick-borne diseases control practices. Experience shows that there is no justification for continuing or attempting to re-establish intensive acaricide application in indigenous low producing cattle. Current policies is to combine two or more of the available techniques to produce an integrated system of tick management rather than the use of a single method such as intensive acaricides application. The main elements of an integrated tick control strategy are namely:

- Host resistance to ticks using the correct breed
- Enzootic stability to tick-borne diseases
- Appropriate legislation
- Economics and marketing, considering the costs of acaricides production, delivery and type of farming
- Appropriate strategies, such as minimal control in periods of low challenge and strategic control for seasonal challenges.

The main advantage associated with this strategy is that it reduces costs and decreases the tick population of an area thereby assisting in increasing animal production. However, tick-borne diseases do not exist in vacuum. It needs to be complemented with other aspects necessary for livestock development in less developing areas. Such aspects involve the formation of farmers' organisation and improvement of livestock production extension services. The latter aspect further calls for a continual government investment in disease research.

8.3 Areas for Future Research

This study primarily provides an overview of the justification of the existence of the dipping programme in less developed areas particularly focusing on the socio-economic impact of the programme. In this regard a question still remain unanswered. What is an optimal tick control dipping frequency in the area? In an attempt to answer this question, *inter alia*, a multi-criteria strategy need to be applied that takes into account the social, economic, environmental and technical consequences of such a strategy, unlike cost-benefit analysis that is based on costs and benefit of the programme. To achieve this, the expertise of epidemiologists, animal scientists and social scientists need to be integrated to produce an optimal tick control frequency. It is evident that to have a reasonable chance of success, such research should be multi-disciplinary in nature.

Socio-economic capacity in veterinary components of the South African national agricultural research system is often non-existence or ill-equipped to conduct research. It is therefore crucial to integrate the social discipline within the national agricultural research system. This will, *inter alia*, ensure that the new technologies developed by research are appropriate to the needs of target clients and can be sustainable, without causing any detrimental effects on household, community and national economies.

BIBLIOGRAPHY

AAKER, J. (1994). *Livestock for a Small Earth*: The Role of Animals in Just and Sustainable World. Seven Locks Press, Washington.

ANANDAJAYASEKERAM, P., MARTELLA, D.R. and RUKUNI, M. (1996). *A Training Manual for Biological Scientists on Impact Assessment of Investment in Agricultural and Natural Resource Research*. SADC-SACCAR, Gaborone, Botswana.

ANDREW, R., NORVAL, I. and PERRY, B.D. (1994). Dynamic Association of Tick-Borne diseases Affecting Animal Health. In: D.E., Sonenshine and T. N., Mather (Eds), *Ecological Dynamics of Tick-Borne Zoonoses*. Oxford University Press, New York. 283-305.

BACHMANN, M. (1992). *Tick control*: Beef in Natal- Agricultural Production Guidelines for Natal. Department of Agricultural Development, Natal

BAILEY, K.D (1987). *Methods of Social Research*. Collier Macmillan Publishers. London.

BAKER, A.G., NETO, J.S. and KNIPSCHEER, H.C. (1988). The Willingness-To-Pay Technique in Evaluating On-Farm Animal Research in Brazil. *Agricultural Systems*, 28: 91-102.

BEAL, V.C. (1981). Animal Health Economics with Special Emphasis on Mathematical Modeling of Animal Disease Change. *Bull. Off. Int. Epiz,* 93 (5-6): 893-902.

BEHNKE, R. (1985). Measuring the Benefits of Subsistence versus Commercial Livestock Developments in Africa. *Agricultural Systems*, 16: 109-135.

BEHNKE, R.H. (1987). Cattle Accumulation and the Commercialisation of the Traditional Livestock Industry in Botswana. *Agricultural Systems*, 24: 1-29

BELLANI, D. and MANTOVANI. (1983). Animal Health Protection and Economy in Hungary. *Bull. Off. Epiz*, 92 (5-6), 319-324.

BEMBRIDGE, T.J. (1979). Problems of Livestock Production in the Black States of Southern Africa and Future Strategy. *South African Journal of Animal Science*, 9: 163-176.

BEZUIDENHOUT, J.D. and BIGALKE, R.D. (1987). The Control of Heartwater by Means of tick control. *Onderstepoort Journal of Veterinary Research*, 54: 525-528.

BEZUIDENHOUT, J.D., PROZESKY, L. and AMSTEL, S.R. (1994). Heartwater. In: J.A.W. Coetzer, G.R., Thomson R.C., Tustin and N.P.J., Kriek (Eds), *Infectious Diseases of Livestock with Special Reference to Southern Africa*, vol. (1). Oxford University Press, Cape Town. 351-338.

BLESS, C. and ACHOLA, E. (1995). *Fundamentals of Social Research Methods*: An African Perspective. Creda Press, Cape Town.

BOOYSEN, M. (Undated). *Venda Agricultural Development.* Agriven. Thohoyandou, Venda.

BOTHA, N. (1994). A Modern Approach to Rural Farming Development. *Farmer's Weekly*, 4 March, 38-39.

COETZER, J.A.W., THOMSON, G.R and TUSTIN, R.C. (1994). *Infectious Diseases of Livestock with Special Reference to Southern Africa*. Oxford University Press. Cape Town.

COETZER, K. (1995). Diseases of Domestic and Wild Animals that may have a Significant Socio-Economic Impact on Communities in Southern Africa. *Paper Presented* *at Workshop on Socio-Economic Aspects of Animal Diseases in Southern Africa*, 3 May 1995. Foundation for Research Development: Pretoria, South Africa.

