The socio-economic impact of the 2008–2010 Rift Valley fever outbreaks on livestock farmers in South Africa

By

Ntombimbini Zimbini Mdlulwa

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DECLARATION

I, Ntombimbini Zimbini Mdlulwa declare that the dissertation, which I hereby submit for the degree of MSc. (Agric) Economics at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

Signature: …………………….

Date: …………………….

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ABSTRACT

The socio-economic impact of the 2008–2010 Rift Valley Fever outbreaks on livestock farmers in South Africa

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Ntombimbini Zimbini Mdlulwa

Degree: MSc. Agric (Agricultural Economics)

Department: Agricultural Economics, Extension and Rural Development

Supervisor: Professor Johan Kirsten

Co-Supervisor Professor Kurt Klein

Livestock production is an important industry in South Africa. The contribution of the livestock sector to the total agricultural gross domestic product (GDP) is the largest of all the agricultural sectors, contributing more than 40% of the gross value of the total agricultural sector. Although livestock production plays an important role in the economies of most nations, livestock remains vulnerable to diseases. Recently, South Africa experienced varying episodes of Rift Valley Fever (RVF) outbreaks. RVF is viral zoonotic disease spread by infected mosquitoes and characterised by high rates of abortion and neonatal mortality, primarily in sheep, goats and cattle, but also in exotic and wild animals.

To justify efficient and effective policies of prevention and control of RVF, it is paramount to understand the true impact of this disease. The amount of additional research that should be budgeted to develop newer and more effective vaccines for the control of RVF can be more adequately judged with a more accurate accounting of the overall costs of an RVF outbreak. Using a combination of evaluation methods, this study therefore sought to estimate the economic losses incurred by livestock farmers in South Africa due to the 2008–2010 RVF outbreaks.

A questionnaire was administered to 150 livestock farmers in the Eastern Cape, Northern Cape and Free State provinces, believed to have been the most severely affected provinces in the recent RVF outbreaks. Based on secondary data and expert opinions, two municipalities that were severely affected by the 2008–2010 RVF outbreaks were selected in each of the three provinces: Cacadu and Chris Hani municipal districts in the Eastern Cape; Pixley Ka Seme and Frances Baard municipal districts in the Northern Cape; and Fezile Dabi and Lejweleputswa in the Free State. The study focused on both black and white livestock farmers who keep cattle, goats, or sheep.

This study hypothesised that farmers with sound animal production systems and animal health-care programmes that included vaccination against RVF were least affected by the outbreak when it occurred, and that farmers and their representative organisations overestimated the income losses from the RVF outbreaks. The findings of the study revealed the importance of vaccination in that, regardless of the application of biosecurity measures and general vaccination programs, farmers who did not vaccinate all their animals against RVF were the most affected (59%) compared to 37% of farmers who vaccinated all their animals.

The findings from the survey reveal that more than 30% of farmers reported losses in the form of mortalities, abortions and reduction in animal products such as milk. Farmers incurred extra expenditure in the form of prevention, control and treatment costs. Although most of the 150 livestock farmers indicated that they vaccinated against RVF, less than half used their own funds to purchase the vaccine. Black communal and emerging farmers were provided vaccines by the state. Due to lack of substantial data, expenditure costs were only up-scaled to district level. Thus an estimated total expenditure of R50.3 million was spent by farmers on prevention, control and treatment.

The survey revealed a high rate of animal mortalities and abortions, much higher than indicated by official notifications of the disease. For example, Pienaar and Thompson (2013) indicated that in 2010, "484 outbreaks were reported, with 13 342 animal cases and 8 877 animal deaths." The 150 livestock farmers in the survey reported 4 783 animal deaths, more than half of all mortalities officially reported for the whole country. In addition, 6 460 abortions were reported in the survey of 150 farmers. Although other diseases can also cause abortions, follow-up discussions with farmers and animal health officers resulted in a fairly high level of confidence that the abortions reported in the survey were due to RVF.

Production losses by livestock farmers in the survey (including mortalities, abortions and reduced milk production) were found to be R296 000 in 2008 (R427 000 in 2014 Rand), R990 000 in 2009 (R1.3 million in 2014 Rand), and R4.4 million in 2010 (R5.4 million in 2014 Rand). In 2010, production losses on surveyed farms in the Eastern Cape were found to be R1.8 million (R2.2 million in 2014 Rand), R2.5 million in the Northern Cape (R3.0 million in 2014 Rand), and R149 000 in the Free State (R182 000 in 2014 Rand).

The survey results were further up-scaled to district and provincial level. Farmers in Chris Hani and Cacadu districts of Eastern Cape incurred revenue losses of about R42.3 million (R51.7 million in 2014 Rand). In Free State only farmers in Lejweleputswa district reported revenue losses due to RVF and these were estimated at R479 053(R625 444 in 2014 Rand). Farmers in the Northern Cape Province reported animal losses in 2010 only and these were farmers in Pixley Ka Seme district. Revenue losses incurred by farmers in this district are estimated at R40.6million (R49.7 million in 2014 Rand).

At provincial level total revenue losses in the three provinces are estimated at R295.2 million Although farmers from the Northern Cape did not report any losses to the 2008–2009 outbreaks, reported animal losses to the 2010 outbreaks are estimated at R174.9 million (59%) of the total losses to 2008–2010 RVF outbreaks. These estimated losses are two and four times more than the total 2008–2010 losses incurred by farmers from the Eastern Cape and Free State, estimated at R77.9 million (26%) and R42.3 million (15%) respectively.

Changes in livestock performance parameters were also observed wherein during the 2010 outbreaks there was a decline in herd size, weaning rate and offspring rate, while an increase in mortality rate was observed. This impact was also felt at provincial level, all provinces experienced a decline in livestock numbers with other provinces taking a little bit longer to improve from the incident.

The losses reported during the survey occurred despite the relatively high rate of vaccinations against the disease. However, it was observed that average revenue losses incurred by farmers who only started vaccination during the 2010 outbreaks were R50 726, double the R24 377 incurred by farmers who started vaccination prior the 2010 outbreaks. This observation suggests that there is value in vaccination if farmers follow the correct vaccination protocols.

Key words: Livestock, RVF, Economic costs, Expenditures, Animal losses, Revenue losses

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LIST OF ABBREVIATIONS AND ACRONYMS

ARC	Agricultural Research Council
BFAP	Bureau for Food and Agricultural Policy
BMI	Business Monitor International
DAFF	Department of Agriculture Forestry & Fisheries
FMD	foot-and-mouth disease
GDP	Gross Domestic Product
LSD	lumpy skin disease
MPO	Milk Producers Organisation
OBP	Onderstepoort Biological Products
OVI	Onderstepoort Veterinary Institute
RFV	Rift Valley Fever
RPO	Red Meat Producer's Organisation
Stats SA	Statistics South Africa

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Globally, the livestock sector plays an important role in the economies of many developing countries (Blench, Chapman and Slaymaker, 2003). About 800 million to 1 billion of the world's poor and landless derive their livelihoods from livestock activities (Livestock in Development [LID] 1999; Thornton et al., 2000 in Birol, Ndirangu, Roy & Yakhshilikov, 2011). Morgan and Tallard (2007) estimated that food derived from items such as meat, milk and eggs in Africa contributes, on average, 30% to agricultural gross domestic product (GDP). About 70% of the rural poor in Africa own livestock and over 200 million of these livestock owners rely on their livestock for income as well as draught power and fertiliser for crop growing (Morgan & Tallard, 2007).

In South Africa, livestock contributes more than 40% to the total agricultural GDP, the largest of all the agricultural subsectors. With about 80% of agricultural land in South Africa suitable mainly for extensive livestock farming, livestock farming plays a vital role as a source of livelihood for many rural communities and a resource for poor farmers (Spies, 2011). Livestock farming is normally practiced in conjunction with other farming enterprises. Data provided by the Department of Agriculture, Forestry and Fisheries (DAFF, 2014) suggest that in 2012 there were about 13.9 million heads of cattle, 21.4 million sheep and 2.0 million goats in South Africa.

Although livestock production plays an important role in the economies of most nations, livestock remains vulnerable to diseases. These diseases sometimes result in outbreaks that vary in severity and magnitude of economic impact. Immediate impacts of a disease outbreak include a reduction in the productive capacity of the animals and a subsequent reduction in the supply of meat and meat products (Pritchett, Thilmany, & Johnson, 2005). In the short run these outbreaks can affect prices and markets, which have multiplier impacts throughout connected sectors in the economy, and might later result in reduced incentives for long-term investment and affect production decisions.

Between 2008 and 2010, South Africa experienced varying episodes of RVF outbreaks. Classified as a notifiable disease in South Africa, RVF is a zoonotic disease that is spread by infected mosquitoes. It is characterised by high rates of abortion and neonatal mortality, primarily in sheep, goats and cattle, but also in exotic and wild animals. This serious disease also can affect people, even causing death in isolated cases. The 2009/10 RVF disease outbreaks in South Africa were reported to have had a significant economic impact on cattle and sheep production, especially affecting thousands of animals in the Free State, Northern Cape, Eastern Cape, and North West province. Several cases of RVF in humans, as well as mortalities, were also reported.

Rich and Wanyioke (2010) assessed the regional and national socio-economic impacts of the 2007 RVF outbreak in Kenya. They established that the outbreak prevented the farmers from conducting sales because of quarantines on animal movement and slaughter. Famers who could sell their animals received prices that were 20% lower than those that prevailed before the outbreak. The main negative impacts on producers were caused by the loss of animals that died, which affected their food security and future income due to loss of future stock as a result of animal abortions. Other actors along the value chain, including livestock traders, abattoirs, casual labourers and butchers as well as non-agricultural sectors also incurred significant losses. The total economic losses from livestock mortality were estimated to be over US$9.3 million, and US$77.00 for potential milk production, while RVF-induced abortions in sheep resulted in a 22% reduction in potential flock size (Rich and Wanyioke, 2010).

1.2 PROBLEM STATEMENT

The importance of livestock as the primary source of livelihood for many rural communities implies that resources have to be prioritised and channelled to research and development (R&D) programs that seek to control and eradicate animal diseases. With the recent outbreaks of RVF in South Africa, farmers started to question the efficacy of the vaccine that they used to prevent the disease. Many farmers claimed the vaccine was ineffective and resulted in a storm of abortions. These recent outbreaks, together with questions around the efficacy of the current RVF vaccine, have triggered an interest among researchers to develop ways to better combat occurrences of RVF. One research program involves the development of a new vaccine for Rift Valley fever by Agricultural Research Council (ARC) researchers.

Several farmer organisations in South Africa have issued estimates about how much the recent RVF outbreaks have cost the livestock industry. For instance, an article by Coleman in the *Farmers Weekly* of 23 April 2010, reports that the chairperson of the Red Meat Producers Organisation (RPO) in the Free State Province estimated that the 2010 outbreak cost the Free State livestock industry about R3.9 million in animal losses alone. At the national level, RPO estimated that large-scale export bans due to the outbreak could cost the country almost R2 billion.

Despite the knowledge that the RVF outbreaks in 2008 and 2010 affected farmers negatively, the extent of this impact on farmers' herds, marketable income and livelihoods is not known. Without understanding the true impact of this disease, it is difficult to justify efficient and effective policies for disease prevention and control. The amount of additional research that should be budgeted to develop newer and more effective vaccines for the control of RVF can be more adequately judged with a more accurate accounting of the overall costs of an RVF outbreak.

1.3 RESEARCH OBJECTIVES

This dissertation seeks to quantify the socio-economic impact of 2008–2010 RVF outbreaks on livestock farmers in South Africa.

The specific objectives of the study are:

- To describe the RVF prevention and control measures practised by livestock farmers in South Africa
- To estimate the economic costs incurred by livestock farmers in South Africa due to the RVF outbreaks in 2008–2010
- To determine if losses to RVF were correlated with demographic variables and management practices used by livestock producers.

1.4 STATEMENT OF HYPOTHESES

RVF vaccines are manufactured by Onderstepoort Biological Products (OBP). According to OBP's sales records, for the last fourteen years very few sales of the RVF vaccine were made and most of these were exports. This evidence supports claims that few South African farmers had been vaccinating against the disease until the recent outbreaks. That left livestock producers (and all associated stakeholders) vulnerable to severe losses when RVF occurred;

losses that could have been avoided if farmers had implemented continuous vaccination programmes against the disease. Consequently, this study will test the following hypotheses:

- That farmers with sound animal production systems and animal health-care programmes that included vaccination against RVF were least affected by the outbreak when it occurred.
- That farmers and their representatives organisations overestimated the income losses from the RVF outbreaks

1.5 RESEARCH APPROACH

The study used both secondary and primary data which consisted of livestock market trends and activities. The process to achieve the study's objectives was as follows: Firstly, secondary data were obtained through requests made to authorities from DAFF, Milk Producers Organisation (MPO), input suppliers such as Pfizer and OBP, Onderstepoort Veterinary Institute (OVI) and Departments of Agriculture in the provinces for data on related market variables and areas that were affected by the outbreaks. The data acquired included livestock numbers from the respective provinces and municipalities, average product prices, input prices, RVF diagnostics performed between 2008 and 2010 and lists of livestock farmers in the main affected provinces. The production data obtained were disaggregated by animal type for each of the districts in each province. Other secondary data were obtained from various websites and government publications such as the Abstract of Agricultural Statistics (DAFF, 2014).

Secondly, a farm survey was conducted to obtain primary data from farmers from the Chris Hani and Cacadu districts of the Eastern Cape Province, Frances Baard and Pixley Ka Seme districts of the Northern Cape Province and Fezile Dabi and Lejweleputswa districts of the Free State Province. The questionnaire was pre-tested on eight livestock farmers in the Free State Province and then adjusted to incorporate lessons learned from the pilot survey. The aim of the farm survey was to obtain data on demographics, natural resources, livestock activities, animal health practices, prevention of RVF and the impact of RVF.

Finally, data were analysed and chi-square tests and Poisson tests were performed to test for associations and correlations between demographic data and the impact of RVF. A deterministic model was used to quantify the economic costs of the 2008–2010 RVF outbreaks.

The aggregate costs were then disaggregated to capture the distribution of costs by animal type, district and province.

1.6 OUTLINE OF DISSERTATION

This study consists of seven chapters. Subsequent to the introductory chapter, chapter 2 provides an overview of the livestock industry in South Africa in terms of characteristics of the industry, production systems, livestock numbers and slaughter numbers. Chapter 3 draws from of a wide range of studies and experiences in South Africa and internationally with the aim of reviewing literature on methods of estimating economic losses of disasters and outbreaks. Chapter 4 presents research methods and methodological issues that pertain to study area, survey design, data collection and an empirical model for analysis of the survey data. Chapter 5 presents the descriptive analysis of the households surveyed in the study areas including demographic characteristics of the farmers, livestock production and management practices. Chapter 6 presents the model used to estimate losses, types of losses estimated and results of the econometric models. Chapter 7, the last chapter of the dissertation, deals with the conclusions and recommendations.

CHAPTER 2

LIVESTOCK FARMING IN SOUTH AFRICA

2.1 INTRODUCTION

This chapter presents an overview of the livestock industry in South Africa. It is important to know the size of the industry in order to understand the extent of the impact of the RVF outbreak on the industry. Data provided in this chapter include the contribution of livestock to agricultural gross domestic product, production trends, livestock numbers, number of jobs provided and number of farmers involved in each sub-sector. Data about animal products such as milk, wool and mohair also are included. The focus is on cattle, sheep and goats, which are the most economically important types of livestock in South Africa that are susceptible to RVF.

2.2 AN OVERVIEW OF THE SOUTH AFRICAN LIVESTOCK INDUSTRY

About 80% of agricultural land in South Africa is suitable for extensive livestock farming (DAFF, 2012a). Consequently, many rural communities and resource poor farmers derive their livelihoods from livestock farming. Livestock production includes cattle (for both dairy and beef production), small stock (sheep and goats), poultry and pig farming.

Livestock farming in South Africa is characterised by three main groups:

- Commercial farmers (mostly white farmers), whose production is relatively high and comparable with developed countries.
- Emerging livestock farmers (mainly beneficiaries of government programs such as Land and Rural Agricultural Development) who own or lease land.
- Communal farmers who operate their farms on communal grazing land

Both the emerging and communal livestock farmers are regarded as resource poor farmers since they are characterised by limited financial and land resources as well as low-level technical and business skills. Consequently, their production levels are perceived to be very low (DAFF, 2011a).

The contribution of the livestock sector to total agricultural gross domestic product (GDP) is the largest of all the agricultural sectors, contributing more than 40% of the gross value of production in the total agricultural industry (Spies, 2011). The gross value of livestock production grew from about R21 billion in 2000/01 to almost R85 billion in 2011/12 (Table 2.1).

Table 2. 1: Gross value of livestock production in R million (in current and 2014 Rand)

Year	Gross value (Rand)	Gross value (2014 Rand)
2000/01	21 168.7	43 771
2001/02	25 321.3	49 708
2002/03	30 319.2	56 294
2003/04	31 325.5	53 131
2004/05	33 837.9	54 225
2005/06	38 936.0	62 823
2006/07	47 014.2	74 367
2007/08	54 319.0	83 228
2008/09	60 952.5	87 967
2009/10	65 516.2	85 924
2010/11	67 799.1	82 898
2011/12	75 779.7	89 011
2012/13	84 611	94 637

Source: DAFF, 2014

2.3 CATTLE PRODUCTION

South Africa is estimated to have about 13.9 million heads of cattle, composed of a variety of international beef and dairy cattle breeds as well as indigenous breeds such as Nguni and the Afrikaner. The highest concentration of cattle farming occurs in the provinces of the Eastern Cape, KwaZulu-Natal, Free State and North West (DAFF, 2011a).

Claiming a share of 20% of the total number of cattle in South Africa, the dairy industry provides jobs to about 100 000 people, both as farm workers and within the value chain. Herds of dairy cattle vary from less than 50 to large herds of more than 1 000 dairy cows. There are about 4 000 milk producers in South Africa and the industry contributes about 0.5% to the world's milk production (DAFF, 2012b).

Beef cattle farms range from small with less 20 herd of cattle to large farms and feedlots with more than 1 000 herd of cattle. There are about 50 000 commercial farmers, 240 000 emerging farmers and 3 million communal farmers. About 500 000 people are employed by the beef industry, while 2 125 000 derive their livelihoods from the industry (DAFF, 2012 a).

2.3.1 Beef production, slaughtering and consumption

About 60% of the total cattle herd is estimated to be in the hands of commercial farmers while the small-holder farmers contribute about 40% of the total herd (DAFF, 2012a). Table 2.2 shows South Africa's national cattle numbers and numbers slaughtered for the period 2000/01 to 2012/13. The total livestock herd has remained quite constant, adding less than half a million animals over this twelve year period.