DANKWA, K.B. (1992). *Determinants of Household Food Security in Lebowa and Venda.* Unpublished Masters Thesis: University of Pretoria. South Africa.

DE CASTRO, J.J. and NEWSON, R.M. (1993). Host Resistance in Tick Control. *Parasitology Today*, 9 (1): 13-17.

DE VOS, A.J. and POTGIETER, F.T. (1994). Bovine Babesiosis. In: J.A.W. Coetzer, G.R., Thomson, R.C., Tustin, and N.P.J., Kriek (Eds), *Infectious Diseases of Livestock with Special Reference to Southern Africa*, Vol. 1. Oxford University Press, Cape Town. 278-294.

DENES, L. (1983). Animal Health Protection and Economy in Hungary: Animal Health and Economics, Technical Series No.3. *Office International Des Epizootic*, Paris.

DIDA, E. (1983). Animal Health and Economics in Mali. *Bull. Off. Int. Epiz.*, 92 (5-6): 849-854.

DIJKHUIZEN, A.A., RENKEMA, J.A. and STELWAGEN, J. (1991). Modeling to Support Animal Health Control. *Agricultural Economics*, 5: 263-277.

DIPPING POLICY SURVEY (1997). Report on the Implementation of a Dipping Policy for Cattle in the Northern Transvaal Region, PP 6

DOLAN, T.T. (1987). Control of East Coast Fever. *Parasitology Today*, 3 (1): 4-6.

DORAN, M.H., LOW, A.R.C. and KEMP, R.L. (1979). Cattle as a Store of Wealth in Swaziland. *American Journal of Agricultural Economics*, 61 (1): 41-47.

DREYER, K. (1997). *Occurrence and Control of Parasites on Cattle in Urban and Peri-Urban Environments with Specific Reference to Ticks*. Unpublished Msc thesis. University of the Free State, Bloemfontein.

DÜVEL, G.H. and AFFUL, D.B. (1996). Socio-Cultural Constraints on Sustainable Cattle Production in Some Communal Areas of South Africa. *Development Southern Africa,* 13 (3): 429-439.

EWANG, P.N. (1995). Address the Basics. *Farmer's Weekly*, 12 May, 4-5.

FARMERS WEEKLY (1998). Combat Ticks and Win a Rugby Ticket to the World Cup. 30 October.

FASANMI, F. and ONYIMA, V.C. (1992). Current Concepts in the Control of Ticks and Tick-borne diseases in Nigeria-A Review. *Insect Sci. Applic.,* 13 (4): 615-619.

FEDER, G., JUST, R.E and ZILBERMAN, D. (1985). Adoption of Agricultural Innovations in Developing Countries: A Survey. *Economic Development and Cultural Change*, 32 (2): 255-298.

FEUERSTEIN, M.T., SHAW, A and LOVEL, H. (1987). The Role of Livestock in Community Development. *Community Development Journal*, 22 (3): 174-188.

GEORGE, J.E. (1992). Naturally Acquired Immunity as an Element in Strategies for the Control of Ticks in Livestock. *Insect Sci. Applic.,* 13 (4): 515-524.

GITTINGER, J.P. (1982). *Economic Analysis of Agricultural Projects*. John Hopkins University Press, London.

GRIFFITH, R.B. (1976). The International Control of Animal Diseases. In: A.J. Smith (ed). *Beef Cattle Production in Developing Countries*. Proceedings of the conference held in Edinburg from 1st –6th September 1974. University of Edinburg, Edinburg.

GROS, G.J. (1994). Of Cattle, Farmers, Veterinarians and the World Bank: The Political Economy of Veterinary Services Privatisation in Cameroon. *Public Administration and Development*, 14: 37-51.

GUJARATI, D.N (1988). Basic Econometrics. 2nd edn. McGraw-Hill Book Company, New York.

HENNING, M.W. (1956). *Animal Diseases in South Africa:* Central News Agency LTD.

HERMANS, C., UDO, H.M.J. and DAWOOD, F. (1989). Cattle Dynamics and Their Implications in Babna Districts, Bangladesh. *Agricultural Systems*, 29: 371-384.

HOWELL, C.J., DE VOS, A.J., BEZUIDENHOUT, J.D., POTGIETER, F.T. and BARROWMAN, P.R. (1981). The Role of Chemical Tick Eradication in the Control or Preventative of Tick-Transmitted Disease of Cattle. In: G.B., Whitehead and J.D., Gibson (Eds), *Tick Biology and Control*: Proceedings of an International Conference Held at the Tick Research Unit, Rhodes University, Grahamstown, South Africa., 27-29 January. Tick Research Unit, Rhodes University, Grahamstown. 61-66.

JAMES, A.D. (1977). Models of Animal Health Problems. *Agricultural Systems,* 2: 183-190.

JONES, E., BATTE, M.T. and SCHNITKEY, G.D. (1989). The Impact of Economic and Socio-Economic Factors on the Demand for Information: A Case Study of Ohio Commercial Farmers. *Agribusiness*, 5: 557-571.

JONGEJAN, E and UILENBERG, G. (1994). Ticks and Control methods. *Rev. Sci. Tech. Off. Int. Epiz.*, 13 (4): 1201-1226.

KAPOSHI, C.K.M. (1992). The Role of Natural Products in Integrated Tick Management in Africa. *Insect Sci. Applic.*, 13 (4): 595-598.