Table 2. 2: National cattle numbers and slaughtering for the period 2000–2012

Year	Cattle numbers in millions	Cattle slaughtering in thousands	Calf slaughtering in thousands
2000/01	13.5	2 247	55
2001/02	13.5	2 452	58
2002/03	13.6	2 478	57
2003/04	13.5	2 544	57
2004/05	13.5	2 616	57
2005/06	13.5	2 915	57
2006/07	13.9	3 020	57
2007/08	13.9	2 644	57
2008/09	13.8	2 783	58
2009/10	13.7	2 839	58
2010/11	13.7	2 831	58
2011/12	13.9	2 851	58
2012/13	13.9	2 908	58

Source: DAFF, 2014

2.3.2 Gross value of milk, beef cattle and calves slaughtered

Over the twelve year period, the average gross value of beef produced has increased from about R3.4 billion in 2000 to over R18 billion in 2012 (Table 2.3) (DAFF, 2011b). The gross value of fresh milk produced also has increased dramatically over this twelve-year period, rising from 3.7 billion to R11.6 billion by 2012/13 (Table 2.3).

Table 2. 3: Gross value of cattle and calves slaughtered and milk (R'000 in current and 2014 Rand)

Period	Gross value (R)	Gross value (2014 Rand)	Gross value of milk (R)	Gross Value of milk (2014 Rand)
2000/01	3 445 060	7 123 351	3 734 537	7 721 902
2001/02	4 632 129	9 093 332	4 257 484	8 357 867
2002/03	5 753 004	10 681 603	4 880 873	9 062 317
2003/04	6 411 735	10 874 944	5 198 697	8 817 510
2004/05	7 329 051	11 744 804	5 324 423	8 532 388
2005/06	9 493 184	15 317 252	5 311 544	8 570 176
2006/07	12 374 576	19 574 104	6 140 312	9 712 746
2007/08	11 592 663	17 762 278	9 232 004	14 145 277
2008/09	12 776 089	18 438 452	8 932 958	12 892 045
2009/10	14 210 428	18 636 976	9 522 799	12 489 151
2010/11	15 088 470	18 448 672	9 149 129	11 186 640
2011/12	17 693 260	20 782 503	10 299 301	12 097 559
2012/13	18 564 921	20 764 864	11 645 023	13 024 958

Source: DAFF,2014

2.4 SHEEP AND GOAT FARMING

Although practiced throughout the country, sheep farming is concentrated in the Northern Cape, Eastern Cape, Western Cape, Free State and Mpumalanga provinces. About 8 000 commercial sheep farms and 5 800 communal farmers supply sheep meat and sheep products in the country. Sheep numbers in 2010 were estimated to be 24.17 million. Sheep are kept mainly for wool and mutton production (DAFF, 2011c).

The country possesses less than 1% of the world's goats. Goat production is practiced mainly in the Eastern Cape, Limpopo and KwaZulu-Natal provinces (DAFF, 2011d). Boer goats are kept mainly for meat production while Angora goats are kept for mohair production (DAFF, 2011d).

Table 2.4 depicts national numbers for sheep and goats as well as slaughtering. Annual slaughtering of sheep at registered abattoirs is estimated at 4.5 million while in the informal sector estimations are in the range of 25 to 30% of annual sheep slaughtering (DAFF 2011c). Goat slaughtering in the commercial sector is estimated at 0.55% of the goat slaughtering (DAFF, 2011d).

Table 2. 4: National sheep and goat numbers in South Africa

Year	Sheep	Goats	Slaughtering combined
	Thousands		
2000/01	23 586	2 355	5 964
2001/02	22 998	2 427	5 964
2002/03	22 614	2 216	6 012
2003/04	22 693	2 160	6 117
2004/05	22 289	2 164	6 192
2005/06	22 236	2 136	6 279
2006/07	21 945	2 181	6 693
2007/08	21 924	2 116	6 700
2008/09	21 995	2 114	6 865
2009/10	21 917	2 077	7 018
2010/11	21 493	2 052	6 331
2011/12	21 325	2 033	6 158
2012/13	21 427	2 028	6 775

Source: DAFF 2014

2.4.1 Gross value, production and consumption of goat meat and mutton

The production of lamb and mutton in the formal sector amounts to an average of 110 000 tons per annum (DAFF, 2011c). Over the past decade, South Africa was a net importer of sheep meat and is projected to remain a net importer of meat in general (BFAP, 2013). During the past ten years, average chevon production per year was estimated at 8.5 million kg per year (DAFF 2011d).

The gross value of mutton production increased continuously from 2000/01 to 2012/13. Over these twelve years, the gross value of sheep and goat meat produced increased from about R1.3 billion to R4.2 billon (Table 2.5).

Table 2. 5: Combined gross value of sheep and goats slaughtered (R'000 in current and 2014 Rand)

Year	Gross value (R)	Gross value (2014 Rand)
2000/01	1 266 839	2 619 443
2001/02	1 318 449	2 588 247
2002/03	1 614 523	2 997 685
2003/04	1 717 272	2 912 665
2004/05	1 777 940	2 849 149
2005/06	1 988 594	3 208 596
2006/07	2 559 253	4 048 226
2007/08	2 835 462	4 344 495
2008/09	3 097 518	4 470 338
2009/10	3 402 635	4 462 556
2010/11	3 570 799	4 366 016
2011/12	4 048 539	4 755 414
2012/13	4 241 514	4 744 133

Source: DAFF, 2014

2.4.2 Wool and mohair gross value of production

More than 50% of wool is produced in two provinces: the Eastern Cape and Free State (DAFF, 2011e). About 50% of the world's mohair is produced in South Africa (DAFF, 2011f). Average annual production of wool and mohair production over the last decade is estimated at 41.9 million kilograms and 4 million kilograms, respectively (DAFF, 2012c). The gross value of wool has increased from R0.6 billion in 2000/01 to over R2.4 billion in 2012/13, while the gross value of mohair has increased from almost R0.2 billion to almost R0.3 billion over this twelve year period (Table 2.6).

Table 2.6: Gross value of wool and mohair (R'000 in current and 2014 Rand)

Period	Gross Value of wool (R)	Gross Value of wool (2014 Rand)	Gross Value of mohair (R)	Gross Value of Mohair (2014 Rand)
2000/01	646 721	1 337 225	194 532	402 234
2001/02	877 043	1 721 723	186 523	366 163
2002/03	1 241 936	2 305 903	217 557	403 938
2003/04	947 821	1 607 599	167 548	284 178
2004/05	737 611	1 182 022	177 216	283 989
2005/06	690 064	1 113 418	236 372	381 386
2006/07	1 131 931	1 790 488	247 688	391 793
2007/08	1 436 741	2 201 375	223 282	342 113
2008/09	1 083 604	1 563 857	197 249	284 670
2009/10	1 378 435	1 807 818	209 211	274 380
2010/11	1 607 481	1 965 467	216 730	264 996
2011/12	2 087 639	2 452 141	226 855	266 464
2012/13	2 435 839	2 724 486	291 053	325 543

Source: DAFF, 2014

2.5 SUMMARY

This chapter highlighted the importance of the livestock industry in South Africa. The potential significance of livestock in the development of rural livelihoods is demonstrated by the enormous contribution of the livestock sector at a macroeconomic level. The gross value of livestock production has increased steadily over the past twelve years.

The important role of livestock production in South Africa remains vulnerable to animal disease. Livestock farmers in South Africa, especially small-holder farmers, face many challenges that need to be addressed if this sector is to make its maximum contribution to economic development in South Africa. Challenges such as animal diseases require interventions by both the private and public sectors to invest in research and development of animal vaccines. Of significance is that farmers must identify those areas where they could have a direct impact and engage in serious efforts to address such challenges.

CHAPTER 3

ASSESSING THE ECONOMIC IMPACT OF ANIMAL DISEASE OUTBREAKS: A LITERATURE REVIEW

3.1 INTRODUCTION

The impact of animal diseases on agriculture is typically assessed in quantitative terms — lost revenues, cost of eradication, decontamination, vaccination and restocking; and the numbers of affected farms, animals and humans.

The aim of this chapter is to review some of the methods that have been applied previously when estimating the economic costs of an outbreak or disaster. This chapter further highlights the established limitations and advantages of each method. The chapter begins by highlighting several definitions of the concepts under discussion, after which several approaches for estimating economic losses of disasters are explored. In addition, the chapter highlights some of the findings from past international studies so as to get a better understanding and impact assessments of a disease outbreak, and develop a framework to conduct this study.

3.2 DEFINITIONS

To estimate the economic cost of an outbreak, proper identification of losses incurred and their quantification are important. According to McInerney, Howe and Schepers (1992) the economic costs of a disease, comprise two components: losses, and expenditures. During a disease outbreak producers incur extra costs in mitigating the outbreak. Costs of an outbreak are generated mainly from three sources: (i) surveillance, control and eradication, (ii) losses of production, and (iii) loss of access to export markets. In addition to these costs there may be non-market impacts and costs to consider (Alam & Rolfe, 2006). Hence, the economic impact of the disease can be categorised into direct and indirect losses (Mochabo, Kitala, Gathura, Ogara, Eregae, Kaitho & Catley, 2006). Direct impacts of animal disease at the farm level include increased mortality and morbidity, as well as reduced feed efficiency and lower average daily gain (Pritchett et al., 2005). Indirect losses include control costs, and loss of markets, as well as loss of production potential, i.e. production that could have been achieved had the RVF outbreak not occurred.

3.3 METHODS ON ESTIMATING ECONOMIC LOSSES RESULTING FROM DISASTERS AND OUTBREAKS

Several methods have been used to assess the indirect and direct economic losses resulting from disasters. These include surveys, econometric models, input–output models, general equilibrium models and economic accounting models. Although a number of methods to estimate costs exist, two approaches have been widely used to estimate the cost of an invasion, impact modelling and economic surplus analysis. Some of the methods used to assess the indirect and direct effects of an incursion and their application are discussed below.

3.3.1 Economic surplus approach

Economic surplus analysis is used to evaluate the net gains and losses of different impacts to society. The net losses due to the invasion, and the distribution of such losses among producers and consumers expressed as changes in producer and consumer surplus, can be estimated using the partial equilibrium approach. The economic surplus approach can be performed at a case study level, where the net surplus can be estimated with the application of cost–benefit analysis (CBA). This method allows for the demonstration of how a disease outbreak can reduce the welfare gains that might have been gained from the industry in the absence of the invasion (Alam & Rolfe, 2006). Although widely used, the economic surplus approach cannot sufficiently capture the indirect or flow–in effects of an impact.

Paarlberg, Lee and Seitzinger (2003) employed an economic surplus approach using a partial equilibrium model to estimate the welfare effects of a Foot and Mouth Disease (FMD) outbreak in the United States. The authors investigated how decomposition of welfare changes for agents led to more accurate measures of changes in national economic welfare resulting from a livestock disease outbreak. The authors argued that the welfare effects of an FMD outbreak on producers differ for those with animals quarantined and slaughtered compared to those who escaped FMD. They decomposed the impacts by groups, including livestock producers with animals quarantined and slaughtered and those not quarantined, using lost sales and producer surplus measures respectively. Likewise, consumer surplus was decomposed for consumers with and without changes of consumption behaviour. The authors argued that decomposition of aggregate welfare for different groups offered an opportunity for more accurate estimates of changes that could better inform policy decisions and also help in the design of compensation provisions.

3.3.2 Econometric modelling approach

In the econometric modelling approach, estimation of disease costs is derived from an econometrically estimated cost function using a dataset that is representative of a particular group of producers (Tiongco, 2006). Cost functions are derived mostly by using multivariate analysis and parametric estimation. Applying any regression technique, the fully–partial effects of a disaster can be modelled as an intrusion on a series of data. One major drawback of this approach is that most econometric approaches do not easily account for product substitution and immediate changes in the import of goods when the economy receives a significant shock (Clower, 2006). Despite this drawback, one major advantage of the econometric approach is that it captures the experience of the entire industry, reflecting actual production choices (Fearne, Garcia, Bourlakis, Brennan, Caswell, Hooker & Henson, 2004).

Velthuis, Saatkamp, Mourits, Koeijer and Elbers (2010) used an econometric model to estimate the financial consequences of the bluetongue 8 (BTV8) epidemics of 2006 and 2007 in the Netherlands. The costs of the outbreaks were estimated using a deterministic economic model that was compatible with the Dutch livestock production systems for cattle, sheep and goats. The financial consequences of the outbreak included the impact on production, treatment of infected animals, diagnostic costs and costs of control measures applied during the course of the outbreak. The cattle sector incurred the highest costs of all sectors: 88% and 85% of the net costs for the 2006 and 2007 outbreaks respectively. The study revealed that the introduction and establishment of BTV8 in the Netherlands caused significant losses, due to both the clinical disease and control measures that were constantly required.

3.3.2 Impact modelling

Impact modelling can be applied in the form of an input–output model or a computable general equilibrium (CGE) model. An input–output (I/O) model captures the flow of goods and services across the economy in a particular period, as well as interdependencies among the industries and associated primary factors of production (Elliston, et al., 2005 in Alam & Rolfe, 2006). I/O models are characterised by major weaknesses of being static and linear, plus the disaggregated impacts occasionally require epic assumptions. In addition, I/O models do not easily account for product substitutions, do not allow for changes in prices and are unable to consider dynamic changes in sector overtime (Rich, Miller and Winter-Nelson, 2005).

Ekboir (1999) employed an I/O model to estimate the potential impact of Foot and Mouth Disease in California. Direct production losses were estimated as the average daily production in the region multiplied by the proportion of infected farms multiplied by the number of days the farms could not sell their output. Components of the total cost of the outbreak in California included direct, indirect and induced output losses, plus the cost of cleaning and disinfection, enforcing the quarantine, plus the losses due to trade restrictions. The study revealed that the high intensity of production practices in dairies and feedlots, including large herds and considerable movements of services and products, stimulated the rapid spread of the disease. The results emphasised the crucial importance of quick detection and immediate control of an outbreak of the disease. In addition, the results indicate that a few days of animal health surveillance and monitoring services could make a difference of billions of dollars in control costs, production losses, and the cost of marketing losses owing to quarantine.

CGE is the most popular used method in disaster research. The application of this approach is most appropriate to answer questions that need a high level of aggregation. One distinct advantage of CGE models over I/O models is that they are more accurate because they can capture a wide range of economic linkages across sectors. However, the amount of information contained in a CGE model often makes it difficult to comprehend and deduce results (Rich, et al., 2005).

Gohin and Rault (2013) assessed the economic costs of an outbreak of Foot and Mouth Disease in the Brittany region of France, using a dynamic computable general equilibrium. The study assessed the impacts of culling infected animals and placing live animals in quarantine, on the livestock sectors and downstream food industries. They found that economic losses were spread over a number of periods even with a one-time shock and that the impacts on the primary sectors and downstream food sectors did not move in parallel. They also observed that the food industries suffered most in the first period, while the negative effects on agriculture were observed later.

3.3.3 Cost survey approach

In the cost survey approach, costs are estimated by means of surveys of farms. This approach involves gathering of actual costs at farm or household and institutional level. The power of this method is in its ability to capture the variability in costs among farms depending on the control measures that are used (Tiongco, 2006). Although the cost survey approach is clouded by non-response bias, it still offers the best opportunity for obtaining directly relevant data.

Rich and Wanyoike (2010) estimated the regional and national socio-economic impact of the 2007 RVF outbreak in Kenya using a combination of the cost survey approach and impact modelling. Semi-structured interviews of key value chain stakeholders in the cattle, sheep and goat sectors were conducted. The survey approach was used to estimate impacts along the value chain while the input–output analysis was employed to estimate the macro-level impacts using the most recent social accounting matrix (SAM) for Kenya. The study revealed negative impacts among producers in terms of food insecurity and reduction in income. Significant losses also were found among other downstream actors in the value chain, including livestock traders, abattoirs, casual labourers and butchers, as well as other non-agricultural sectors. The study highlighted the need for greater sensitivity and analyses to address the multitude of economic losses resulting from animal disease to better inform policy and decision making during animal health emergencies.

3.3.4 Economic accounting approach

The economic accounting approach explicitly includes the valuation of human life and injuries to humans. This approach also draws from other methods to estimate business losses by using surveys, econometric or I/O models. The major challenge of this method is the valuation of human life.

Zimmerman, Restrepo, Simonoff and Lave (2005) estimated the risk and economic costs of a terrorist attack on the electrical systems in the USA. Three areas were used to obtain estimates of economic and social costs: human fatalities and injuries, business losses, and transportation-related congestion. A sequence of steps was followed to estimate the economic and social costs which included identification of components in the electrical system that were vulnerable to disruption, and areas within the USA where vulnerabilities in such components are likely to exist. For one of these areas a quantification of selected economic costs on the basis of human fatalities and injuries, business losses and transportation –related congestion was conducted. To estimate human fatalities the study used estimates from government agencies for value of life in connection with air quality, insurance and jury awards. The authors realized that obtaining monetary value for fatalities was difficult as the electrical outages in the US have produced few deaths and injuries. Using the $40 billion paid out and the total number of deaths in connection with the 11 September 2001 attacks, the value of life lost estimated for civilians for those attacks was about $3 million.

3.3.5 Benefit–cost analysis

Based on budgets for specific activities, benefit–cost analysis (BCA) is frequently used to measure the costs of animal disease outbreaks. BCA examines changes in the profit or income of a farm, commercial operation or public agency. These budgets can be expressed in market prices, or in "shadow prices" that also reflect non-market values (Rich et al., 2005). The budgets in BCA are often combined with an epidemiological model to conduct simulations of alternative disease mitigation strategies and determine changes in profits or programme costs under different scenarios. Some dynamic considerations can be modelled by projecting a series of budgets over time and discounting the projected future revenues and costs at an appropriate rate. Results can be summarised by the computation of the net present values (NPV), benefit-cost ratio (BCR) and internal rate of return (IRR). The major weakness of BCA is its reliance on fixed budgets with pre-determined input/output coefficients and no endogenous links to other sectors of the economy. Hence, BCA is more appropriate for the analysis of the short-term effects of isolated disease-related outbreaks.

Zansler, Spreen and Muraro (2005) used a cost–benefit analysis to determine whether the citrus canker eradication program in Florida, USA, could be a useful example of a policy tool to contain the economic consequences of disease outbreaks, using the predicted values of the benefits and costs associated with an intervention. The benefit–cost analysis was developed using the predicted values of the benefits and costs associated with citrus canker. The actual cost of implementation was weighed against the estimated loss of revenue and the cost savings in an industry affected by pervasive citrus canker. The results of the analysis suggested that the benefits of the program outweighed the costs.

3.4 SUMMARY

This chapter summarized various methods that have been used to estimate economic costs of diseases. The studies reviewed were varied in both methods and breadth and scope of analysis. Important is that methods for estimation of economic costs all have inherent limitations and, as such, usually have led to a mix of approaches. Even though numerous quantitative studies on impacts of animal diseases were conducted in several international regions and Africa, these were not specifically on South Africa. The studies reviewed were useful in providing a methodological framework on which this study was based.

CHAPTER 4

RESEARCH METHODS AND DESIGN

4.1 INTRODUCTION

This chapter describes the method used to determine the socio economic impact of RVF on the livestock economy in South Africa in 2008 – 2010. The discussion indicates how the study was conducted, including survey design, selection of sample, data collection methods, and statistical procedures used. The chapter begins by discussion of the choice of study area, followed by the method used to quantify the economic costs of the outbreaks, and then a description and explanation of model variables. The chapter concludes with a discussion of the relevance of questions asked.

4.2 STUDY AREA

Three provinces were chosen for this study: the Eastern Cape, Northern Cape and Free State. Livestock farmers in these three provinces are believed to have been most severely affected by the recent RVF outbreaks (Appendix 1). Based on secondary data and expert opinions, two municipalities that were affected by the 2008–2010 RVF outbreaks were selected in each of the three provinces.

4.2.1 Cacadu municipal district

This district is one of the largest in the Eastern Cape Province as depicted in Figure 4.1 and is situated in the western part of the province. It forms about 34% of the entire province and covers an area of about 58 242 square kilometres. The central part of the district is mainly dry Karoo and grasslands comprised of commercial farms with an average annual rainfall of about 300 mm (Cacadu Municipal District, 2011). Livestock farming in the district largely consists of cattle, sheep and goats. The Cacadu municipal district is the largest producer of mohair in South Africa. The survey was conducted in Graaff Reinet and Aberdeen in the Cacadu municipal district.

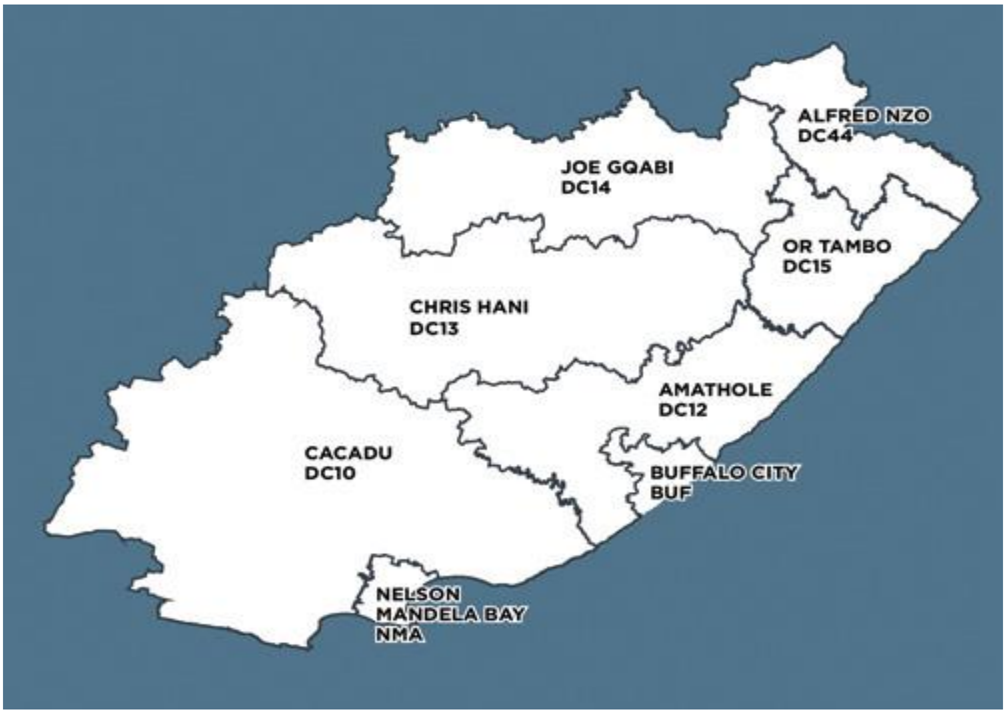

Figure 4. 1: District municipalities of the Eastern Cape Province

Source: South Africa Yearbook 2012/13

4.2.2 Chris Hani municipal district

The Chris Hani municipal district is situated in the centre of the Eastern Cape Province. It is the second largest district in the Eastern Cape, covering an area of about 3 7111 square kilometres (Figure 4.1). The greater part of the district is arid to semi-arid and receives less than 400 mm of rainfall per annum. The district is characterised by a number of major dams that serve the various irrigation schemes (Chris Hani District Municipality, 2011). The survey was conducted in Cradock, Middleburg and Hofmeyr/Tsolwana.

4.2.3 Pixley Ka Seme municipal district

Pixley Ka Seme district lies in the south-east of the Northern Cape Province and shares its borders with the Free State province to the east, the Eastern Cape to the south-east and the Western Cape to the south-west. The district is surrounded by the Chris Hani and Cacadu districts of the Eastern Cape Province as well as Frances Baard of the Northern Cape Province. It is the second largest municipality in the province covering a surface area of about 102 727 square kilometres (Figure 4.2). The survey was conducted in Prieska, Douglas and Britstown.

Figure 4. 2: District municipalities of the Northern Cape Province

Source: South Africa Yearbook 201/13

4.2.4 Frances Baard municipal district

Frances Baard District Municipality is the smallest district in the Northern Cape Province, (Figure 4.2). It covers an area of 13 518 square kilometres, about 3.4% of the total area of the province. Most of the agricultural activities in the district consist of the cultivation of various irrigated crops, livestock and game farming. The survey was conducted in Kimberly.

4.2.5 Fezile Dabi district municipality

Fezile Dabi District Municipality is the second smallest district in the Free State Province as can be seen in Figure 4.3. It covers 16.4% of the provincial area, about 20 668 square kilometres. The district is characterised by a number of dams and numerous river systems. Commercial farming activities in the form of livestock and crop production claim a large portion of the land in the district. Livestock farming consists mainly of sheep and cattle production. The survey was conducted in Kroonstad and Steynsrus.

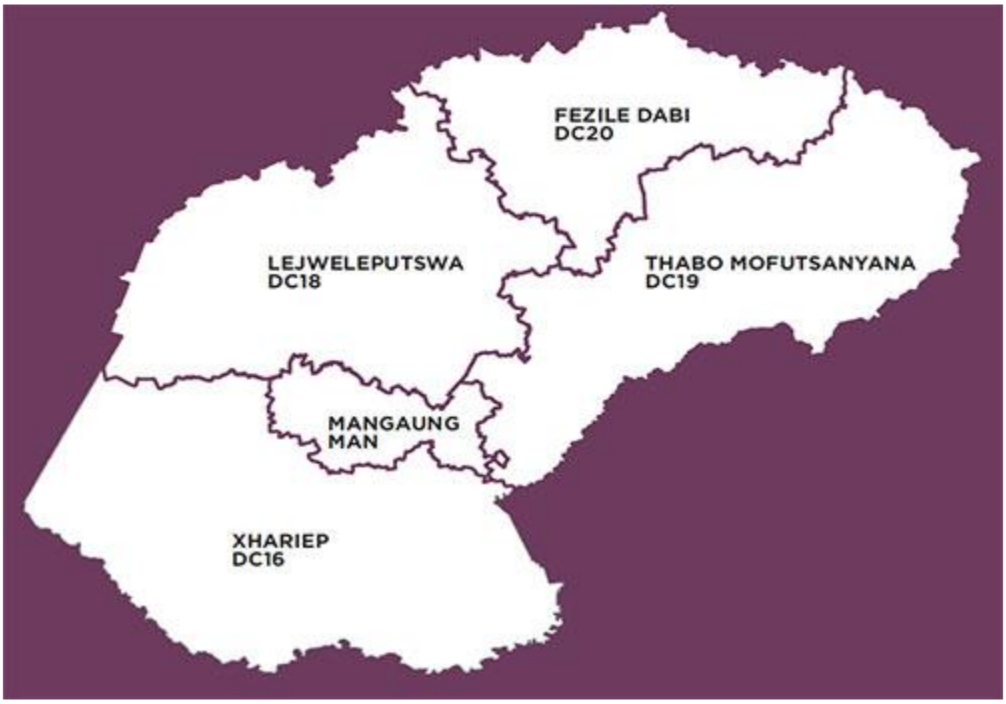

Figure 4. 3: District municipalities of the Free State Province

Source: South Africa Yearbook 2012/13

4.2.6 Lejweleputswa District Municipality

This district is situated in the north-western part of the Free State (Figure 4.3). It shares borders with the Northern Cape and North West and Gauteng provinces. The main agricultural product in this district is maize. It has the second-largest area in the province: 24.3% of the area of the Free State. This district is characterised as a semi-arid region with average yearly rainfall of about 550mm of which 400mm is mainly summer rainfall (Lejweleputswa District Municipality, 2010). The survey was conducted in Brandfort, Bultfontein and Welkom.

4.3 DATA COLLECTION METHODS AND STATISTICAL PROCEDURES

The study used both secondary and primary data. Secondary data was used for background information on livestock farming in South Africa as well as for literature review on methods of estimating economic losses of disasters and outbreaks. A questionnaire was developed for farmer interviews in consultation with animal health practitioners from the respective provinces. The questionnaire was pre-tested on eight livestock farmers in the Free State province, followed by adjustments to the questionnaire, which then was used in the farm survey. Animal health practitioners from each of the three provinces also were interviewed as key informants, using a list of specifically formulated questions. The aim of the interviews with key informants was to gain additional insights into local perceptions of animal diseases and the roles played by the animal health practitioners during the RVF outbreaks in 2008 - 2010.

4.3.1 Farm survey

A list of 266 livestock farmers from the three provinces where the main RVF outbreaks occurred in South Africa was obtained from the respective animal health practitioners. From this list, a total of 150 livestock farmers in the two districts in each of Northern Cape, Free State and Eastern Cape provinces were selected for the survey (as described below). The study focused on both black and white livestock farmers who keep cattle, goats, and sheep or any combination of the three.

4.3.2 Sampling design and sample size

Sampling involves a process of selecting units from a population of interest so that by studying the sample the results can be generalised to the population from which they were chosen. This implies that the sample should reflect all the characteristics of the population relevant to the research in question. A statistically adequate sample is one that is of such size that the inferences drawn from the sample are accurate to a given level of confidence (Frick & Groenewald, 1999).

This study used a three-stage probability sampling: primary, secondary and tertiary. Primary sampling involved the selection of the three provinces: the Eastern Cape, Northern Cape and Free State. Free State. Pienaar and Thompson 2013, report that farmers in these three provinces were most severely affected by the 2010 outbreaks. Based on availability of resources (time and personnel), two affected districts in each province were selected. Secondary and tertiary sampling was done in consultation with animal health practitioners of the respective provinces to select the two districts per province as well as the affected towns in each district.

A list of livestock farmers around the selected towns with information on the type of livestock farming the farmers practised was obtained from the respective animal health practitioners. Within towns, farmers with contact details were stratified by type of livestock they kept. To ensure representativeness, 75% of farmers for each stratum were selected and within each stratum, simple random sampling was applied to select 50% of the farmers. From each stratum the first ten farmers who were available and willing to participate in the study were interviewed using the revised questionnaire. Table 4.1 indicates the selected study sites and the number of respondents in each province. The total sample size was 150 livestock farmers.

Table 4. 1: Number of respondents in each province

Eastern Cape Province N = 105 n = 47	Cacadu District N = 28 n = 11	Graaff-Reinet N = 12 n = 05
		Aberdeen N = 16 n = 06
	Chris Hani District N = 77 n = 36	Cradock N = 33 n = 19
		Hofmeyr N = 28 n = 14
		Middelburg N = 16 n = 03
Northern Cape Province N = 58 n = 39	Pixley Ka Seme District N = 43 n = 31	Prieska N = 14 n = 10
		Douglas N = 18 n = 13
		Britstown N = 11 n = 08
	Frances Baard District N = 15 n = 8	Kimberly N = 15 n = 08
Free State Province N= 103 n = 64	Fezile Dabi District N = 33 n = 25	Steynsrus N = 18 n = 13
		Kroonstad N = 15 n = 12
	Lejwele Putswa District N = 70 n = 39	Brandfort N = 35 n = 16
		Bultfontein N = 18 n = 12
		Welkom N = 17 n = 11

N = population as received from the respective animal health practitioners and n = sample

4.3.3 Description of questions asked

The purpose of this study is to estimate the socio economic impact of the RVF outbreaks in 2008 – 2010 on livestock farmers in three provinces of South Africa. Data gathered in the farm survey includes the following; demographic details, livestock activities, animal health practices, production and management practices, prevention of RVF, biosecurity activities, as well as the impact of the outbreak on livestock production and marketing activities; (Appendix 2).

Questions pertaining to the location (province, district, local municipality and town) of the farmer were included in the questionnaire to permit analysis of the impact on a provincial basis. One of the specific objectives of this study is to establish whether there is any correlation between the demography of respondents and the impact of the RVF outbreak. Hence, Part 1 of the questionnaire asked questions related to the demographic characteristics of each respondent. Respondents were asked to indicate their race, gender, age and farming experience as well as their level of education and their main source of income.

Part 2 and Part 3 of the questionnaire deal with questions related to the economic costs of the RVF outbreaks. To identify animal production systems and animal health care-practices, farmers were asked to provide data on production systems, type of livestock kept as well as the outlets they use for marketing of their livestock. To understand whether the size of farms was associated with RVF impacts and whether farmers with open water surfaces (where mosquitoes breed) were affected differently compared to those without, the questionnaire included questions on their land tenure system and water sources. The questionnaire also deals with questions investigating whether RVF affected the animal types differently and also whether farmers with large herds of livestock adopted different strategies to minimise their losses compared to those with small herd sizes. Farmers were asked to provide data on the type, as well as number of animals kept.

Part 4 of the questionnaire deals with questions to test the hypothesis that farmers who vaccinated against RVF and had good management and sound animal health practices were least affected by the outbreaks. Farmers were asked if they vaccinated all their animals against RVF and whether or not they usually vaccinate their animals and apply biosecurity measures.

Part 5 dealt with the prevention of RVF. Farmers were asked to list the animal diseases they experienced between 2008 and 2010. They also were asked about when they started RVF vaccination as well as which vaccine they used. Since some farmers complained about the efficacy of the vaccine, they were asked if they experienced any challenges with the vaccine used. Questions were asked about specific challenges of vaccination, including administration of vaccine, efficacy, storage and packaging. In addition, farmers were asked where they had purchased their vaccine and whether or not they hired somebody to administer the vaccine. That information was useful to address the issue of efficacy and also for determining the cost of vaccination.

Part 6 of the questionnaire investigates the impact of RVF. To determine the costs of the outbreaks, farmers were asked to identify which year they incurred animal losses. Data on the number of mortalities and abortions were requested as well as type and nature (pregnancy, gender, age and type of breed) of animals lost. Data on any other capital losses incurred also was requested. To estimate expenditures farmers were asked to specify the control measures applied and costs incurred to minimize their losses. To understand how the RVF affected farmers' marketing activities, they were asked to specify the quantities marketed from 2007 to

2012. To understand the impact of RVF on livestock numbers, farmers were asked to provide data on herd size, calving/ lambing rates and mortality rates from 2008-2012.

To test the hypothesis that farmers overestimated their losses, farmers were asked to estimate their own income loss and costs incurred as a result of the 2010 outbreak. Farmers also were afforded an opportunity to provide comments on the outbreak such as what could have been done better and by whom to minimize the losses.

4.4 METHODS USED TO ESTIMATE THE SOCIO-ECONOMIC IMPACT OF THE RVF OUTBREAKS

The economic costs of a livestock disease comprise two components: loss of production and additional expenditures (McInerney et al., 1992). Extra expenditures could be in the form of treatment or prevention of a disease, while a production loss implies a potential benefit that is not realised (McInerney et al., 1992).

Due to data limitations, this study uses a combination of methods to estimate economic losses to the 2008–2010 RVF outbreaks. To gather actual costs at farm level and to capture the variability in costs amongst farms regarding the control measures that were implemented, this study uses the cost survey analysis approach.

To estimate the financial cost analysis of the RVF outbreaks at the farm level, this study adopted the deterministic economic model used by Velthuis et al. (2010) to measure the financial costs of the Bluetongue virus outbreaks in the Netherlands in 2006 and 2007.

The basic model proposed by Velthuis et al. (2010) is as follows:

$$L = \Sigma i \Sigma j \, Pi.j + Ti.j + Di + Mi.j$$

Where, L represents the total loss to the entire livestock population due to the outbreak, P the production losses of farm type i in the context of animal type j, T the corresponding treatment costs, D the diagnostic costs, and M the cost of the control measures. Each of these items is then detailed into equations that include more specific inputs.

Production losses with financial costs include mortality(MT), abortions (AB) reduced milk production (MP), and reduced wool production (WP).

Losses due to mortality are computed as:

$MT = ad\,(sv)$

Where, ad equals the number of dead animals in infected farms and sv the slaughter value of an animal

Abortions are computed as:

$AB = ab(bv)$

Where, ab is the number of abortions and bv the value of an animal at birth.

Milk production losses

$MP = ai.\,amp.\,10rd.\,vm$

Where, ai equals the number of vaccinated dairy cows, and amp equals the average daily milk production. After vaccination, dairy cows are withdrawn from milk production for a period of 10 days, rd is rest days and vm equals the value of milk lost.

Wool production losses

Wool production losses were not immediate, but rather were felt one to two years after the outbreak. It also was established during the survey that despite the import ban imposed by China on South Africa's wool due to RVF outbreaks, farmers were able to sell their wool products to the agents. It is acknowledged that the ban might have affected the market prices; however, there were no substantial and definitive data to estimate such an impact and therefore wool production losses are not estimated in this study.

Treatment costs

There is no specific treatment for RVF infections in livestock. However, 6% of farmers indicated that they applied antibiotics (Terramycin) to boost the immune system of the animals. No extra labour costs were reported for this activity as this formed the normal routine of the farm activities.

$TC = atab\,(pab),$

Where, $atab$ is equal to the number of animals treated with antibiotics and pab is equal to the price of antibiotics.

Diagnostic costs

No farmer reported having incurred any costs for diagnostics. According to the ARC–OVI which performed the diagnostic tests for RVF, all the diagnostics they performed during the outbreaks were paid for by the state. It is acknowledged that some farmers might have incurred post mortem costs by using private veterinary practitioners; however, no substantial data were available to estimate diagnostic costs.

Costs of control measures

Control measures with financial implications applied by farmers included vaccination and frequent use of dip as a repellent.

$$M = DC + VC$$

Where DC is the cost of dipping or spraying with dip and VC equals the cost of vaccination

$$DC = ad\,.pd\,.8dd$$

Where ad is the number of animals dipped and pd is the price of dip per animal. During the survey 9% of farmers indicated a weekly use of Drastic Deadline as a repellent for a period of two months, which is approximately eight days of treatments.