KIRSTEN, J.F. and RANDELA, R. (1998). The Value of the Diagnostic Programme of OVI and OIED to South Africa: A case for Government Intervention. Unpublished Report.

KRECEK, R.C., and STARKEY, P.H. and JOUBERT, A.B.D. (1994). Animal Traction in South Africa: Research Priorities in Veterinary Science. *Journal of the South African Veterinary Association*, 65: 150-153.

KRYDER, H.A. (1983). Animal Health and Economics. *Bull. Off. Int.Epiz.*,92 (5-6): 399-415.

LATIF, A.A. (1992). Sustainable control methods for ticks and tick-borne diseases in Africa. In: J.A Kategile and S. Mubi (Eds), *Future of Livestock Industries in East and Southern Africa.* Proceedings of a Workshop held in Nairobi, 20-23 July 1992, Kenya. 119-122.

LAWRENCE, J.A., de VOS, A.J. and IRVIN, A.D. (1994). Theileria Mutans. Infection. In: J.A.W., Coetzer, G.R. Thomson, R.C., Tustin and N.P.J., Kriek (Eds), *Infectious Diseases of Livestock with Special Reference to Southern Africa*, vol. 1. Oxford University Press, Cape Town. 337-338.

LAWRENCE, J.A., de VOS, A.J. and IRVIN, A.D. (1994). Theileriosis. In: J.A.W. Coetzer, N.P.J., Kriek, G.R., Thomson and R.C., Tustin (Eds), *Infectious Diseases of Livestock in Southern Africa*. Oxford University Press, Cape Town.

LAWRENCE, J.A. (1996). Tick Borne Haemoparasitic Disease with Special Reference to Theileriosis. In: H.H. Meissner (Eds.), *Food Security in Africa: Challenges, Opportunities and Targets for Animal Production* – Proceedings of the Second all Africa Conference on Animal Agriculture, 1-4th April. Pretoria, South Africa.

LEHMANN, T. (1993). Ectoparasites: Direct Impact on Host Fitness. *Parasitology Today*, 9 (1): 13-17.

LEONARD, D. (1993). Structural Reform of the Veterinary Profession in Africa and the New Institutional Economics. *Development and Change*, 24: 227-267.

LUBBE, P. (1998). Personal Communication. National Department of Agriculture. Pretoria, South Africa.

LUGURU, S.M.K.J. (1994). Tick Control in Zambia. *Insect Sci. Applic.*, 15 (2): 211-213.

MACGREGOR, J. (1990). The Crisis in African Agriculture. *Africa insight*, 20 (1): 4-16.

MACPHERSON, C.N.L (1995). The Socio-Economic Consequences of Animal Diseases on Individual, Communities and Nations. *A Paper Presented at Workshop on Socio-Economic Aspects of Animal Disease in Southern Africa*, 3 May 1995. Foundation for Research Development Auditorium, Pretoria, South Africa.

MANSFIELD, E. (1975). *Microeconomics: Theory and Applications*. 2nd edition. Norton, NewYork.

MARASAS, C.N. (1999). Socio-Economic Impact of the Russian Wheat Aphid Integrated Control Programme. Unpublished Ph.D Thesis. University of Pretoria, South Africa.

McINERNEY, J.P., HOWE, K.S. and SCHEPERS, J.A. (1992). A Framework for the Economic Analysis of Disease in Farm Livestock. *Preventative Veterinary Medicine*, 13: 137-154.

McINERNEY, J. (1996). Old Economics for New Problems - Livestock Diseases: Presidential Address. *Journal of Agricultural Economics*, 47 (3): 295-451.

MGHENI, M., MUKHEBI, A.W., SETSHWAELO, L.L., TSIRESY, R., NYATHI, P., OSUJI, P. and KATEGILE, J.A. (1992). Synthesis of Constraints to Livestock Research and Development and Recommendations. In: J.A., Kategile and S., Mubi (Eds), *Future of Livestock Industries in East and Southern Africa*. Proceedings of a Workshop held in Nairobi, 20-23 July: 219-224.

MORAN, M.C. and NIGARURA, G. (1990). Strategic Tick Control in Burundi. *Parassitologia*, 32: 177-1990.

MORRIS, R.S. AND MEEK, A.H. (1980). Measurement and Evaluation of the Economic Effects of Parasitic Diseases. *Vet. Parasitol.*, 6: 165-184.

MORTON, J. and MATTHEWMAN, R. (1996). Natural Resource Perspectives: Improving Livestock through Extension. *Natural Resource Institute*, 12: pp4.

MUKHEBI, A.W. (1992). Economic Impact of Theileriosis and Its Control in Africa. In: R.A.I. Norval, B.D. Perry and A.S. Young (Eds.), *The Epidemiology of Theileriosis in Africa*. Academic Press, London.

MUKHEBI, A.W. and PERRY, B.D. (1992). Economic Implications of the Control of East Coast fever in Eastern, Central and Southern Africa. In: J.A., Kategile and S., Mubi (Eds), *Future of Livestock Industries in East and Southern Africa*. Proceedings of a Workshop held in Nairobi, 20-23 July 1992. Kenya. 107-112.

MUKHEBI, A.W. and PERRY, B.D. (1995). Socio-Economic Aspects of Tick Borne Diseases. A Paper Presented at the Post-Conference Workshop on Ticks and Tick Borne Disease held at the Onderstepoort Veterinary Institute, 4-7 September. Pretoria, South Africa.

NALEDZANI, A.T. (1992). *The Farmers Support Programme and Agricultural Development in Venda.* Unpublished Ph.D Thesis: University of Pretoria, South Africa.