The survey revealed that no additional labour and private veterinary services were utilised by farmers for the administration of the RVF vaccine. The vaccine costs were estimated as follows;

$$VC = avc\,(pvc)$$

Where avc equals the number of animals vaccinated and pvc the price of vaccine.

To estimate economic costs at the district and provincial level the following formulae, used by Bennett (2003) to estimate the direct costs of 30 endemic livestock diseases in Great Britain, were adopted

$$for\ each\ disease\ effect\ (L + R) = p\ id\ \ ie\ e\ vl$$

$$for\ each\ type\ of\ disease\ treatment\ T = p\ it\ vt$$

$$for\ each\ type\ of\ disease\ prevention\ \ P = p\ ip\ vp$$

Where:

p: $size\ of\ livestock\ population\ at\ risk$

id: $annual\ incidence\ of\ disease\ as\ a\ proportion\ of\ the\ population\ at\ risk$

ie: $incidence\ of\ disease\ effects\ as\ a\ proportion\ of\ the\ affected\ population$

e: $magnitude\ of\ physical\ disease\ effects\ (\ e.g.R/\ litres\ of\ milk\ lost)$

vl: $unit\ value\ of\ lost\ output\ (\ e.g.R/\ abortion\ incurred)$

it: $proportion\ of\ population\ at\ risk\ treated$

vt: $cost\ of\ treatment\ per\ animal$

ip: $proportion\ of\ population\ at\ risk\ where\ prevention\ measure\ taken$

vp: $cost\ of\ prevention\ measure\ per\ animal$

4.3 DESCRIPTION OF MODEL VARIABLES AND DATA

"The magnitude of the economic losses depends on a myriad of factors including the absolute and spatial size of the outbreak, the geography of the outbreak and the strategy used to combat the outbreak" (Pritchett et al., 2006). Hence, the study chose the following model variables;

- Geography – The location of the outbreak, size of the affected area, animal numbers and density, and frequency of mobility of affected animals are important. The survey is conducted in the Free State, Northern Cape and Eastern Cape provinces.

- Type of livestock – Small stock especially sheep are more susceptible to RVF than are cattle. The study focuses on sheep, goats and cattle farmers irrespective of type of production.

- Number of animals – Farmers with small farming land such as communal farmers might face difficulties in separating sick animals from the rest of the herd, thereby increasing the number of infections. Farmers are stratified according to farm size and livestock numbers.

- Strategy – The strategy employed to prevent, contain and respond to the outbreak will influence the degree of economic loss.

- Time – This study will investigates three annual outbreaks of RVF and estimates losses as a result of each outbreak.

4.6 SUMMARY

This chapter provided a detailed description of the research methods and design applied. A detailed description of the study area and data collection methods also was presented. A combination of methods is used to estimate the economic losses to 2008-2010 RVF outbreaks. To estimate farm level losses, the study uses a deterministic model applied on primary data collected from the two districts in each of the Eastern Cape, Free State and Northern Cape provinces. The methods of estimating district and provincial economic costs also were discussed. A 3-stage sampling procedure was used to select the sample of 150 farmers interviewed. A detailed description of model variables, sampling design processes and questions asked also were highlighted.

CHAPTER 5

DESCRIPTIVE ANALYSIS

5.1 INTRODUCTION

"Conventional estimates of 'the cost of disease' have no particular significance, because their magnitude carries no indication as to what, if anything, should (or could) be done about the situation" (McInerney et al., 1992). To inform effective policy making in the control and prevention of RVF, this chapter provides a detailed descriptive analysis that explores the relationship among animal losses and demographic characteristics, livestock activities, animal health, production and management activities as well as prevention of RVF in the selected study areas.

The significance of the relationship between farmers who incurred animal losses and the specific variables was tested with the $\chi 2$ (Chi2df=1) test for equal proportions (H0: p1= p2) and a normal approximation (Z) of a Poisson variate was used to test for equal response totals (H0:T1=T2). The significance of the relationship is reported based on the results of Poisson (Z) test. Pearson correlation tests between revenue losses and specific variables also were performed. The significance of the correlation were tested at the 5% significance level.

5.2 RELATIONSHIP AMONG DEMOGRAPHIC VARIABLES AND IMPACT OF RVF

5.2.1 Age

There was a significant positive correlation (p = 0.018) between animal losses and age (Table 5.1). This correlation also was significant (p= 0.0038) in Northern Cape. The relationship was significant at age categories of 55-64, 65-70 and >70 at probability values of 0.0001, 0.0416 and 0.0001, respectively. The mean age of farmers in Eastern Cape and Northern Cape was 55 while in the Free State, it was 59. The majority of farmers who kept sheep were younger. Sheep were the main animal species that was affected by the RVF outbreaks. Consequently, farmers that were less than 54 years of age in Eastern Cape and Northern Cape were the most affected in terms of revenue losses as they kept large herds of sheep.

Table 5.1: Relationship between age and impact of RVF

Age	Number of farmers who incurred animal losses	Number of farmers who did not incur animal losses	χ2 test *P value*	Z test *P value*
<= 45	14	13	0.8474	0.4237
46–54	14	21	0.2367	0.1184
55–64	9	34	0.0001	0.0001
65–70	9	18	0.0833	0.0416
> 70	1	17	0.0002	0.0001

Source: Survey results

5.2.2 Race

A total of 115 farmers in the survey were black, and 45% were located in communal areas of the three provinces. In all three provinces, the majority of respondents were blacks. Despite the small number of white respondents in the 3 provinces, Northern Cape had the largest percentage (41%) of white respondents followed by Eastern Cape (34%) and Free State (4.7%). There was a significant relationship between race and animal losses (P = 0.0000 and 0.0056) for black and white farmers respectively (Table 5.2). Consequently, a significant correlation (p <0.0001) between race and revenue losses was established. This correlation also was significant in Eastern Cape (p = 0.000) and Northern Cape (p = 0.006). The majority (93%) of black farmers indicated that they vaccinated all their animals against RVF compared to only 54% of white commercial farmers. Twenty-five (53.2%) white farmers incurred animal losses and much larger revenue losses compared to 46.8% of black farmers.

Table5.2: Relationship between race and impact of RVF

Age	Number of farmers who incurred animal losses	Number of farmers who did not incur animal losses	χ2 test *P value*	Z test *P value*
Black	22	93	0.0000	0.0000
White	25	10	0.0112	0.0056

Source: Survey results

5.2.3 Gender

Participation and ownership of livestock by women remains a challenge in South Africa. Out of 150 livestock farmers in the survey, only 13 (9%) were females (Table 5.3). There was a significant relationship (p = 0.0011 and p = 0.0001) between gender and animal losses for female and male respondents, respectively. Female farmers in the survey were all black and they kept few animals, which were mostly cattle, the animal species least affected by RVF. Consequently, just one (0.6%) of female farmers incurred animal losses compared to 46 (30.7%) of male farmers.

Table 5.3: Relationship between gender and impact of RVF

Age	Number of farmers who incurred animal losses	Number of farmers who did not incur animal losses	$\chi 2$ test *P value*	Z test *P value*
Female	1	12	0.0023	0.0011
Male	46	91	0.0001	0.0001

Source: Survey results

5.2.4 Education

There was a statistically significant relationship between education and RVF impact, with values of p = 0.0101 and 0.0000 for farmers with no years of school education and those with less than grade 12 level of education, respectively (Table 5.4). Despite the presumption that educated farmers might be less likely to incur large financial losses to the outbreaks of RVF, 56% of white commercial farmers with tertiary education incurred losses compared to just 20% of those with no schooling. Consequently, a significant positive correlation ($p<0.0001$) was found between level of education and revenue losses. This correlation also was statistically significant (p = 0.017 and p = 0.030) in Eastern Cape and Northern Cape, respectively and the white commercial farmers were mainly from these two provinces. All farmers with no schooling were communal farmers for whom the state provided free RVF vaccine for all their livestock while white commercial farmers kept large herds of sheep and in most instances did not vaccinate all their livestock.

Table 5.4: Relationship between education and impact of RVF

Age	Number of farmers who incurred animal losses	Number of farmers who did not incur animal losses	$\chi 2$ test *P value*	Z test *P value*
No school	3	12	0.0201	0.0101
< grade 12	14	59	0.0000	0.0000
Grade 12	7	14	0.1266	0.0633
Tertiary	23	18	0.4349	0.2174

Source: Survey results

5.2.5 Farming experience

Farming experience was grouped into three categories; < 15 years, 15- 24 years and > 25 years. Of 150 respondents 43 (29%) had less than 15 years of farming experience while 54 (36%) and 53 (35%) had 15- 24 and more than 25 years farming experience, respectively (Table 5.5). The average years of farming experience was highest in Free State at 22 years followed by Northern Cape and Eastern Cape provinces where farming experience averaged 18 years. A statistically significant relationship was found between farming experience and the impact of RVF, with p = 0.0000, p = 0.0147 and p = 0.0467 for farmers with less than 15, 15 to 25 years and more than 25 years of farming experience, respectively (Table 5.5). Farmers with more than 15 years of farming experience were the most affected. Among white farmers, 91% of them fell within this group while only 57% of black farmers had more than 15 years of farming experience. White farmers with more than 15 years of farming experience kept large herds of sheep, which are the most vulnerable species to RVF; black farmers raised mostly cattle.

Table 5.5: Relationship between farming experience and impact of RVF

Farming experience	Number of farmers who incurred animal losses	Number of farmers who did not incur animal losses	$\chi 2$ test *P value*	Z test *P value*
<15	12	41	0.0001	0.0000
15–25	19	35	0.0295	0.0147
>25	16	27	0.0934	0.0467

Source: Survey results

5.3 RELATIONSHIP BETWEEN NATURAL RESOURCES AND IMPACT OF RVF

5.3.1 Land

Of 150 farmers interviewed, 68 (45%) were communal farmers, 21 (14%) farmed on leased land while 61 (41%) are on free hold land. A highly significant relationship (p <0.0001) was established between the impact of RVF and the land tenure system. This relationship was significant with farmers who operated on communal land with p = 0.0000 (Table 5.6). At 48%, farmers who operated on freehold land were the most affected, followed by 33% and 16% of farmers who operated on leased and communal land, respectively. Farmers on freehold land kept large herds of animals and that consisted mainly of sheep.

Table 5.6: Relationship between land tenure system and impact of RVF

Land Tenure system	Number of farmers who incurred animal losses	Number of farmers who did not incur animal losses	χ2 test *P value*	Z test *P value*
Communal	11	57	0.0000	0.0000
Leased	7	14	0.1266	0.0633
Freehold	29	32	0.7009	0.3504

Source: Survey results

Another significant relationship (p = 0.0000) was found between farmers who kept livestock only and impacts of RVF (Table 5.7). Of 150 sampled farmers, 135 (90%) were purely livestock farmers on natural pastures while 15 (10%) practiced mixed farming under irrigation in a form of planted pastures and some with few hectares allocated for crop production. The majority (60%) of farmers who practiced mixed farming were affected by the outbreaks compared to only 28% of farmers who kept livestock only. Free State had a large number (42%) of respondents who kept livestock only, followed by Eastern Cape (32%) and Northern Cape (27%). Hence, respondents from Free State were least affected by the outbreaks compared to the Northern Cape and Eastern Cape farmers.

Table 5.7: Relationship between type of farming and impact of RVF

Type of farming	Number of farmers who incurred animal losses	Number of farmers who did not incur animal losses	χ2 test *P value*	Z test *P value*
Livestock only	38	97	0.0000	0.0000
Mixed	9	6	0.4386	0.2193

Source: Survey results

A significant relationship also was found between the size of the farm land and the impacts of RVF (Table 5.8). The mean land size was the highest (7 703 ha) in Northern Cape, followed by Eastern Cape and Free State with mean sizes of land of 3 632 and 1 396 ha, respectively. Farmers with more than 3 000 hectares were the most affected (37%), followed by farmers with less than 500 hectares and 500 to 3 000 hectares (34% and 26%, respectively). Consequently, a highly significant correlation ($p < 0.0001$) was found between revenue losses and the size of the farm land. This correlation also was highly significant ($p < 0.00001$ and $p = 0.001$) in Northern Cape and Easter Cape, respectively. Those with large farms were mostly sheep farmers; hence Northern Cape farmers who kept sheep incurred very large revenue losses, followed by those from Eastern Cape and Free State, respectively.

Table 5.8: Relationship between land size and impact of RVF

Land size in hectares	Number of farmers who incurred animal losses	Number of farmers who did not incur animal losses	$\chi 2$ test *P value*	Z test *P value*
<500	12	23	0.0630	0.0315
500–3000	17	49	0.0001	0.0000
>3000	18	31	0.0633	0.0316

Source: Survey results

5.3.2 Water sources

Of 150 farmers 74 (49%) had no open water sources while 76 (51%) had. Fifty-three percent of those with open water surfaces such as dams and streams passing through the farm were affected compared to 24% of those who had no open water sources. A statistically significant correlation was found between water sources and RVF impacts (p = 0.023). This correlation was found to be significant only in Eastern Cape (p= 0.024). Eastern Cape had a large number (68%) of respondents with open water surfaces followed by Free State (45%) and Northern Cape (39%).

5.4 RELATIONSHIP BETWEEN LIVESTOCK ACTIVITIES AND IMPACT OF RVF

A highly significant correlation (p = 0.0000) between impacts of RVF and sheep herds of size 1-100 was found (Table 5.9). Another statistically significant relationship (p = 0.0206) was found between the impacts of RVF and farmers who kept more than 1000 head of sheep. Compared to the other two provinces, Eastern Cape farmers had the highest average sheep flock size at 1 083, followed by Northern Cape and Free State farmers at 972.9 and 582.8 sheep, respectively. Statistically significant correlations (p= 0.021 and p<0.0001) were found between revenue losses and farmers who kept sheep and sheep herd size, respectively. Both correlations were found to be significant (p = 0.010 and p = 0.004) in Free State while significant correlations (p = 0.004 and p<0.0001) between revenue losses and sheep herd size were found in Eastern Cape and Northern Cape provinces. Farmers who kept sheep incurred larger revenue losses than did those who kept mostly other animal species in all three provinces.

Table 5.9: Relationship between herd size and impact of RVF

Animal species	Herd size	Number of farmers who incurred animal losses	Number of farmers who did not incur animal losses	χ2 test *P value*	Z test *P value*
Sheep	0	11	52	0.0000	0.0000
	1–100	7	32	0.0001	0.0000
	101–1000	12	12	1.0000	0.5000
	>1000	17	7	0.0412	0.0206
Cattle	<25	9	56	0.0000	0.0000
	25–50	13	22	0.1282	0.0641
	51–100	12	16	0.4497	0.2248
	>100	13	9	0.3938	0.1969
Goats	0	28	58	0.0012	0.0006
	1–50	6	23	0.0016	0.0008
	> 50	9	15	0.2207	0.1103

Source: Survey results

Statistically significant correlations between revenue losses and cattle herd size were found throughout the study area (p= 0.027) and in specific provinces of Eastern Cape (p=0.046) and Northern Cape (p=0.003).

The mean cattle herd size was highest in Eastern Cape followed by Northern Cape and Free State at 142, 91 and 41 head, respectively. The majority of farmers (59.1%) who kept more than 100 head of cattle were the most affected, followed by farmers who kept cattle herds of size 51-100, 25-50 and less than 25 head at 42.9%, 37.1% and 13.9%, respectively (Table 5.9). Consequently, cattle farmers in Eastern Cape incurred larger revenue losses than did farmers in the other two provinces.

Farmers who kept goats were the least affected by the RVF outbreaks. A statistically significant correlation (p =0.009) was found between revenue losses and farmers who kept goats in Eastern Cape while in Northern Cape a statistically significant correlation (p = 0.028) was found between revenue losses and goat herd size. The mean size of goat herd was highest in Eastern Cape, followed by Northern Cape and Free State at 102, 66 and 5 head, respectively. Consequently, Eastern Cape farmers who kept goats incurred larger revenue losses than did goat farmers in Northern Cape and Free State provinces, respectively. The relationship between animal losses and goat herd size was found to be statistically significant (p = 0.0008) with those farmers who kept between 1-50 goats (Table5.9).

5.5 RELATIONSHIP BETWEEN THE IMPACT OF RVF AND ANIMAL HEALTH, PRODUCTION AND MANAGEMENT ACTIVITIES

5.5.1 Animal health practices

Statistically significant relationships were found between animal health practices and the impacts of RVF (Table 5.10). During the survey, 98% of farmers indicated to apply biosecurity measures in the form of isolating sick and new animals from the rest of their herds. Black farmers indicated that the state provided them with free vaccine and also administered the vaccine to all animals on their behalf. This was to ensure that the right vaccine was administered on time and effectively. Some white commercial farmers indicated that they vaccinated during the outbreak using one needle for more than 20 animals while others admitted that they changed the needle only when it broke. This practice has the potential to spread the infection if there are infected animals in the herd. Consequently, 71% of white commercial farmers were affected by the outbreak compared to 29% of black farmers whom the state assisted with application of the vaccine.

Table 5.10: Relationship between animal health practices and impact of RVF

Practice	**Number of farmers who incurred animal losses**	**Number of farmers who did not incur animal losses**	**$\chi2$ test** ***P value***	**Z test** ***P value***
None	0	5	0.0253	0.0127
Biosecurity only	1	5	0.1025	0.0512
Biosecurity and general vaccination	26	45	0.0241	0.0121
Biosecurity, general and RVF vaccination	20	48	0.0007	0.0003

Source: Survey results

5.5.2 Prevention of RVF

Although there was no significant correlation between revenue losses and vaccination of all animals against RVF, there was a highly significant relationship ($p = 0.0000$) between animal losses and vaccination of all animals against RVF (Table 5.11). Consequently, 11 (35%) of farmers who did not vaccinate all their livestock against RVF incurred animal losses compared to 36(31%) of farmers who vaccinated all their livestock.

Table 5.11: Relationship between vaccination of all animals and impact of RVF

Vaccinated all animals	Number of farmers who incurred animal losses	Number of farmers who did not incur animal losses	$\chi 2$ test *P value*	Poisson test *P value*
No animals	0	4	0.0455	0.0228
No	11	20	0.1059	0.0530
Yes	36	79	0.0000	0.0000

Source: Survey results

5.6 SUMMARY

This chapter presented the descriptive findings on relationships between the main categories of the questionnaire and the incidences and impacts of RVF. Contrary to expectations that those with greater farming experience and education would have lower animal losses from RVF, the results from the survey showed the opposite. Those who incurred the greatest losses were farmers with the highest education and most experience. Of course, other factors were involved. Those with greater experience also tended to have larger herds/flocks.

Statistically significant relationships were found between natural resources such as size of land base and whether or not farms contained open water sources and the incidence of RVF. Those who operated on freehold land were more affected by RVF than were those who operated on leased land and communal land while 53% of farmers with open water sources were more affected by the RVF outbreaks compared to 24% of those who had no open water sources.

A statistically significant relationship was found between type of farming and the incidence of RVF. Those who practiced mixed farming were more affected by the RVF outbreaks than were those who kept livestock only. Extensive livestock farmers were the most affected, especially those who kept sheep. Statistically significant correlations were found between revenue losses and farmers who kept sheep and sheep herd size, respectively.

Although no significant correlation was found between revenue losses and vaccination of all animals against RVF, one was found between vaccination of all animals against RVF and the impact of RVF. The majority (59%) of farmers who did not vaccinate all their livestock incurred animal losses while just 31% of those who vaccinated all their livestock against RVF incurred losses.

CHAPTER 6

ESTIMATION OF 2008–2010 RVF IMPACT ON LIVESTOCK FARMERS IN SOUTH AFRICA

6.1 INTRODUCTION

Animal disease outbreaks pose substantial threats to livestock sectors in terms of the economic effects of the diseases themselves as well as the actions taken to alleviate the risk of disease introduction or spread (Perry and Randolph, 2003). The multidimensional nature of these effects tends to complicate effective policy responses (Rich et al., 2005). The first response to policy-related appraisal of animal diseases control often requires analyses of the economic impacts of a disease outbreak (Rich et al, 2005). The total economic costs of a disease often is described as composed of two individual components; (i) output losses following disease occurrence; and (ii) expenditures made to treat disease or prevent its occurrence (McInerney et al,1992).

The aim of this chapter is to present the quantitative analysis of the economic costs incurred by livestock farmers due to RVF outbreaks. The estimated economic cots represent the impacts of both losses and expenditures due to the outbreaks. The chapter begins by describing the nature of the losses and expenditures incurred by the sampled livestock farmers from the two districts in each of the three provinces. Secondly, the actual costs incurred by these farmers are estimated at district and provincial levels. An overall impact of the outbreaks on livestock numbers also is provided. The chapter ends with a summary of the findings among the provinces.

6.2 ESTIMATION OF EXPENDITURES ($\boldsymbol{Ti.j} + \boldsymbol{Mi.j}$)

Expenditures on disease control include the total value of resources used either to reduce or to prevent potential losses due to output reductions (Bennett, 2003). Practically, disease control expenditures have become immersed into standard management practices and are now less immediately observed as disease prevention measures such as hygiene procedures and additives (McInerney et al., 1992). Both treatment and preventative expenditures have the mutual goal of abating losses in the future. Treatment is an ex post response to disease that has occurred, while prevention is an ex ante response to disease that might occur (McInerney et al., 1992). During the outbreaks some farmers used either prevention or treatment while others used treatment and prevention simultaneously. This is in line with earlier findings of McInerney et al. (1992) when they developed a framework for the economic analysis of disease in farm livestock. The study focuses only on the economic costs incurred by the livestock farmers and therefore any costs such as vaccination provided by the state is not considered in this study.

The extra expenditures incurred by the farmers were of three types: prevention costs in the form of vaccination; control costs in the form of spraying animals with dip to repel insects; and antibiotics administered as a form of treatment to boost the immune system of livestock (since there is no vaccine or specific treatment that cures RVF in infected livestock).

6.2.1 Cost of vaccination ($VC = avc\ (pvc)$)

Farmers were asked to indicate the type and number of animals vaccinated during the period of the three outbreaks. Vaccination costs were estimated by multiplying the number of vaccinated animals by the cost of vaccine used. Three approved commercial vaccines are available for prevention of RVF in South Africa (Clone 13, Smithburn and an inactivated RVF vaccine). An average price of the three vaccines was used to estimate the cost of vaccination per animal as farmers could not always recall which vaccine they used. The market price of the vaccine per animal for the respective years was obtained from Onderstepoort Biological Products, the sole manufacturer in South Africa of the three vaccines and the price was the same in all provinces. The cost of vaccinating sheep and goats increased from R2.33 per head in 2008 to R3.23 in 2010, while the costs of vaccinating cattle increased from R3.77 per head in 2008 to R5.01 in 2010 (Table 6.1). Overall, 133(88.6%) of the respondents vaccinated their livestock against RVF. Eighty-eight (66%) of the 133 respondents used their own funds to purchase the vaccine while 45 (33%), mainly black farmers were assisted by the state.

Cost of RVF vaccination – Eastern Cape

Although 43 of the 47 respondents (91.5%) in the Eastern Cape indicated that they vaccinated against RVF, only the 19 white commercial farmers used their own funds to purchase the vaccine. Of the 19 white commercial farmers, 12 (63.2%) indicated that they vaccinated all their livestock in 2010, while 7 vaccinated only part of their livestock herd (usually sheep and not cattle, or vice versa). The number of vaccinated animals increased from 2008 to 2010. The 24 black communal and small holder farmers vaccinated their entire herds as the cost and application of the vaccine was provided by the state.

The estimated total expenditure of R 312 361 was incurred for vaccination of 97 477 livestock herd by the 19 respondents who vaccinated their livestock (Table 6.1). Throughout the three outbreaks, sheep farmers incurred the majority of vaccine costs, from R40 076 in 2008 to R114 145 in 2010.

Table 6. 1: Costs of vaccination incurred by 19 Eastern Cape farmers

Animal	Year	Number of animals vaccinated	Cost/animal (R)	Total costs (current Rand)	Total costs (2014 Rand)
Sheep	2008	17 200	2.33	40 076	48 973
	2009	22 500	2.93	65 925	80 560
	2010	35 339	3.23	114 145	139 485
Cattle	2008	3 070	3.77	11 574	14 143
	2009	6 270	4.67	29 281	35 781
	2010	5 676	5.01	28 437	34 750
Goats	2009	3 500	2.93	10 255	12 532
	2010	3 922	3.23	12 668	15 480
Total		**97 477**		**312 361**	**381 705**

Source: Own estimation

Costs of RVF vaccination – Northern Cape

Thirty-two of 39 respondents in Northern Cape Province vaccinated their livestock against RVF and they did so only in 2010. Of the 32 respondents who vaccinated, 17 (53.1%) of white commercial farmers paid for their vaccine, while 46.9% of black communal and small-holder farmers received free vaccination from the provincial Department of Agriculture (not shown in tables). A total of 29 041 sheep, 569 cattle and 1 736 goats were vaccinated. The estimated total expenditure of R90 461 was incurred for vaccination of livestock by those 17 respondents who had to purchase their own vaccine (Table 6.2). Sheep farmers incurred the majority (91.3%) of costs, followed by those who kept goats and cattle at 5.6% and 3.2%, respectively.

Table 6.2: Cost of vaccination incurred by 17 Northern Cape farmers

Description	Year	Number of animals	Cost/animal (R)	Total cost (current Rand)	Total Costs (2014 Rand)
Sheep	2010	25 560	3.23	82 559	100 887
Cattle	2010	569	5.01	2 851	3 484
Goats	2010	1 564	3.23	5 052	6 173
TOTAL		**27 693**		**90 461**	**110 544**

Source: Own estimation

Cost of RVF vaccination – Free State

Of the 64 livestock farmers from Free State in the sample, 58 (91%) indicated that they vaccinated all their livestock against RVF. However, only six (10%) were white commercial farmers who bought their own vaccine while 52 (90%) were black communal and small holder farmers who received free vaccine from the provincial Department of Agriculture.

A total cost of R16 642 (R20 337 in 2014 Rand) was incurred by the 6 respondents who vaccinated their livestock and paid for their vaccine (Table 6.3). None of the 6 farmers vaccinated goats. Sheep farmers incurred the majority of costs (84%) where a total number of 660, 1 460 and 2 530 sheep were vaccinated in 2008, 2009 and 2010, respectively (Table 6.3).

Table 6.3: Cost of RVF vaccination incurred by 6 Free State farmers (current and 2024 Rand)

Description	Year	Number of animals	Cost/ animal (R)	Total costs (current Rand)	Total Cost (2014 Rand)
Sheep	2008	660	2.33	1 538	1 879
	2009	1 460	2.93	4 278	5 227
	2010	2 530	3.23	8 172	9 986
Cattle	2008	3	3.77	11	14
	2009	197	4.67	920	1 124
	2010	344	5.01	1 723	2 106
Total		**5 194**		**16 642**	**20 337**

Source: Own estimation

6.2.2 Control costs: $DC = ad.pd.8dd$

During the survey farmers were asked to indicate which control measures they applied to minimize animal losses to RVF. They also were asked to indicate the type and number of animals treated with control measures during the period of the three outbreaks. Of 150 respondents, 13 (9%) indicated that they tried to control the spread of the virus by using insecticidal dip to repel insects. Animals were dipped or sprayed generally once a week over a period of two months, which is approximately about 8 days of control. Control costs in the form of spraying or dipping animals with insecticide were estimated by multiplying the number of animals dipped by the cost of each dose applied. Drastic Deadline was the most commonly used dip product; hence estimations were made based on the use of that product. Expert opinion was obtained to estimate the cost of dipping or spraying per animal for the respective years.

Control costs incurred by Eastern Cape farmers

Of 47 respondents in the Eastern Cape, only five (11%) farmers in Chris Hani district indicated that they used dip to repel insects during the 2009 and 2010 outbreaks. An estimated cost of about R1.6 million (R1.9 million in 2014 Rand) was incurred for dipping a total of 31 580 animals (Table 6.4). Cattle farmers incurred the majority of costs R 905 600 (58%) due to the higher dipping costs of cattle, which are 10 times more than those of sheep.

Table 6.4: Control costs incurred by 5 Eastern Cape livestock farmers (in current and 2014 Rand)

Description	Year	Number of animals	Cost/animal (R)	Total cost for 8 days (current Rand)	Total Costs (2014 Rand)
Sheep	2009	1300	2.9	30 160	36 856
	2010	19 500	3	468 000	571 896
Cattle	2009	200	29	46 400	56 701
	2010	3 580	30	859 200	1 049 942
Goats	2009	3 500	2.9	81 200	99 226
	2010	3 500	3	84 000	102 648
TOTAL		**31 580**		**1 568 960**	**1 917 269**

Source: Own estimation

Control costs incurred by Northern Cape farmers

Of 39 respondents from the Northern Cape, only four (10%) in Pixley Ka Seme district indicated that they dipped their animals to repel insects and they did so only in 2010. A total cost of about R340 000 (R415 000 in 2014 Rand) was incurred by the four respondents who dipped a total number of 11 004 animals to repel insects (Table 6.5). Respondents who kept sheep incurred most of the costs (72%).

Table 6. 5: Control costs incurred by 4 Northern Cape farmers in the survey (in current and 2014 Rand)

Description	Year	Number of animals	Cost/animal (R)	Total costs 8 days (current Rand)	Total Costs (2014 Rand)
Sheep	2010	10 200	3	244 800	299 146
Cattle	2010	350	30	84 000	102 648
Goats	2010	454	3	10 896	13 315
TOTAL		**11 004**		**339 696**	**415 109**

Source: Own estimation

Control costs incurred by Free State farmers

Only four (6.25%) of the 64 respondents in the Free State dipped their animals to repel insects and these were farmers in Lejweleputswa district. A total of 1 702 animals were dipped during the 2009 and 2010 outbreaks at an estimated cost of about R64 570 (R78 904 in 2014 Rand) (Table 6.6). Respondents who kept sheep incurred the majority R36 502 (57%) of costs, followed by those who kept cattle R 26 552 (41%) and those who kept goats at R1 516 (2%).

Table 6.6: Control costs incurred by 4 Free State farmers (in current and 2014 Rand)

Description	Year	Number of animals	Cost/animal (R)	Total costs for 8 days (R)	Total (2014 Rand)
Sheep	2009	63	2.9	1 462	1 786
	2010	1 460	3	35 040	42 819
Cattle	2009	101	29	23 432	28 634
	2010	13	30	3 120	3 813
Goats	2009	55	2.9	1 276	1 559
	2010	10	30	240	293
TOTAL		**1 702**		**64 570**	**78 904**

Source: Own estimation

6.2.3 Treatment costs: $\mathbf{TC = atab\,(pab)}$

Of 150 respondents, just eight (5.33%) from the Northern Cape and Free State provinces indicated that they used antibiotics (LA Terramycin) to boost the immune systems of their animals. During the survey farmers were asked to indicate the type and number of animals treated with antibiotics. The market price of the dose per animal of the LA Terramycin was obtained from Pfizer, the vaccine manufacturer. The price was the same in all the provinces. To estimate the treatment costs, the number of animals treated with Terramycin was multiplied by the cost per dose per animal treated.

Treatment Costs – Northern Cape

Of 39 respondents in Northern Cape, only one (3%) reported the use of Terramycin to boost the immune system of livestock. An estimated cost of R6 000 (R7 332 in 2014 Rand) was incurred on that farm from treatment of 300 sheep, 40 cattle and 50 goats (Table 6.7).

Table 6.7: Estimated treatment costs incurred by 1 Northern Cape farmer (in current and 2014 Rand)

Description	Year	Number of animals	Cost/animal (R)	Total costs (current Rand)	Total costs (2014 Rand)
Sheep	2010	300	8	2 400	2 933
Cattle	2010	40	80	3 200	3 910
Goats	2010	50	8	400	489
TOTAL		**390**		**6 000**	**7 332**

Source: Own estimation

Treatment costs – Free State

Of 64 respondents, only seven (11%) in Lejweleputswa indicated that they treated their livestock with Terramycin during the 2009 and 2010 outbreaks. A total of 276 were treated with Terramycin at an estimated total cost of about R12 419 (R15 175 in 2014 Rand) (Table 6.8).

Table 6.8: Costs of treatment incurred by 7 Free State farmers (in current and 2014 Rand)

Description	Year	Number of animals	Cost/animal (R)	Total costs (current Rand)	Total costs (2014 Rand)
Sheep	2009	63	6.5	410	**501**
	2010	9	8	72	**88**
Cattle	2009	78	65	5 070	**6 196**
	2010	82	80	6 560	**8 016**
Goats	2009	30	6.5	195	**238**
	2010	14	8	112	**137**
TOTAL		**276**		**12 419**	**15 175**

Source: Own estimation

6.2 ESTIMATION OF EXPENDITURES AT DISTRICT LEVEL

Expenditures at district level were estimated by multiplying the number of animals at district level by the percentage of animals treated by the respondents at their own cost. The number of animals at district level was obtained from DAFF. During the survey farmers indicated that they used dip as an insect repellent for a period of eight days. For the purpose of this analysis, it was assumed that the average livestock producer dipped only four times. Expenditure costs are aggregated at district level using the formula;

$$for\ each\ type\ of\ disease\ treatment\ T\ =\ p\ it\ vt$$

$$for\ each\ type\ of\ disease\ prevention\ \ P\ =\ p\ ip\ vp$$

6.2.1 Estimation of expenditures by farmers in the two districts of the Eastern Cape Province

Farmers in the Chris Hani district reported that they vaccinated and dipped animals to repel insects in order to minimise animal losses to RVF. Farmers in Cacadu district mentioned vaccination as the only measure applied to minimise losses to RVF; hence control costs at the district level were not estimated. During the 2008-2010 RVF outbreaks, farmers in the two districts of Eastern Cape incurred total expenditure of about R29.2 million

(R36.4 million in 2014 Rand). Farmers who kept sheep incurred about R13 765 689(47%) of expenditures while those who kept cattle spent about R 13 577 165 (46%). About R9.7 million of expenses were spent on vaccines. In addition to vaccine costs, farmers in Chris Hani district also spent about R19.4million on control measures in the form of dipping activities that were applied to repel insects (Table 6.9). Since the 2008 outbreaks were on isolated farms, farmers in the survey indicated that they did not apply any control measures to minimize animal losses to RVF; hence no estimation of control costs was made for 2008.

Table 6.9: Estimation of expenditures incurred by farmers in Chris Hani and Cacadu districts of the Eastern Cape Province (in current and 2014 Rand)

Description	Year	Sheep	Cattle	Goats	Total (R)	Total (2014 Rand)
Vaccine Costs in Chris Hani District (R)	2008	1110 110	302 828	0	**1 412 938**	**2 039 152**
	2009	1 809 421	751 041	147 729	**2 708 191**	**3 551 792**
	2010	2 885 432	701 820	166 380	**3 753 632**	**4 589 566**
Total Vaccine Costs in Chris Hani District		**5 804 963**	**1 755 689**	**314 109**	**7 874 761**	**10 180 510**
Vaccine Costs in Cacadu District (R)	**2010**	**1 255 257**	**284 582**	**367 059**	**1 906 898**	**2 331 564**
2 district total vaccine costs		**7 060 220**	**2 040 271**	**681 168**	**9 781 659**	**12 512 074**
Dipping Costs in Chris Hani District (R)	2009	413 896	595 069	584 864	**1 593 829**	**2 090 307**
	2010	6 291 573	10 941 825	599 295	**17 832 693**	**21 804 034**
Total Control costs		**6 705 469**	**11 536 894**	**1 184 159**	**19 426 522**	**23 894 340**
Total Costs		**13 765 689**	**13 577 165**	**1 865 327**	**29 208 181**	**36 406 414**

Source: Own estimation

6.2.2 Estimation of expenditures by farmers in the two districts of the Northern Cape Province

Interviewed farmers in the Frances Baard district were all black and the state provided them with free RVF vaccine. These farmers did not apply any additional control measure to minimise animal losses to RVF. Hence, the reported estimated expenditures are only those of farmers in Pixley Ka Seme district. During the survey, it was established that farmers in the Northern Cape Province became concerned about RVF in 2010. Both vaccine and control expenses (R14.1million; R17.7 million in 2014 Rand) were incurred during the 2010 outbreaks (Table 6.10). The majority (95%) of expenses (R13.3m) were incurred by farmers who kept sheep followed by farmers who kept goats at 3% (R413 468) and those who kept cattle at 2% (R309 507).

Table 6.10: Estimation of expenditures incurred by farmers in Pixley Ka Seme district of the Northern Cape Province(in current and 2014 Rand)

Description	**Year**	**Sheep**	**Cattle**	**Goats**	**Total (R)**	**Total (2014 Rand)**
Vaccine Costs (R) *P*	2010	5 599 613	29 931	190 846	5 820 390	7 116 591
Dipping costs (R) *T*	2010	5 921 457	234 341	109 589	6 265 387	7 660 689
Treatment costs (R) *T*	2010	1 812 261	45 235	113 033	1 970 526	2 409 362
Total costs (R)	**2010**	**13 333 331**	**309 507**	**413 468**	**14 056 303**	**17 186 642**

Source: Own estimation

6.2.3 Estimation of expenditures by farmers in the two districts of the Free State Province

All interviewed farmers in Fezile Dabi district were black and the state provided them with free vaccine. These farmers did not vaccinate for RVF before 2010 and they also did not apply any additional control measures to minimise animal losses to RVF. Hence, the reported estimated expenditures are only those of farmers in Lejweleputswa district. During the 2008-2010 RVF outbreaks, farmers in Lejweleputswa district incurred expenditures of almost R8 million (R 10 million in 2014 Rand) in attempts to reduce animal losses against RVF Table 6.11). The majority (75%) was spent on control measures in the form of antibiotics and dip to repel insects while 21% (R1 .7 million) was spent on vaccines. During this period no goats were vaccinated, hence the estimated cost is zero. The majority (73%) of vaccine costs (R1.2 million) were incurred by farmers who kept sheep followed by farmers who kept cattle at 27% (R0.45 million). About 50% of these expenses were incurred during 2010 outbreaks.