NATIONAL DEPARTMENT OF AGRICULTURE (1996/97). Annual Report: Veterinary Services and Livestock Improvement.

NELL, W.T., VAN SCHALKWYK, H.D., SANDERS, J.H., SCHWALBACH, L. and BESTER, C.J. (1998). *Adoption of Veterinary Surgeon Services by Sheep and Goat Farmers in Qwaqwa.* A paper presented at the Agricultural Economics Society of South Africa at Swakopmund, Namibia, 30 September – 02 October 1998.

NELUVHALANI, P.E (1997). Personal Communication. Chief Extension Animal Health Officer, Veterinary Division. Northern Province, South Africa.

NKONYA, E., SCHROEDER, T. and NORMAN, D. (1997). Factors Affecting Adoption of Improved Maize Seed and Fertilizer in Northern Tanzania. *Journal of Agricultural Economics,* 48(1): 1-12.

NKOSI, S.A (1994). *Livestock Marketing in South Africa's Developing Areas*: A case Study in Lebowa. Unpublished Msc Thesis. University of Pretoria, South Africa.

NORVAL, R.A.I., FIVAZ, B.H., LAWRENCE, J.A. and BROWN, A.F. (1984). Epidemiology of Tick-Borne Diseases of Cattle in Zimbabwe. II. Anaplasmosis. *Trop. Anim. Hlth Prod.,* 16: 63-70.

NORVAL, R.A.I., PERRY, B.D. and YOUNG, A.S (Eds) (1992). Control Methods and Their Effect on Disease Epidemiology. *The Epidemiology of Theileriosis in Africa.* Academic Press, New York.

NORVAL, R.A.I., BARRETT, J.C., PERRY, B.D. and MUKHEBI, A.W. (1992). Economics, Epidemiology and Ecology: A Multidisciplinary Approach to the Planning and Appraisal of Tick and Tick Borne Disease Control in Southern Africa. In: B., Fivaz, T., Petney. and I.G., Horak (Eds), *Tick Vector Biology: Medical and Veterinary Aspects.* Springer – Verlag, Berlin. 35-54.

NORVAL, R.A.I. (1994). Vectors. In: J.A.W. Coetzer, G.R., Thomson, R.J., Kriek and R.C., Tustin (Eds), *Infectious Disease of Livestock with Special Reference to Southern Africa*, Vol.1. Oxford University Press, Cape Town. 11-24.

OBEREM, P.T. and SCHRODER, J. (1994). Ecto- and Endoparasites. In: C. Maree and N.H. Casey. *Livestock Production Systems.* Pretoria: Agri-Development Forum. 335-359.

OBEREM, P.T. (1998). Personal Communication. Hoechst. Johannesburg.

OKELLO-ONEN, J., SSEKITTO, C.M.B., SSENTONGO, Y.K. and KUDAMBA, C.A.L. (1992). Tick Situation and Control Strategies in Uganda. *Insect Sci. Applic.*, 13 (4): 657-660.

OLUOKUN, S.B. (1980). Economic Evaluation of Animal Disease Control Programmes in the Developing Countries: A Case Study on Nigeria. *Bull. Off. Int. Epiz.*, 92 (5-6): 399-415.

ONDERSTEPOORT VETERINARY INSTITUTE (1996). Project Description and Progress Report. Pretoria, South Africa.

OWEN, I.L. (1985). Field Efficacy of Ear Tags Impregnated with Insecticides against the Cattle Tick *Boophilus Microplus*. Aust. Vet. J., 62: 24-25.

PANIAGUA ARELLANO, F.J. and YUBERO, D. (1983). Animal Health and Economics, Technical Series No.3. *Office International Des Epizootic*, France.

PEGRAM, R.G., TATCHELL, R.J., de CASTRO, J.J., CHIZYUKA, H.G.B., CREEK, M.J., McCOSKER, P.J., MORAN, M.C. and NIGARURA, G. (1993). *Tick Control*: New Concepts.

PERRY, B.D. and MUKHEBI, A.W. (1995). The Socio-Economic Factors Influencing the Occurrence of Diseases in Animals. Paper Presented at Workshop on Socio-Economic Aspects of Animal Diseases in Southern Africa, 3 May 1995. Foundation for Research Development Auditorium, Pretoria, South Africa.

PROVOST, A. and BEZUIDENHOUT, J.D. (1987). The Historical Background and Global Importance of Heartwater. *Onderstepoort Journal of Veterinary Research*, 54: 165-169.

RENKEMA, J.A. (1983). Economic Aspects of Diseases in Animals with Special Reference to the Assessment of Losses. *Bull. Off. Int. Epiz.*, 92 (5-6): 443-458.

REPUBLIC OF VENDA (1984). Animal Diseases and Parasites Act. Thohoyandou, Venda.

ROCHA, A., STARKEY, P and DIONISO, A. (1991). Cattle Production and Utilisation in Smallholder Farming Systems in Southern Mozambique. *Agricultural Systems*, 37; 55-75.

ROE, R.T. (1980). Animal Health Economics in Australia. *Bull. Off. Int. Epiz.*, 419-430.

SCHOLTZ, M.M., SPICKETT, A.M., LOMBARD, P.E. and ENSLIN, B. (1991). The Effects of Tick Infestation on the Productivity of Cows of Three Breeds of Cattle. *Onderstepoort Journal of Veterinary Research*, 58: 71-74.

SCHWABE, C.W. (1984). *Veterinary Medicines and Human Health*. Williams and Wilkins, London.