Table 6.11: Estimation of expenditures incurred by farmers in Lejweleputswa district of the Free State Province (in current and 2014 Rand)

Description	Year	Sheep	Cattle	Goats	Total (R)	Total (2014 Rand)
Vaccine Costs (R)	2008	138 185	1 941	0	140 126	202 230
	2009	382 954	157 452	0	540 406	708 742
	2010	720 572	293 196	0	1 013 768	1 239 534
Total vaccine costs		**1 241 711**	**452 589**	**0**	**1 694 300**	**2 150 506**
Control Costs (R)	2009	65 422	2 005 140	193 757	2 264 319	2 969 654
	2010	1 544 858	265 391	34 642	1 844 891	2 255 748
Total control costs		**1 610 280**	**2 270 531**	**228 399**	**4 149 210**	**5 225 403**
Treatment Costs (R)	2009	36 659	867 707	59 219	963 585	1 263 742
	2010	6 349	1 116 003	32 333	1 154 685	1 411 833
Total treatment costs		**43 008**	**1 983 710**	**91 552**	**2 118 270**	**2 675 575**
Total Costs(R)($P + T$)		**2 894 999**	**4 706 830**	**319 951**	**7 961 780**	**10 051 484**

Source: Own estimation

6.3 ESTIMATION OF ANIMAL PRODUCTION LOSSES ($Pi.j$)

Animal losses incurred by livestock farmers were in the form of mortalities and abortions, as well as milk production losses incurred by dairy farmers in Chris Hani district of the Eastern Cape. Revenue losses were estimated by multiplying the number of affected animals by the market price. Prices for the respective types of animal losses were obtained by consulting industry experts and these were in accordance with the reported prices by farmers during the survey. Milk prices were obtained from the Abstract of Agricultural Statistics published in 2014 (DAFF, 2014) while the value of an aborted dairy calf was obtained by consulting experts from the Milk Producers Organisation.

6.3.1 Animal mortalities and abortions – 2008

Respondents to the survey reported minimal animal losses in 2008: only the deaths of eight non-pregnant cows and two cattle abortions in Lejweleputswa district in Free State, and 20 cattle abortions in Chris Hani district of the Eastern Cape (Table 6.12) were reported. Farmers in the two districts of the Northern Cape did not report any animal losses to RVF in 2008; hence the estimated animal losses there were zero.

Table 6.12: Three Province summary – Number of animal losses from RVF, 2008

Province	Description	Non-pregnant	Abortions
Eastern Cape	Cattle	0	20
	Total	**0**	**20**
Northern Cape	Cattle	0	0
	Total	0	0
Free State	Cattle	8	2
	Total	**8**	**2**
3 Province Total		**8**	**22**

Source: Survey results

In addition to the eight deaths and 22 abortions in the two provinces, dairy farmers in Chris Hani district of the Eastern Cape reported reduction in milk output due to the ten days withdrawal period after vaccination. The total estimated gross losses from mortalities, abortions and reduced milk production among livestock farmers in the survey in 2008 is R296 000 (R427 000 in 2014 Rand) (Table 6.13).

Table 6.13: Three Province summary – Gross losses from RVF, 2008 (R'000 in current and 2014 Rand)

Province	Description	Non-pregnant	Abortions	Milk	Total (R)	Total (2014 Rand)
Eastern Cape	Sheep	0	0	0	0	0
	Cattle	0	7	250	257	371
	Goats	0	0	0	0	0
	Total	**0**	**7**	**250**	**257**	**371**
Northern Cape	Sheep	0	0	0	0	0
	Cattle	0	0	0	0	0
	Goats	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**
Free State	Sheep	0	0	0	0	0
	Cattle	38	0.7	0	39	56
	Goats	0	0	0	0	0
	Total	**38**	**0.7**	**0**	**39**	**56**
Total for three provinces		**38**	**8**	**250**	**296**	**427**

Source: Own estimation

6.3.2 Animal mortalities and abortions – 2009

Losses due to RVF became more pronounced on surveyed farms in 2009. During that year, not only cattle were affected, but also sheep. A total of 117 ewes were reported to have died and 238 ewes aborted in the Eastern Cape (Table 6.14). Cattle farmers (mainly dairy farmers) reported both mortalities and abortions. No animal losses were reported by respondents from both districts of the Northern Cape. In the survey only farmers in Chris Hani district in the Eastern Cape and farmers in Lejweleputswa district in the Free State reported animal losses to 2009 RVF outbreaks.

Table 6.14: Three-province summary – Number of animal losses from RVF, 2009

Province	Description	Pregnant ewes/cows	Non-pregnant ewes/cows	Abortions
Eastern Cape	Sheep	0	0	238
	Cattle	9	9	17
	Total	**9**	**9**	**255**
Northern Cape	Sheep	0	0	0
	Cattle	0	0	0
	Total	**0**	**0**	**0**
Free State	Sheep	100	17	0
	Cattle	14	9	43
	Total	**114**	**26**	**43**
Total for three provinces		**123**	**35**	**298**

Source: Survey results

There were no reported losses on surveyed livestock farms in the Northern Cape in 2009 from RVF. Financial losses reported by livestock farmers in the Eastern Cape and Free State totalled R694 000 and R305 000 respectively (Table 6.15).

Table 6.15: Three Province summary – Gross losses from RVF, 2009 (R'000 in current and 2014 Rand)

Province	Description	Pregnant ewes/cows	Non-pregnant	Abortions	Total Rand	Total (2014 Rand)
Eastern Cape	Sheep	0	0	36	36	47
	Cattle	90	43	6	659	864
	Total	**90**	**43**	**42**	**694**	**910**
Northern Cape	Sheep	0	0	0	0	0
	Cattle	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**
Free State	Sheep	120	14	0	134	176
	Cattle	91	54	16	161	211
	Total	**211**	**68**	**26**	**305**	**400**
Total for three provinces		**301**	**111**	**69**	**999**	**1 310**

Source: Own estimation

Animal mortalities and abortions – 2010

RVF imposed major losses on livestock producers in the study area in 2010. Only 32 farms (21.3%) in the survey reported losses, but the losses on those farms were extensive. More than one thousand pregnant ewes/cows and 41 non-pregnant ewes/cows died on the 32 farms (Table 6.16). In addition, 3 714 suckling lambs/calves died and 6 460 abortions were reported (mostly sheep). In the Eastern Cape losses were incurred on livestock farms in both districts while in the Northern Cape and Free State provinces only farmers in Pixley Ka Seme and Lejweleputswa reported animal losses due to RVF. All respondents from Frances Baard and Fezile Dabi districts were black communal farmers who kept only a small number of cattle, the animal species least affected by the virus. The reported animal losses during the 2010 outbreak were experienced in all three types of livestock.

Table 6.16: Three Province summary – Number of animal losses from RVF, 2010

Province	Description	Pregnant ewes/cows	Non-pregnant	Suckling animals	Abortions
Eastern Cape	Sheep	50	0	1 600	1 900
	Cattle	7	1	0	10
	Goats	0	22	0	0
	Total	**57**	**23**	**1 600**	**1 910**
Northern Cape	Sheep	951	8	2 114	4 246
	Cattle	0	0	0	0
	Goats	2	0	0	118
	Total	**953**	**8**	**2 114**	**4 364**
Free State	Sheep	2	8	0	161
	Cattle	13	1	0	25
	Goats	2	0	0	0
	Total	**17**	**9**	**0**	**186**
Total for three provinces		**1 028**	**40**	**3 714**	**6 460**

Source: Survey Results

The estimated value of animal losses incurred by the 32 respondents who were affected by the 2010 outbreaks was R4.4 million (R5.4 million in 2014 Rand) (Table 6.17). Included in the financial loss was an R880 000 reduction in the value of milk produced by dairy cows in the Eastern Cape. Cattle farmers in the Northern Cape and Free State provinces mainly kept beef cattle and none of them reported milk yield losses. During the 2010 outbreaks, about three-quarters of the total losses were incurred by sheep farmers (Table 6.17).

Table 6. 17 : Three Province summary – Gross losses from RVF, 2010 (R'000 current and 2014 Rand)

Province	Description	Pregnant ewes/cows	Non-pregnant	Suckling animals	Abortions	Milk	Total Rand	Total (2014 Rand)
Eastern Cape	Sheep	60	0	480	285		825	1 009
	Cattle	70	7	0	4	880	961	1 175
	Goats	0	0	0	68		14	17
	Total	**130**	**21**	**480**	**289**	**880**	**1 800**	**2 201**
Northern Cape	Sheep	1141	7	634	637		2 419	2 958
	Cattle	8	7	0	0		14	14
	Goats	2	0	0	30		31	38
	Total	**1 150**	**13**	**634**	**666**		**2 464**	**3 013**
Free State	Sheep	2	7	0	24		33	40
	Cattle	98	7	0	10		114	139
	Goats	2	0	0	0		2	2
	Total	**102**	**13**	**0**	**34**		**149**	**182**
Total for three provinces		**1 382**	**47**	**1 114**	**990**	**880**	**4 413**	**5 396**

Source: Own estimation

ESTIMATION OF ANIMAL PRODUCTION LOSSES AT DISTRICT LEVEL ($L + R$)

Animal losses at district level were estimated by employing the formula;

$(L = R) = p\ id\ ie\ vl$ as defined in the methodology where,

p: $size\ of\ livestock\ population\ at\ risk$

id: $annual\ incidence\ of\ disease\ as\ a\ proportion\ of\ the\ population\ at\ risk$

ie: $incidence\ of\ disease\ effects\ as\ a\ proportion\ of\ the\ affected\ population$

e: $magnitude\ of\ physical\ disease\ effects\ (\ e.g.\ R/\ litres\ of\ milk\ lost)$

vl: $unit\ value\ of\ lost\ output\ (\ e,g\ R/\ abortions)$

6.3.3 Estimation of animal production losses in the two districts of the Eastern Cape Province

Due to the 2008–2010 RVF outbreaks, farmers in the two districts of Chris Hani and Cacadu districts of Eastern Cape incurred animal losses of about R42.3 million (R51.8 million in 2014 Rand). About 99.9% was incurred by sheep farmers (Table 6.18). The reported animal losses are in the form of mortalities and abortions. The reported mortalities were dominated by death of suckling lambs and neo-natal animals.

Farmers in Chris Hani district incurred revenue losses of about R27.8 million and R 13.9million to mortalities and abortions respectively. Major mortalities that resulted in revenue losses of R27.8 million were incurred by farmers who kept sheep and (100%) of these losses was incurred during the 2010 outbreaks. Major losses to abortions, R13.9 million (99.9%) were incurred during the 2010 outbreaks where 99.9% was incurred by farmers who kept sheep.

Farmers in Cacadu district reported animal losses in the form of abortions that were incurred during 2010. No mortalities were reported by farmers in Cacadu district. Farmers who kept sheep incurred losses of about R602 499 due to abortions.

Table 6.18: Estimation of animal production losses in the two districts of the Eastern Cape Province (in current and 2014 Rand)

Description	Period	Sheep (R)	Cattle (R)	Goats (R)	Total (R)	Total (2014 Rand)
Chris Hani (Mortalities)	2008	0	0	0	0	0
	2009	0	1 613	0	1 613	2 115
	2010	27 792 351	514	1 480	27 794 345	33 984 146
Total (Mortalities)		**27 792 351**	**2 127**	**1 480**	**27 795 958**	**33 986 261**
Chris Hani (Abortions)	2008	0	419	0	419	605
	2009	45 731	279	0	46 010	60 342
	2010	13 894 480	60	0	13 894 540	16 988 854
Total (Abortions)		**13 940 211**	**758**	**0**	**13 940 969**	**17 049 801**
Cacadu (Abortions)	2010	602 499	0	0	602 499	736 676
Total (Abortions)		**602 499**	**0**	**0**	**602 499**	**736 676**
2 District Total		**42 335 061**	**2 885**	**1 480**	**42 339 426**	**51 754 738**

Source: Own estimation

6.3.4 Estimation of animal production losses in the two districts of the Free State Province

During the 2008–2010 RVF outbreaks, farmers in the Lejweleputswa district of the Free State Province incurred estimated revenue losses of about R479 053 in the form of abortions and mortalities (Table 6.19). About R449 630 (94%) of the animal losses were incurred by farmers who kept sheep. The majority (98%) of mortality losses (R433 379) were incurred during the 2009 outbreaks. Farmers in Fezile Dabi district did not report any animal losses.

Table 6.19: Estimation of animal production losses in the two districts of Free State Province (in current and 2014 Rand)

Description	Period	Sheep (R)	Cattle (R)	Goats (R)	Total (R)	Total (2014 Rand)
Lejweleputswa (Mortalities)	2008	0	931	0	931	1 344
	2009	424 966	8 413	0	433 379	568 377
	2010	157	6 243	24	6 424	7 855
Total Mortalities		**425 123**	**15 587**	**24**	**440 734**	**577 575**
Lejweleputswa (Abortions)	2008	0	1	0	1	1
	2009	0	11 444	0	11 444	15 009
	2010	24 507	2 367	0	26 874	32 859
Total Abortions		**24 507**	**13 812**	**0**	**38 319**	**47 869**
District Total		**449 630**	**29 399**	**24**	**479 053**	**625 444**

Source: Own estimation

6.3.5 Estimation of animal production losses in the two districts of the Northern Cape

Interviewed farmers from the two districts of the Northern Cape reported losses only during the 2010 outbreaks. During these outbreaks, farmers incurred estimated revenue losses of about R 40.7 million (R49.7 million in 2014 Rand) (Table 6.20). Most of the losses were as a result of abortions (R38.2 million) in sheep. Farmers in Frances Baard did not report any losses.

Table 6.20: Estimation of animal production losses in Pixley Ka Seme district of Northern Cape Province (in current and 2014 Rand)

Description	Period	Sheep (R)	Cattle (R)	Goats (R)	Total (R)	Total (2014 Rand)
Mortalities	2010	2 466 091	0	3	2 466 094	3 015 293
Abortions	2010	38 045 718	0	164 897	38 210 615	46 720 119
Total		**40 511 809**	**0**	**164 900**	**40 676 709**	**49 735 412**
District Total		**40 511 809**	**0**	**164 900**	**40 676 709**	**49 735 412**

Source: Own estimation

6.4 ESTIMATION OF ECONOMIC LOSSES AT PROVINCIAL LEVEL

Since the main emphasis of the survey was to collect data on extra costs incurred because of production losses as a result of the RVF outbreaks, the survey was deliberately conducted in two districts of the respective provinces where it was known that a high rate of disease incidence was incurred. No attempt was made to randomly select districts within provinces.

While this method facilitated the collection of cost and loss data, it does not make it easy to estimate the overall financial impacts on the livestock industry at provincial the level.

Interviews with provincial animal health practitioners revealed that, the state provided free vaccine to black communal and small-holder farmers only in districts where there were reported outbreaks. It was also established that even in the affected districts not all farmers vaccinated their livestock and some vaccinated only a proportion of their livestock. It therefore seemed unreasonable to assume that farmers in areas that were not affected by the outbreaks fully employed prevention and control measures to minimise losses to RVF. There were no substantial data to suggest otherwise; hence, this study does not estimate expenditures incurred at provincial level.

According to Pienaar and Thompson (2013), there were 484 reported outbreaks of RVF in all of South Africa in 2010 with an average death loss of just less than 20 animals (sheep, cattle and goats) per outbreak. In the survey conducted in this study, 32 farmers reported an average of about 150 animal mortalities on their farms in 2010.

During the 2008–2010 outbreaks, the ARC biotechnology laboratory at OVI received several samples from the three provinces to test for RVF Eighty five (85), 213 and 351 RVF diagnostics were positive in Eastern Cape, Northern Cape and Free State provinces respectively (Table 6.21). These officially reported diagnostics provide a way to make reasonable estimates of the total financial impact of the disease on the provincial livestock economy.

No data are presently available on the average number of farms that are included in each of the diagnostic results provided by ARC–OVI biotechnology lab. To estimate provincial economic losses, it is assumed that all farms that reported losses in the same town constitute a single outbreak.

In the survey, 47 farms reported impacts of the disease during the 2008-2010 outbreaks. The 15 farms in the survey that reported RVF in the Eastern Cape were in three different towns, while 14 farms that were affected in the Northern Cape also came from three different towns. In the Free State, the 18 farms that were affected came from four different towns. Using the foregoing assumption, the scaling factor to obtain an estimate of losses to the provincial livestock economy would be 28 (85/3), 71(213/3) and 88(351/4) for the Eastern Cape, Northern Cape and Free State respectively (Table 6.21).

Table 6.21: Estimation of animal losses to 2008–2010 RVF outbreaks in the three provinces

Province	Positive RVF diagnostics	Animal losses from survey (R'000)	Scaling up factor	Provincial losses (R'000)
Eastern Cape	85	2 751	28.33	77 936
Northern Cape	213	2 464	71	174 944
Free State	351	483	87.75	42 383
Total for three provinces		**5 698**		**295 263**

Source: Own estimation

Revenue losses to the 2008–2010 RVF outbreaks in the three provinces are estimated at R295.2 million (Table 6.21). Although farmers from the Northern Cape did not report any losses during the 2008–2009 outbreaks, reported animal losses in 2010 outbreaks are estimated at R174.9 million which is (59%) of the total estimated losses to 2008–2010 RVF outbreaks in the three provinces. The estimated losses in Northern Cape Province are two and four times higher than the total 2008–2010 losses in e Eastern Cape and Free State province respectively.

Estimated provincial animal losses were disaggregated according to animal type and period of outbreaks (Table 6.22). Although there were isolated outbreaks in 2008, they intensified during 2009, especially in the Free State province. Farmers from the Eastern Cape and Northern Cape provinces incurred major animal losses in the 2010 outbreaks.

However, the survey revealed that farmers from the Free State incurred major losses during the 2009 outbreaks. Following the 2009 RVF outbreaks in Free State, farmers intensified their vaccination programme against RVF. In addition the Provincial Department of Agriculture also provided free vaccines to the communal and small-holder farmers in the perceived high-risk areas.

The survey revealed that farmers who kept sheep were the most affected by the outbreaks with estimated revenue losses of about R 210.7 million (Table 6.22). Farmers from the Northern Cape incurred most of the losses estimated at R171.7 million (81%), followed by Eastern Cape and Free State farmers at R24.3 million (12%) and R14.6 million (7%), respectively.