SCOONES, I. (1992). The Economic Value of Livestock in the Communal Areas of Southern Zimbabwe. *Agricultural Systems*, 39: 339-359.

SIDIBE, S. (1981). Animal Health and Economics in Mali. *Bull. Off. Int. Epiz.*, 93 (5-6): 849-854.

SIMALENGA, T.E. and JOUBERT, A.B.D. (1997). *Developing Agriculture with Animal Traction*. University of Fort Hare, Alice.

SOLL, M.D. (1989). *The Control of Cattle Ticks with Sustained Release Vermectin*. Unpublished Msc Thesis. University of Pretoria, South Africa.

SPICKETT,A.M. (1998). Personal Communication. Protozoology Division. Onderstepoort Veterinary Institute, Pretoria.

SSENNYONGA, J.W. (1992). Working With Farmers to Develop Integrated Tick Management. *Insect Sci. Applic.*, 13 (4): 599-606.

TAMBI, N.E., MUKHEBI, W.A., MAINA, W.O. and SOLOMON, H.M. (1999). Probit Analysis of Livestock Producers' Demand for Private Veterinary Services in the High Potential Agricultural Areas of Kenya. *Agricultural System*, 59: 163-176.

TAPSON, D.R. and ROSE, C.J. (1984). An Investigation into Kwazulu Natal Cattle Industry. ARDRI: Report No2/ 84: University of Fort Hare.

TATCHELL, R.J. (1987). Tick Control in the Context of East Coast Fever Immunisation. *Parasitology Today*, 3 (1): 7-10.

THEILER, G., 1975. Past Workers on Tick and Tick-Borne Diseases in Southern Africa. *Journal of South African Veterinary Association*, 46 (4): 303-310.

TOWNSEND, R.F. and SIGWELE, H.K. (1998). *Socio-Economic Cost-Benefit Analysis of Action and Alternatives for the Control of Contagious Bovine Pleuropneumonia in Ngamiland, Botswana*. University of Pretoria. South Africa

TYLER, L. (1981). Some Aspects of the Economic Appraisal of East Coast Fever Control Programs. In: A.D. Irvin, M.P. Cunningham and A.S. Young (Eds), *Advances in the Control Theileriosis*. Proceedings of an International Conference Held at the International Laboratory for Research on Animal Diseases in Nairobi, 9-13th February. Martinus Nijhoff publishers, London. 393-404.

UILENBERG, G. (1992). Economics, Epidemiology and Ecology: A Multidisciplinary Approach to the Planning and Appraisal of Tick and Tick Borne Disease Control in Southern Africa. In: B. Fivaz, T., Petney,. and I., Horak (Eds), *Tick Vector Biology – Medical and Veterinary Aspects*. Springer- Verlag, Berlin. 23-33.

UMALI, D.L., FEDER, G. and de HAAN, C. (1994). Animal Health Services: Finding the Balance Between Public and Private Delivery. *The World Bank Research Observer*, 9 (1): 71-96.

UNKLESBAY, N (1992). *World Food and You.* The Haworth Press Inc, New York.

UPTON, M. (1993). Livestock Productivity Assessment and Modeling. *Agricultural Systems*, 43: 459-472.

VAN ROOYEN, C.J., de SWARDT, S.J and FRASER, G.C.G. (1981). An Economic Evaluation of Cattle Marketing in Less Developed Agriculture with Special Reference to the Ciskei. *Development Studies Southern Africa*, 3 (3): 295-305.

VENDA STATISTICAL REPORT NO.1 (1993). Population census. Thohoyandou, Venda.

WAMUKOYA, J.P.O. (1992). The Status of Tick Infestation of Livestock and Tick Control Methods in Kenya. *Insect Sci. Applic.*, 13 (4): 665-670.

YOUNG, A.S., GROOCOCK, C.M. and KARIUKI, D.P. (1988). Integrated Control of Ticks and tick-borne diseases of Cattle in Africa. *Parasitology*, 96: 403-432.

APPENDIX 1

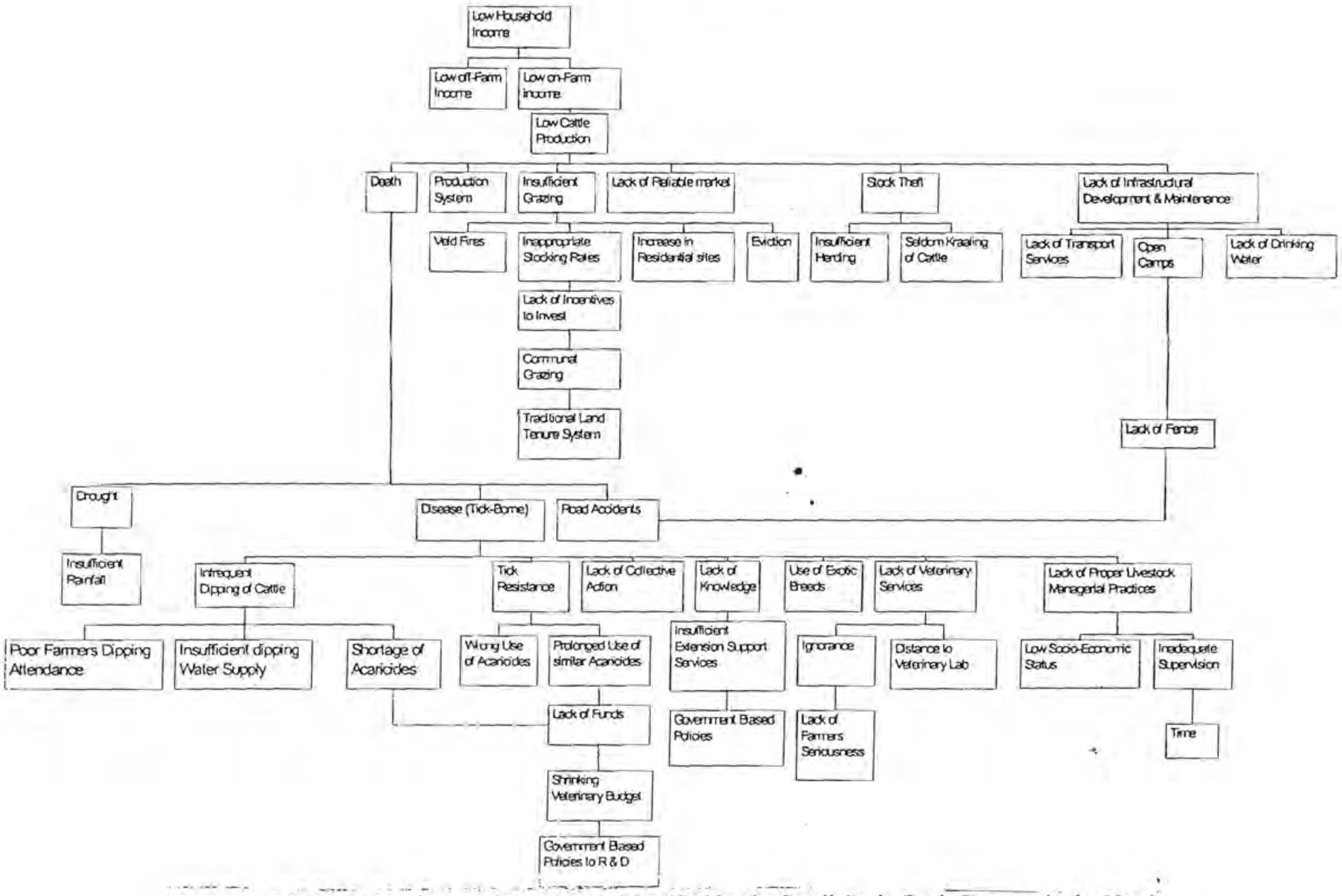

Figure1: The Main Problems and Constraints Identified by the Small-Scale Cattle Farmers in the Venda Region

Appendix 2

Table 1: Estimated Regional Losses in 1989 due to East Coast fever in 11 African Countries affected by the Disease*.

Item	Quantity (t)	Loss in US$ thousand	Percentage of total loss
Beef loss, total (t)	19 428	20 607	12
- Mortality loss (t)	16 246	17 232	-
- Morbidity loss (t)	3 182	3 375	-
Milk loss, total (t)	97 482	78 697	47
- Mortality loss (t)	9 284	7 495	-
- Morbidity loss (t)	88 198	71 202	-
Animal traction loss (ha)	488 000	21 306	13
Manure loss (t)	701	66	-
Treatment	-	8 114	5
Acaricide application	-	33 008	20
Research and extension	-	6 550	4
Total loss, US$	-	168 402	100

* Burundi, Kenya, Malawi, Mozambique, Rwanda, Sudan, Tanzania, Uganda, Zaire, Zambia and Zimbabwe.

Source: (Mukhebi and Perry, 1992: 109)

Table 2: **Demographics and Socio-Economic Characteristics of the Respondents.**

Characteristics	Vyeboom	Malongana	Guyuni	Matshena	Dzanani	Tshifudi	Average
Household size	7	8	7	8	7	8	7.5
Age of cattle owners	65	56	68	52	56	57	59
Years of farming	38	22	28	18	22	25	26
	Percentages (%)						
Male cattle owners	88	87	91	87	100	94	91
Female cattle owners	12	13	9	13	-	6	9
Marital status							
Married	88	87	87	87	91	88	88
Widowed	12	13	13	9	6	12	10
Single	-	-	-	4	6	-	2
Residential status							
Employed – home	6	26	-	26	9	18	14
- away	-	13	-	13	5	-	7
Unemployed	6	26	4	30	14	35	19
Self employed	12	4	17	4	14	-	9
Pensioners	77	30	78	26	59	47	53
Educational qualifications							
Primary	53	26	39	30	18	77	38
Secondary	18	13	17	9	32	12	17
Tertiary	-	4	4	-	-	-	2
Never attended	29	57	39	61	50	12	43

Table 3: **Respondents Preferred Breed of Cattle for Future Use.**

Breed	Vyeboom	Malongana	Guyuni	Matshena	Dzanani	Tshifudi	Total	Percentage
Brahman	1	6	1	7	2	3	20	16
Nguni	4	11	20	13	17	8	73	58
Afrikaner	8	2	1	-	2	1	14	11
Bonsmara	-	2	-	-	-	1	3	2
Simmentaler	-	-	-	2	-	1	3	2
Friesland	-	-	-	-	1	1	2	2
Crossbreed	2	-	1	-	-	-	3	2
Brahman + Nguni	2	2	-	-	-	-	4	3
Afrikaner + Nguni	-	-	-	-	-	2	2	1
Simmentaler + Afrikaner	-	-	-	1	-	-	1	1
Total	17	23	23	23	22	17	125	100

Appendix 3

QUESTIONNAIRE

Instructions

Please:

-Write legibly.

-Comment, fill in and circle the correct letter where choice is given (remember one question might have multiple answers applicable to you).