Compared to the Northern Cape and Free State provinces, dairy farmers in the Eastern Cape incurred more losses in milk production due to the ten days rest period after vaccination. Inclusive of milk losses estimated at R32 million, revenue losses incurred by cattle farmers in the Eastern Cape are estimated at R53.1million (65%), followed by those in Free State and Northern Cape at R27.5million (33%) and R994 000(1%), respectively (Table 6.22).

Estimated revenue losses of R 2.7 million were incurred by farmers who kept goats and these losses were mainly incurred during the 2010 outbreaks. Farmers from the Northern Cape incurred most of the losses estimated at R2.2 million (80%) followed by the Eastern Cape and Free State at R396 000 (14%) and R175 000 (6%), respectively (Table 6.22).

Table 6.22: Three Province summary – Gross losses from 2008–2010 RVF outbreaks in (R'000 current and 2014 Rand)

Province	Period	Sheep	Cattle	Goats	Total	Total (2014 Rand)
Eastern Cape	2008	0	7 278	0	7 278	10 504
	2009	1 020	18 663	0	19 683	25 814
	2010	23 364	27 215	396	50 975	62 327
Total		**24 384**	**53 156**	**396**	**77 936**	**98 645**
Northern Cape	2008	0	0	0	0	0
	2009	0	0	0	0	0
	2010	171 749	994	2 201	174 944	213 904
Total		**171 749**	**994**	**2 201**	**174 944**	**213 904**
Free State	2008	0	3 428	0	3 428	4 947
	2009	11 714	14 146	0	25 860	33 915
	2010	2 924	9 995	175	13 094	16 010
Total		**14 638**	**27 569**	**175**	**42 383**	**54 873**
Total for three provinces		**210 771**	**81 719**	**2 772**	**295 263**	**367 422**

Source: Own estimation

6.5 OVERALL IMPACT ON LIVESTOCK NUMBERS

To understand the overall impact of RVF outbreaks on livestock numbers, farmers were asked to indicate their herd size, offspring rate, mortality rate and weaning rate before, during and after the outbreaks. This was checked against the average performance parameters reported by famers against the reported provincial livestock numbers.

6.5.1 Impact of RVF on livestock numbers – Eastern Cape

The impact of RVF on livestock numbers is depicted in Table 6.23. During the intense episodes of RVF outbreaks (2009–2010), the average lambing rate of sheep declined from 115% in 2008 to 104% in 2009. In addition, the mortality rate increased from 5% in 2008 to 11% in 2010 while the weaning rate declined from 92% to 84% during the same period. Consequently, the average herd size decreased from 6 263 in 2008 to 5 995 in 2010 while the provincial sheep numbers declined from 7.5 million to 7.3 million during the same period.

The calving rate of cattle declined from 75% in 2008 to 68% in 2010 while the mortality rate increased from 26% in 2008 to 29% in 2009 and it normalised again in 2010 (Table 6.23). While the impact of these production rates did not show any change in average herd size, the weaning rate declined from 95% in 2008 to 80% in 2009 and provincial cattle numbers also show a slight decline from 3.2 million in 2008 to 3.1 million in 2010.

Goat numbers also declined from a lambing rate of 80% in 2008 to 65% in 2010 (Table 6.23). Consequently, the average herd size showed a continuous decline while provincial numbers also showed a slight decline from 2.4 million goats in 2008 to 2.3 million in 2010.

Table 6.23: Impact of RVF on livestock numbers in Eastern Cape

Description	Period	Provincial numbers[1]	Herd size	Offspring rate (%)	Mortality rate (%)	Weaning rate (%)
Sheep	2008	7 571 170	6 263	115	5	92
	2009	7 589 870	6 256	105	6	84
	2010	7 316 381	5 995	104	11	84
	2011	7 302 429	5 545	113	6	92
	2012	7 084 656	6 123	121	5	93
Cattle	2008	3 273 978	270	75	26	95
	2009	3 235 188	372	60	29	80
	2010	3 146 250	423	68	26	95
	2011	3 221 407	623	75	26	98
	2012	3 267 217	819	75	26	99
Goats	2008	2 428 176	78	80	33	99
	2009	2 385 218	76	80	33	99
	2010	2 355 392	68	65	35	94
	2011	2 328 371	42	76	33	99
	2012	2 314 377	42	80	33	98

Source: Own estimation

6.5.2 Impact of RVF on livestock numbers – Northern Cape

From the survey, it was observed that few goat farmers were affected by the outbreak while none of the cattle farmers in Northern Cape were affected. Consequently, the main reported impact of RVF on livestock numbers was on sheep (Table 6.24). The lambing rate declined from 117% in 2008 to 89% in 2010, then improved in 2011 and normalised again in 2012. The mortality rate increased from 8% in 2008 to 13% in 2010, improved in 2011 and normalised to

[1] Livestock numbers obtained from Abstract of Agricultural Statistics, 2014

8% in 2012, while the weaning rate declined from 96% in 2008 to 82% in 2010 and improved again in 2011. Farmers reported large numbers of mortalities in suckling lambs. Consequently, the average mean herd size declined from 4 207 in 2008 to 4 118 and continued to decline in 2011, but improved in 2012. This impact also was felt at the provincial level where sheep numbers declined from 6.2 million in 2008 to 6.1 million in 2010 and continued to decline up to 2012 as the farmers were building the replacement stock.

Table 6.24: Impact of RVF on sheep numbers in the Northern Cape

Average means– Northern Cape						
Description	**Period**	**Provincial numbers[2]**	**Herd size**	**Offspring rate (%)**	**Mortality rate (%)**	**Weaning rate (%)**
Sheep	2008	6 204 217	4 207	117	8	96
	2009	6 214 617	4 230	115	8	94
	2010	6 119 201	4 118	89	13	82
	2011	6 054 733	4 018	110	9	98
	2012	6 082 972	4 082	117	8	103

Source: Own estimation

6.5.3 Impact of RVF on livestock numbers – Free State

The lambing rate of sheep declined from 125% in 2008 to 120% in 2009 and continued to decline to 123% in 2010 (Table 6.25). During the same period, the mortality rate increased from 2% to 3% while the weaning rate declined from 98% to 97%. While at the farm level, the mean herd size showed an increase, at the provincial level sheep numbers declined from 4.9 million in 2008 to 4.8 million in 2010 and continued to decline to 4.7 million in 2012.

The calving rate declined from 91% in 2008 to 88% in 2010 while during the same period the weaning rate declined from 99% to 98% in 2010 (Table 6.25).

During the same period, the mean herd size declined from 1 200 to 1 185 and continued to decline to 1 170 in 2011. At the provincial level, cattle numbers declined from 4.9 million to 4.8 million in 2010. Cattle losses to livestock were reported mainly in 2008 and 2009 and these were mainly incurred by communal farmers, hence very little impact is shown on average mean herd size and provincial numbers.

[2] Livestock numbers obtained from Abstract of Agricultural Statistics,2014

Table 6.25: Impact of RVF on livestock numbers in Free State

Average means– Free State						
Description	**Period**	**Provincial numbers[3]**	**Herd size**	**Offspring rate (%)**	**Mortality rate (%)**	**Weaning rate (%)**
Sheep	2008	4 945 228	600	125	2	98
	2009	4 886 255	886	120	3	98
	2010	4 875 111	883	123	3	97
	2011	4 880 030	900	125	3	98
	2012	4 767 750	900	125	3	99
Cattle	2008	2 300 764	1 200	91	3	99
	2009	2 392 894	1 196	90	3	99
	2010	2 252 289	1 185	88	3	98
	2011	2 348 420	1 170	90	3	99
	2012	2 305 989	1 200	90	3	99

Source Own estimation

6.6 ESTIMATING THE VALUE OF VACCINATION

The losses reported by farmers in the survey occurred despite the relatively high rate of vaccinations against the disease. There is no way to tell definitively from the survey results why the mortalities and abortions were so high. Some livestock farmers speculated that using the same needles in numerous animals could have helped to spread the disease among animals in the herd. Some speculated that the vaccinations might have been administered at the wrong time. Others speculated about the efficacy of the vaccine under field conditions. Given the set of speculations about the high rate of abortions and mortalities, the study compared the average revenue losses incurred by farmers who were already vaccinating against RVF before 2010 with those of farmers who only started vaccination in 2010 (Table 6.26).

The calculation of animal losses does not only provide the economic cost of the disease but it also helps to estimate the amount of losses that could be avoided if the disease has spread to other farms (Dijkhuizen, Huirne and Jalvingh, 1995). To estimate the value of vaccination, this study then assumes that farmers who were already vaccinating prior to 2010 followed the correct vaccination protocols and those who vaccinated only in 2010 did not. Average revenue losses incurred by farmers who started vaccinating only during the 2010 outbreaks are R50 726, which is double the average losses of R24 377 estimated to have been incurred by

[3] Livestock numbers obtained from Abstract of Agricultural Statistics,2014

farmers who started vaccinations prior to 2010. Using a Chi-square test, the expected average revenue losses of not following correct vaccination protocols were estimated at R50 069 while the losses of farmers who followed the correct vaccination protocols were estimated at R25 035. Despite the fact that this study could not determine a reliable estimate of the value of vaccination against RVF, this observation suggests that there is value in vaccination if farmers follow the correct vaccination protocols.

Table 6. 26: Comparison of revenue losses with vaccine protocols

Description	Farmers who vaccinated only in 2010	Farmers who vaccinated before 2010
Actual revenue lost(R)	50 726	24 377
Expected revenue loss (R)	50 069	25 035

Source: Own estimation

6.7 SUMMARY

The financial impact of the RVF outbreaks on the South African livestock industry consist of two parts: expenditure incurred by livestock farmers for prevention, control and treatment; and mortalities, abortions and losses of production. A total of R50.3 million was spent by farmers on prevention, control and treatment. These amounts are based on the expenses reported by livestock farmers in the survey. The vaccination expenses of those who obtained state assistance are not included in this total. Since data were not available on the extent of extra expenses for livestock farmers outside the survey, no provincial estimates of these extra expenses were made.

Of the 150 livestock farmers participating in the survey, 47 experienced a large number of mortalities and abortions as a result of RVF, especially in 2010. The RVF diagnostic results obtained from ARC–OVI were used to upscale survey results to provincial level. In total, farmers in the three provinces incurred revenue losses of about R 295.3 million as a result of mortalities and abortions, and the milk production losses incurred by Eastern Cape dairy farmers. The RVF outbreaks, especially the 2010 outbreaks, compromised the livestock performance parameters during this period, with declines in herd size, offspring rate, and weaning rate being observed as well as an increase in mortality rate.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

This chapter presents the conclusions of the study and the follow-on recommendations. A brief summary of the study is outlined, after which the conclusions are discussed. Then specific recommendations for policy-makers as well as cross-cutting recommendations for researchers in public and private institutions are outlined. Limitations of the study are also highlighted.

7.2 SUMMARY OF THE STUDY

Livestock farming plays an important role as a source of livelihood for many rural communities in South Africa, contributing more than 40% to the total agricultural GDP. Nevertheless, livestock remains vulnerable to disease; constraining productive capacity and product supply, which often affects prices, markets and the economy. Recently, South Africa experienced varying episodes of RVF outbreaks; a viral zoonotic disease spread by infected mosquitoes causing high rates of abortion and neonatal mortality, primarily in sheep, goats and cattle.

The recent RVF outbreaks have led to questions about the extent of financial hardship incurred by commercial and emerging livestock farmers as well as the efficacy of the current available RVF vaccines. To justify RVF prevention and control it is paramount to understand the impact of this disease. In addition, the amount of further research that should be budgeted to develop newer and more effective vaccines for control of RVF can be more adequately judged with a more accurate accounting of the overall costs of an RVF outbreak.

This study was based on the hypotheses that farmers with sound animal production systems and animal health-care programmes that included vaccination against RVF were least affected by the outbreak when it occurred, and that farmers and their representative organisations overestimated the income losses from the RVF outbreaks. The findings from the survey reveal that more than 30% of farmers reported losses in the form of mortalities, abortions and reduction in animal products such as milk. Farmers incurred extra expenditures in the form of prevention, control and treatment costs.

Correlation tests between the animal losses and the demographic variables and management practices used by farmers revealed some interesting findings. Contrary to expectations that greater farming experience and education would result in actions that reduce animal losses from RVF, results from the survey showed the opposite. Those who incurred the greatest losses were farmers with the highest education and most experience. Of course, other factors were involved. Those with greater experience also tended to have larger herds/flocks.

There were statistically significant relationships between natural resources such as land and open water sources and the incidence of RVF. A much higher proportion of the farmers who were affected by RVF had open water sources. There was a statistically significant relationship between type of farming and the incidence of RVF. Those who practised mixed farming were more affected by the RVF outbreaks than were those who kept livestock only. Extensive livestock farmers were the most affected, especially those who kept sheep.

Irrespective of application of biosecurity measures and general vaccination programmes, farmers who did not vaccinate all their animals against RVF were the most affected (59%) compared to 37% of farmers who vaccinated all their animals.

Production losses by livestock farmers in the survey were found to be R296 000 in 2008 (R427 000 in 2014 Rand), R990 000 in 2009 (R1.3 million in 2014 Rand), and R4.4 million in 2010 (R5.4 million in 2014 Rand). In 2010, production losses on surveyed farms in the Eastern Cape were found to be R1.8 million (R2.2 million in 2014 Rand), R2.5 million in the Northern Cape (R3.0 million in 2014 Rand), and R149 000 in the Free State (R182 000 in 2014 Rand).

The survey results were further up-scaled to district and provincial level. Farmers in Chris Hani and Cacadu districts of Eastern Cape incurred revenue losses of about R 42.3 million (R51.7 million in 2014 Rand). In Free State only farmers in Lejweleputswa district reported revenue losses due to RVF and these were estimated at R479 053(R625 444 in 2014 Rand). Farmers in the Northern Cape Province reported animal losses in 2010 only and these were farmers in Pixley Ka Seme district. Revenue losses incurred by farmers in this district are estimated at R40.6million (R49.7 million in 2014 Rand).

Different conversion factors were used to upscale survey estimations to provincial level estimations. Thus, a combined total revenue loss of about R74 719 876 and R50.3 million expenditure were incurred by livestock farmers from two respective district municipalities of each of the three respective provinces. Estimation of revenue losses at provincial level revealed that farmers in the three provinces incurred revenue losses of about R295.2 million as a result of mortalities and abortions, and milk production losses incurred by Eastern Cape dairy farmers. Thus, as a result of the 2008–2010 RVF outbreaks, economic costs of about R346.4 million were incurred by livestock farmers from the Eastern Cape, Northern Cape and Free State provinces of South Africa.

The 2010 outbreaks resulted in reduced livestock numbers in the respective provinces. Given the set of speculations about the high rate of abortions and mortalities that might have resulted from the application of improper vaccination protocols, the study compared the average revenue losses incurred by farmers who were already vaccinating against RVF before 2010 with the losses incurred by farmers who only started vaccination in 2010. The study revealed that farmers who only started vaccination during the 2010 outbreaks incurred double the revenue losses compared to those who were already vaccinating before 2010.

7.3 CONCLUSIONS

Irrespective of application of biosecurity measures and general vaccination programs, farmers who did not vaccinate all their animals against RVF were the most affected (59%) in terms of animal losses compared to 37% of farmers who vaccinated all their animals. White commercial farmers, especially those who kept sheep, incurred most of the revenue losses.

The estimated economic losses to the 2008–2010 RVF outbreaks suggest that farmers and their representative organisations underestimated the economic losses to RVF. In addition, the survey revealed a high rate of animal mortalities and abortions, much higher than indicated by official notifications of the disease. According to Pienaar and Thompson (2013), there were 484 reported outbreaks of RVF in all of South Africa in 2010 with an average death loss of just less than 20 animals (sheep, cattle and goats) per outbreak. In the survey conducted in this study, 32 farmers reported an average of about 150 animal mortalities on their farms in 2010. Although other diseases also can cause abortions, follow-up discussions with farmers and animal health officers resulted in a fairly high level of confidence that the abortions reported in the survey were due to RVF. While realising that the farmer survey was conducted in an area known to have a high rate of RVF infection in 2010, the average number of animals lost, not to mention the high rate of abortions as well, was stunning.

The much higher than expected mortalities and abortions raise the question of why they were so high. Some livestock farmers speculated that using the same needles on numerous animals could have spread the disease among animals in the herd. Some speculated that the vaccinations might have been administered at the wrong time. Others speculated about the efficacy of the vaccine under field conditions, while others complained about the lack of the vaccines when they most needed them.

7.4 RECOMMENDATIONS

7.4.1 Recommendations for government and policy makers

The survey findings revealed that the state played an important role in curbing losses to RVF by black communal and emerging livestock farmers by providing them with both the free vaccine and the actual administering of the vaccine. The sporadic nature of the RVF outbreaks seems to be the main cause of farmers not vaccinating against the disease. The recent episodes of the outbreaks did not surprise only farmers, as the sole producer of the vaccine in the country ran out of stock during the crucial time when farmers needed the vaccine. Farmers seek to maximise profit and it is natural for them not to vaccine against a disease that they have never experienced for decades.

The classification of RVF as a notifiable disease implies lack of enforcement for control of the diseases in terms of vaccination. It is therefore recommended that DAFF strengthens their early warning system and intensify the awareness campaigns and when necessary targeting all stakeholders including the vaccine manufacturers. If farmers were warned early enough and provided with enough supply of vaccine, some of the losses incurred might have been avoided.

It seems clear from the estimated financial losses incurred by farmers in the survey (and the projected losses at district and national level) that there is considerable scope to reduce financial losses in any future outbreak of RVF with improved vaccines and vaccination protocols. It is therefore recommended that the ARC should continue to seek funding for more research and development of newer and more effective RVF vaccines.

7.4.2 Recommendation for vaccine manufacturers

During the survey farmers raised concerns about possibly inadequate maintenance of the cold chain from the manufacture to the distributors of the vaccine, which they suspect to compromise the efficacy of the vaccine. It is recommended that, apart from the expiry date of the vaccine, the manufacturers should provide a clear indication such as change of colour of the vaccine to indicate its validity. Small packages of the vaccine are also recommended to cater for the affordability of the vaccine for communal and small-holder farmers. It was also discovered that some farmers were not confident about the applicability of the vaccine and that some of the experienced abortions could have been as a result of lack of knowledge about which vaccine to use or not to use, for instance on pregnant animals. Clear and visual labelling of the package, for example with pregnant animals shown on vaccine that is suitable for pregnant animals, is recommended.

7.4.3 Recommendation for livestock farmers

The survey revealed that farmers who did not vaccinate all their livestock against RVF were the most affected by the outbreaks and, in addition, the study has shown the value of effective vaccination. It is therefore recommended that farmers should vaccinate all their livestock following the recommended application guidelines. In addition, farmers who do not see the benefit of vaccinating for sporadic disease outbreaks are urged to make use of available platforms and services to enquire about the possible outbreaks, more especially after heavy rains which are normally associated with outbreaks so that they can vaccinate in time if necessary.