-All the information provided will be kept confidential.

Date..............................

Area:..

A DEMOGRAPHIC INFORMATION

A.1. Gender

1 Male

2 Female

A.2. Marital status

1 Married

2 Divorced

3 Widowed

4 Single

A.3 Residential status

1 Employed

a) at home

b) elsewhere

2 Unemployed

3 Self employed

4 Pensioner

A.4 Educational Qualification

1 Primary education

2 Secondary education

3 Tertiary education

4 never attended

A.5 Estimated age .... Years

A.6 Composition of household members

Age	Males	Females
< 20	A.6.1	A.6.2
20—30	A.6.3	A.6.4
31—40	A.6.5	A.6.6
41—50	A.6.7	A.6.8
51—60	A.6.9	A.6.10
> 60	A.6.11	A.6.12

A.7 Dependants educational profile

	Male	Female
At primary level	A.7.1	A.7.2
At secondary level	A.7.3	A.7.4
At tertiary level	A.7.5	A.7.6
At home (young)	A.7.7	A.7.8

A.8 Number of household members...................

B. CATTLE PRODUCTION INFORMATION

B.9a Breed of cattle kept
- 9.1 Nguni
- 9.2 Afrikaner type
- 9.3 Brahman type
- 9.4 Other (specify)..

9b What type of cattle breed would you prefer?...

9c And why do you prefer such a breed?...

....

9d What colour do you prefer and why?...

9e For how long have you been in farming?............................years

B.10 a) How many cattle do you have now?..................

b) How many cattle did you have in the household last year (1996)?.........................

B.11.a Herd composition and sales (1996)

Herd	number	number sold
Cows	B.11.1	B.11.2
Heifers	B.11.3	B.11.4
Oxen	B.11.5	B.11.6
Bulls	B.11.7	B.11.8
Calves(<6 month)	B.11.9	B.11.10

(The total of herd composition should be equal with the total in question 10b)

11.b For cattle sold, why did you sell them?..
....
....
....

11.c What is the value (in rand) of your adult cattle? R..................................

11.d To whom did you sell the animal?
1 Auction
2 local butchery
3 Friend for ceremonial purposes
4 other (specify)..

11.e Were any animals sold to raise money for bride wealth(Lobola)?........................

B.12a Cattle purchased (1996

Herd	Number	Amount/head in rand	if non purchased, indicate the willingness to pay in rand /head
Cows	B.12.1	B.12.2	B.12.3
Heifers	B.12.4	B.12.5	B.12.6
Oxen	B.12.7	B.12.8	B.12.9
Bulls	B.12.10	B.12.11	B.12.12
Calves (<6 month)	B.12.13	B.12.14	B.12.15

12b Why did you purchase these animals?..
....
....

B.13.a Cattle slaughtered (1996)

Herd	**Number**
Cows	B.13.1
Heifers	B.13.2
Oxen	B.13.3
Bulls	B.13.4
Calves (< 6 month)	B.13.5

13.b Did you sell some of the meat?..
13.c If yes, how much per kilogram? R...................................
13.d What did you do with the money received?

1 Savings
2 Household purchases
3 Payment of school fees
4 other (specify)...

13.e When do you normally sell your cattle and why?..
....
....

B.14.a Were any of the animals slaughtered in question 13a used for ceremonial purposes?

(Ceremonies such as funeral, wedding, tombstone etc)...
Other ceremonies e.g. Christmas, birthday (specify).....................................

14.b If yes, give details below

Herd	**Number**	**type of ceremony**
Cows		
Heifers		
Oxen		
Bulls		
calves (<6 month)		

B.15 What happened to the number of your cattle for the past three years?

1 Decreased
2 Increased
3 Constant

B.16.a If increased,why?..

....

....

16.b If decreased, why?

Cause	
Diseases	
Drought	
Sold	
Slaughter	
Theft	
Insufficient grazing	
other(specify).....................................	

16.c If died of diseases, which diseases?...

....

16.d How many of these died (1996)?

Herd	**Number**
Cows	
Heifers	
Oxen	
Bulls	
calves (<6 month)	

16.e For the animals that died did you use their meat?..............................

16.f If yes, how ? Explain briefly...

....

16.g If no, please indicate what did you do with the animals?..
....
....

B.17a What is the most common problem(s) within your cattle?

1 Theft
2 Road accidents
3 Diseases
4 other (specify)...

17b What diseases?..
17c Do you have a problem with ticks?...
17d What is the most common tick problem within your livestock?

1 Loss of condition (Tick worry)
2 Tick wounds
3 Tick damage (e.g. teat loss)
4 other (specify)...

17e Do you associate any disease with ticks?...
17F If no, do you know any of these diseases?

1 Red water
2 Galsickness
3 Sweating sickness
4 Heart water
5 Mastitis

B.18 a) How do you control ticks?

1 Dipping tank system
2 Engine oil
3 Hand picking
4 Biological control (e.g. using chickens)
5 Hand spraying
6 Do not control at all
7 Pour on
8 Spray race
9 Handdressing

18b if you also use hand spraying, how do you apply it?...
18c) Why do you control ticks in the way(s) indicated above ?..
....
....
18d Are you satisfied with the way in which ticks are controlled? ....
18e If not, what do you think should be done ?..
....
....
....
....

18f When normally do you experience tick problems?

1 Summer 3 Spring
2 Winter 4 Autumn

B.19. What's your attitude towards ticks?

1 Positive
2 Negative
3 Neutral

B.20.a How often do you currently control ticks?

1 Once per week
2 Once per two weeks
3 Once per month
4 Other (specify)..

20.b How many times would you like to control ticks?..

B.21. Why do you control ticks?..

....
....
....
....
....
....

B.22. What (if applicable) did you spend in 1996 on

1	Purchased worms remedies	R...........................
2	Labour for herding	R...........................
3	Vaccination	R...........................
4	Tickicides (tick medicines)	R...........................
5	Medicines	R...........................
6	Feed	R...........................
7	Licks	R...........................

B.23.a) Are your cattle herded?......................

23.b) Who does the herding ?

1 An employee
2 Your son/ daughter
3 Yourself
4 Grandson/ daughter
5 Other(specify)...

23.C Are they kraaled daily at night?............................

B.24. Does the household have animals belonging to other relatives not normally living in the household?........................

B.25 Do you share your kraal with other household?.......................

B.26.a) Are animals ever paid as fines or compensation in e.g. adultery in this

community?............................
26.b) Does any cattle symbolises any ancestral spirit?.................................

C. ECONOMIC ROLE

C.27. What are the main reasons why the household keeps cattle?

Purpose	
sell cattle, meat, milk	
milk (home consumption)	
Lobola	
Wealth	
meat (home consumption)	
Prestige	
Plough	
Rituals	
other (specify)..	

C.28.a Do you use manure from your cattle kraals on your land?(including the homeyard) ....
28.b) If yes, why ?..
....

28.c) Do you ever sell manure to others?......................
28.d) If yes, how much are you paid/per ton /other? R..........................
28.e) Do you also use cattle manure as a supplementary fuel?......................
28.f) Do you use fertiliser on your land?..

C.29.a) Do you use dung for floor preparation or as a way of decoration?..........................
29.b) Do you also sell dung to others for decoration purposes?.........................
29.c) If yes, how much do you charge? R..............

C.30. a) Do you use animals for ploughing ?................
30. b) if yes, what type?...
30 c) If no, why are traction animals not used in this community?..................................
....
....
....

30d) Do you hire other peoples animal for ploughing ?................

30e) If yes, how many?......................

30f) Do you hire out your own animals for ploughing to others ?...............

30g) If yes, what do you charge per animal/ span/day? R.....................
Other(specify)..

30h) Do you use cattle for transport?..

C.31. For the slaughtered cattle (indicated in question 14) indicate what do you do with skins and hides.

Purpose	
Sell	
Keep them	
Discard them	
Give to friends	
Used for cultural purposes(specify)...............................	

If you sell skins and hides, at what price? R.......................................

C. 32.a) Do you milk your cows for household consumption?..........

32 b) If not, why...

....

32 c) How often do you milk your cow/day/ month?..

32 d) If yes, on average how much milk per day/ cow does your household usually receive........ . litres

32e) On average how many litres of milk per day does your household usually consume................

32f) If you sell, at what price per litre? R...........................

32g) To whom do you sell your milk?...

32h) Do you buy milk?..

32i) If yes, from whom do you buy?..

32j) At what price per litre/ 500ml (specify)..

C.33 a. Is there a better way of investing money than in cattle?.............

33.b If yes, what is better?..

C.34a Are there any other by-products that you use or sell from your cattle?(Please specify)

....

34b If any, indicate the value of the by-product that you sell? R..........................

D. OTHER LIVESTOCK OWNED

D.35.

Livestock	Number	Owner (e.g. wife, children etc)
Goats		
Sheep		
Chicken		
Pigs		
Donkeys		
Dogs		
Other(specify).....................		

C.36. Which member of the household can make the decision concerning the selling or purchasing of the above mentioned livestock?..

E. CROP PRODUCTION INFORMATION

E.37 a) Beside cattle farming do you practice crop farming?..........................

37 b) If yes, how many hectares?.......................

37 c) Which crop do you normally cultivate?..................................

37d) How did you obtain the land?

1 bought
2 given by the chief
3 rented
4 inherited

37e) In harsh times do you feed your cattle with crop remnants?...........................

37f) Do you graze your cattle on the land after harvesting?..

F. OTHER INFORMATION

F.38.a Do you have any animal health based extension officer in your area?

1 Yes
2 No
3 I do not know

38b If yes, is there continuity in communication between farmers and veterinary services or other sources of advice in your area?

1 Good
2 Average

3 Poor
4 No communication at all

F.39.a Do you normally have outreach programmes such as animal health based farmer's days?................

39.b If yes, how often do you attend?......................

39.c When last did you have the outreach programmes?........................

F.40.a Do you have access to veterinary services ?............................

40.b Do you have access to the veterinary laboratory?......................

40.c What's an approximate distance between where you stay and the veterinary services.........km

40.d How often do you visit the laboratory?..

F.41.a Do you use any traditional medicines if your animal get sick?.........................

41.b If yes, do they heal?.........................

F.42.a Do you believe in the remedies recommended by the Department of Agriculture?..............

42b If not, why not?..

....

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F.43.a Are you prepared to contribute to any service(s) at a reasonable price aimed at controlling Ticks and tick-borne diseases? ....

43.b What price do you think would be reasonable?................

1. R0, 50/ animal/ year
2. R1, 00/ animal/ year
3. R2, 00/ animal/ year
4. R3, 00/ animal/ year
5. Other(specify) ....

43.c .How much do you think costs the government to dip a cattle/year?...........................

F.44. What do you think should be done in your area to improve cattle production particularly in the control of ticks and tick-borne diseases or animal health in general? (any suggestion)…..

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