7.5 LIMITATIONS OF THE STUDY

The major limitation to this study was that it was limited to only the two most affected districts of the three provinces, mainly due to budgetary and time constraints.

Another factor in the sampling process was the lack of interest shown, more especially by white commercial farmers, in participating in the study and this might have implications for the estimated economic value of losses to RVF outbreaks.

Although farmers were negatively affected by the RVF outbreaks, farmers were concerned about other diseases such as blue tongue and pulpy kidney which they consider to be of more economic value on terms of annual revenue losses. Given the importance of livestock farming in South Africa, it is strongly recommended that similar studies pertaining to other diseases of economic importance be conducted to better inform the research agenda in terms of animal health-care, prevention and control of animal disease.

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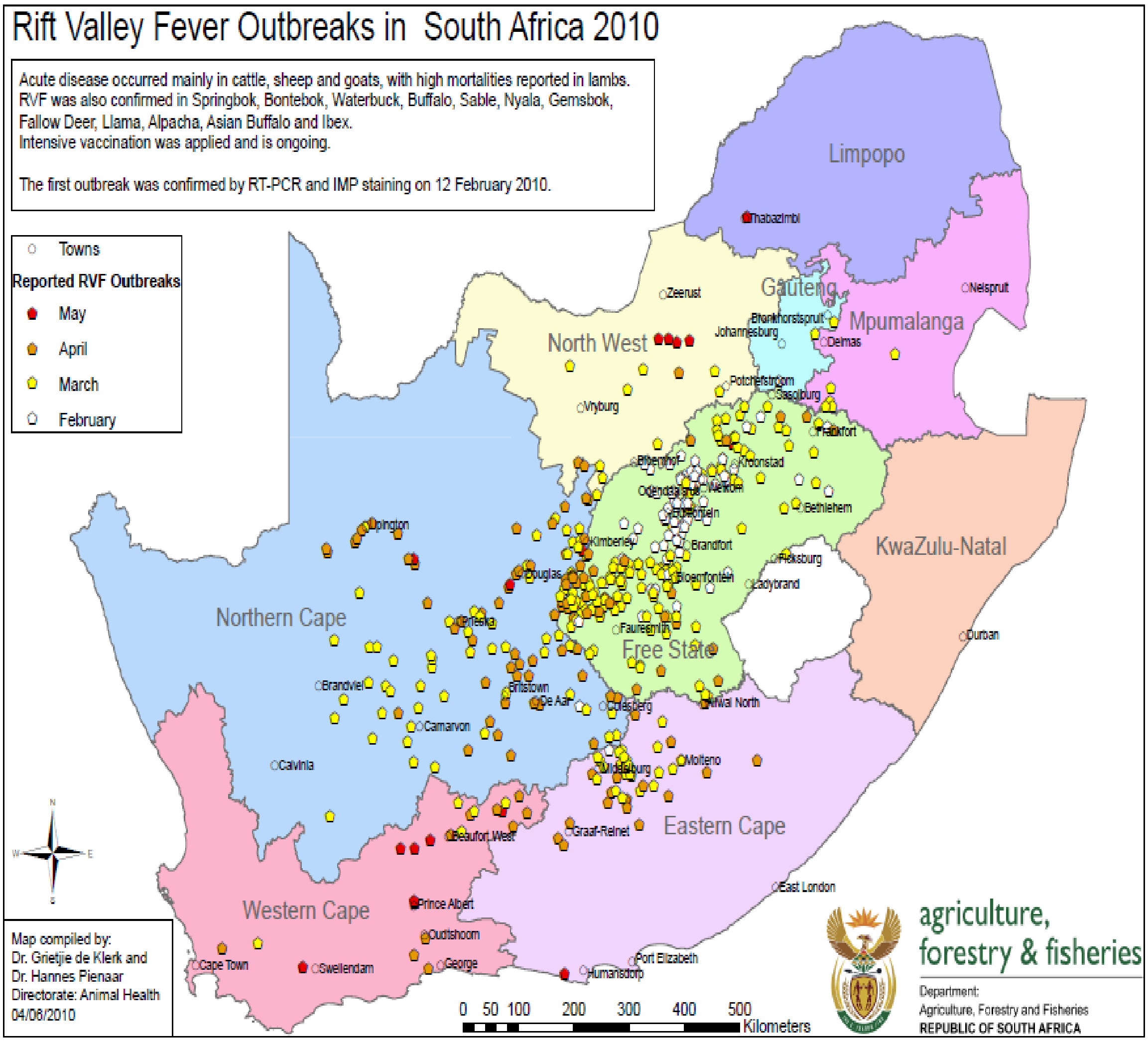
APPENDICES

APPENDIX 1:

RVF MAP INDICATING THE 2010 OUTBREAKS IN SOUTH AFRICA



APPENDIX 2

QUESTIONNAIRE ADMINISTERED TO RESPONDENTS DURING THE SURVEY

Questionnaire for livestock farmers
Information provided will be treated as strictly confidential

Socio-economic impact of 2008 to 2010 RVF outbreaks on livestock farmers in South Africa

Name of the interviewer: ____

Name: _________________________ DATE: ______________ QUESTIONNAIRE NO.__________

Province: _______________________________ District Municipal: ______________________

Local Municipality: _______________________ Town: _______________________________

Contact numbers: ________________________

Part 1: DEMOGRAPHIC INFORMATION (*Please mark (with x) the appropriate answer)*

1. Age in years				
2. Race				
3. Gender	Male	Female		
4. Education	No Schooling	< Grade 12	Grade 12	Tertiary
5. Number of family members living in the household				
6. Farming experience (years)				
7. What is your main source of income?				

Part 2: NATURAL RESOURCE AUDIT

Land

1. Land tenure system	Own land	Communal	Leased

2. Type of farming

Livestock	Mixed

3. What is the total number of hectares used for

Livestock	
Arable	
Other	

Water sources

1. Is there any river(s) passing through the farm?

Yes	No

2. Do you have any farm dams?

Yes	No

3. If yes, how many?

Part 3: LIVESTOCK ACTIVITIES

1. Production system

Breeder	Feedlot	Extensive livestock system

2. Do you keep any of the following livestock?

Animal	Yes	No	How many?
Cattle			
Sheep			
Goats			

3. Which marketing outlet do you use to sell your livestock?

Marketing channel	Yes/No	Rank	Distance (Km)
Private sales			
Butchers			
Abattoirs			
Auction			
Other			

Part 4 – ANIMAL HEALTH, PRODUCTION AND MANAGEMENT PRACTICES

Animal health practices

1. Do you usually vaccinate your animals?

Yes	No

2. If yes, against which disease do you vaccinate?

Type of livestock	**Disease name**

3. How do you control external parasites?

How often?

Weekly	
Monthly	
Other	

4. How much do you spend on veterinary services per year?

Vaccines	
Biosecurity measures	
Vet fees	
Total	

Production and management system

1. How do you feed your animals?

Planted pastures	
Natural veld	
Intensive feeding (feedlot)	
Other	

2. Do you apply biosecurity measures?
If so, which ones?

Yes	No

Clean and disinfect livestock and feed vehicles	
Isolation of new or sick animals	
Dipping	
Restricted access	
Deworming	
Rodent and insect control	
Provide disinfectant and appropriate disposable footwear	
Other:	

Part 5 – PREVENTION OF RVF

1. Indicate which animal diseases you experienced during the years indicated below

Name of disease	2008	2009	2010	Seasonal prevalence

2. Do you vaccinate for RVF? | Yes | No |

If yes, please fill the information below.

3. Which year did you start vaccination against RVF?

4. Which vaccine do you use for RVF?

5. Did you vaccinate all your animals? | Yes | No |

If no, please specify how many animals you vaccinated

	2008	2009	2010	2011	2012
Cattle					
Sheep					
Goats					

6. Where did you buy the vaccine?

7. Did you hire somebody to administer the vaccine? | Yes | No |

If yes, how much did you pay per animal?

8. Did you experience any challenges with the vaccine you used? | Yes | No |

If yes, please specify below

Administration	
Efficacy	
Storage	
Packaging	

9. Do you still experience challenges with the vaccine? | Yes | No |

If yes, please specify below

Administration	
Efficacy	
Storage	
Packaging	

Part 6: IMPACT OF RVF

1. Did you experience any animal losses due to the RVF outbreaks?

Yes	No

If yes, please fill in the table below

Cattle	Pregnant cows		Non- pregnant		Heifers		Bulls		Steers		Suckling calves		Calves		Abortions	
	Pure	Crossed	Pure	Crossed	Pure	Crossed	Pure	Crossed	Pure	Crossed	Pure	Crossed	Pure	Crossed	Pure	Crossed
Losses 2008																
Losses 2009																
Losses 2010																

Sheep	Pregnant ewes		Non- pregnant ewes		Ram		Suckling lambs		Abortions	
	Pure	Crossed	Pure	Crossed	Pure	Crossed	Pure	Crossed	Pure	Crossed
Losses 2008										
Losses 2009										
Losses 2010										

Goats	Pregnant ewes		Non- pregnant ewes		Ram		Suckling lambs		Abortions	
	Pure	Crossed	Pure	Crossed	Pure	Crossed	Pure	Crossed	Pure	Crossed
Losses 2008										
Losses 2009										
Losses 2010										

2. During the RVF outbreaks, were you quarantined?

Yes	No

3. If yes, for how long?

4. How did the quarantine affect your farming activities?

Access to market	
Buying of livestock	
Other:	

5. What did/ could you do during the outbreaks to avoid the losses experienced?

____

____

____

6. Please specify the control costs incurred during the RVF outbreaks (vaccines, foot bath, labour, etc.)

2008		2009		2010	
Item	Costs	Item	Costs	Item	Costs

7. We need to understand the impact of RVF on livestock numbers and we request the following information

	Cattle				
	2008	2009	2010	2011	2012
Herd size					
Calving rate					
Mortality rate					
Weaning rate					

	Sheep				
	2008	2009	2010	2011	2012
Herd size					
Lambing rate					
Mortality rate					
Weaning rate					
Wool production					

	Goats				
	2008	2009	2010	2011	2012
Herd size					
Lambing rate					
Mortality rate					
Weaning rate					
Wool production					

8. If you were affected by the 2010 outbreaks, what is your own estimate on the income loss and costs incurred?

Income loss	
Costs incurred	

9. Any comments?

APPENDIX 3

ESTIMATION OF EXPENDITURES INCURRED BY FARMERS TO MINIMISE RVF LOSSES

Estimation of expenditures incurred by farmers in Chris Hani district

Number of animals					$P = p\,it\,vt$		
Description	**Period**	**Survey**	**Vaccinated**	**District (p)**	**Proportion (i)**	**Price of vaccine vt (R)**	**Cost of vaccine P (R)**
Sheep	2008	44 219	17200	1 224 872	0.3890	2.33	1 110 110
	2009	44 219	22500	1213 664	0.5088	2.93	1 809 421
	2010	44 219	33225	1 188 919	0.7514	3.23	2 885 432
Cattle	2008	6 688	3070	174 990	0.4590	3.77	302 828
	2009	6 688	6270	171 544	0.9375	4.67	751 041
	2010	6 688	5500	170 342	0.8224	5.01	701 820
Goats	2008	4 678	0	69 953	0.0000	2.33	0
	2009	4 678	3500	67 389	0.7482	2.93	147 729
	2010	4 678	3610	66 750	0.7717	3.23	166 380
Number of animals					$T = p\,it\,vt$		
Description	**Period**	**Survey**	**Dipped**	**District (p)**	**Proportion (i)**	**Price of dip vt (R)**	**Dipping Cost T (R)**
Sheep	2008	44 219	0	1 224 872	0.0000	2.5	0
	2009	44 219	1 300	1 213 664	0.0294	2.9	413 896
	2010	44 219	19 500	1 188 919	0.4410	3	6 291 573
Cattle	2008	6 688	0	174 990	0.0000	25	0
	2009	6 688	200	171 544	0.0299	29	595 069
	2010	6 688	3580	170 342	0.5353	30	10 941 825
Goats	2008	4 678	0	69 953	0.0000	2.5	0
	2009	4 678	3500	67 389	0.7482	2.9	584 864
	2010	4 678	3500	66 750	0.7482	3	599 295

Vaccine costs incurred by farmers in Cacadu district

Number of animals					$P = p\,it\,vt$		
Description	**Period**	**Survey**	**Vaccinated**	**District (p)**	**Proportion (i)**	**Price of vaccine vt (R)**	**Cost of vaccine P (R)**
	2008	6 722	0	1 273 094	0	2.33	0
	2009	6 722	0	1 261 446	0	2.93	0
Sheep	2010	6 722	2 114	1 235 724	0.3145	3.23	1 255 251
	2008	483	0	160 140	0	3.77	0
	2009	483	0	156 990	0	4.67	0
Cattle	2010	483	176	155 885	0.3644	5.01	284 582
	2008	846	0	322 920	0	2.33	0
	2009	846	0	311 089	0	2.93	0
Goats	2010	846	312	308 141	0.3688	3.23	367 059

Estimation of expenditures incurred by farmers in Pixley Ka Seme district

Number of animals					$P = p\,it\,vt$		
Description	**Period**	**Survey**	**Vaccinated**	**District (p)**	**Proportion (i)**	**Price of vaccine vt (R)**	**Cost of vaccine P (R)**
Sheep	2010	31 541	25 560	2 139 223	0.8104	3.23	5 599 613
Cattle	2010	3 554	569	37316	0.1601	5.01	29 931
Goats	2010	2 491	1 564	94100	0.6279	3.23	190 846
Number of animals					$T = p\,it\,vt$		
Description	**Period**	**Survey**	**Dipped**	**District (p)**	**Proportion (i)**	**Price of dip vt (R)**	**Dipping Cost T (R)**
Sheep	2010	44 219	10 200	2 139 223	0.23067	3	5 921 457
Cattle	2010	6 688	350	37 316	0.0523	30	234 341
Goats	2010	4 678	454	94 100	0.0971	3	109 589
Number of animals				$T = p\,it\,vt$			
Description	**Period**	**Survey**	**Treated**	**District (p)**	**Proportion (it)**	**Price of dose/unit vt (R)**	**Cost of treatment T (R)**
Sheep	2010	2 833	300	2 139 223	0.1059	8	1 812 261
Cattle	2010	2 640	40	37 316	0.0152	80	45 232
Goats	2010	333	50	94 100	0.1502	8	113 033

Estimation of expenditures incurred by farmers in Lejweleputswa district

Number of animals					$P = p\ it\ vt$		
Description	**Period**	**Survey**	**Vaccinated**	**District (p)**	**Proportion (ip)**	**Price of vaccine vp (R)**	**Vaccine cost P (R)**
Sheep	2008	2 833	660	254 570	0.2330	2.33	138 185
	2009	2 833	1 460	253 614	0.5154	2.93	382 954
	2010	2 833	2 530	249 805	0.8930	3.23	720 572
Cattle	2008	2 640	3	453 073	0.0011	3.77	1 941
	2009	2 640	197	451 824	0.0746	4.67	157 452
	2010	2 640	344	449 123	0.1303	5.01	293 196
Goats	0	0	0	0	0	0	0

Number of animals					$T = p\ it\ vt$		
Description	**Period**	**Survey**	**Dipped**	**District (p)**	**Proportion (it)**	**Price of dip vt (R)**	**Cost of Dip T (R)**
Sheep	2008	2 833	0	254 570	0.0000	2.5	0
	2009	2 833	63	253 614	0.0222	2.9	65 422
	2010	2 833	1 460	249 805	0.5154	3	1 544 858
Cattle	2008	2 640	0	453 073	0.0000	25	0
	2009	2 640	101	451 824	0.0383	29	2 005 140
	2010	2 640	13	449 123	0.0049	30	265 391
Goats	2008	333	0	104 397	0.0000	2.5	0
	2009	333	55	101 127	0.1652	2.9	193 757
	2010	333	10	96 132	0.0300	3	34 642

Estimation of expenditures incurred by farmers in Lejweleputswa district

Number of animals				$T = p\ it\ vt$			
Description	**Period**	**Survey**	**Treated**	**District (p)**	**Proportion (it)**	**Price of dose Vt (R)**	**Cost of treatment T (R)**
Sheep	2008	2 833	0	254 570	0.0000	6	0
	2009	2 833	63	253 614	0.0222	6.5	36 659
	2010	2 833	9	249 805	0.0032	8	6 349
Cattle	2008	2 640	0	453 073	0.0000	60	0
	2009	2 640	78	451 824	0.0295	65	867 707
	2010	2 640	82	449 123	0.0311	80	1 116 003
Goats	2008	333	0	104 397	0.0000	6	0
	2009	333	30	101 127	0.0901	6.5	59 219
	2010	333	14	96 132	0.0420	8	32 333

APPENDIX 4

ESTIMATION OF ANIMAL LOSSES INCURRED BY FARMERS DUE TO 2008–2010 RVF OUTBREAKS

Estimation of expenditures incurred by respondents in Chris Hani district

Losses in cattle herds										
Period	**Pregnant cows**	**Price (R)**	**Loss (R)**	**Non-Pregnant**	**Price (R)**	**Loss (R)**	**Abortions**	**Birth value (R)**	**Loss (R)**	**Total losses (R)**
2008	0	0	0	0	0	0	20	350	7 000	7 000
2009	9	10 000	90 000	9	4 800	43 200	17	380	6 460	139 660
2010	7	10 000	70 000	1	6 500	6 500	10	400	4 000	80 500
Losses in sheep herds										
Period	**Pregnant ewes**	**Price (R)**	**Loss (R)**	**Suckling lambs**	**Price (R)**	**Loss (R)**	**Abortions**	**Birth value (R)**	**Loss (R)**	**Total losses (R)**
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	238	150	35 700	35 700
2010	50	1 200	60 000	1 600	300	480 000	1 600	150	240 000	780 000
Losses in goat herds										
Period	**Pregnant cows**	**Price (R)**	**Loss (R)**	**Non-Pregnant**	**Price (R)**	**Loss (R)**	**Abortions**	**Birth value (R)**	**Loss (R)**	**Total losses (R)**
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	22	650	14 300	0	0	0	14 300

Estimation of milk production losses incurred by respondents due to 2008–2010 RVF outbreaks in Chris Hani District

Item	**2008**	**2009**	**2010**	**Total**
Number of cows vaccinated	500	0	1700	**2200**
Average milk produced/day	16.5	0	17.6	
Average producer price /l[4]	3.034	0	2.942	
Number of days with no production	10	0	10	
Total loss (R)	**250 305**	**0**	**880 246.4**	**1 130 511**

[4] Average producer prices obtained from Abstract of Agricultural Statistics, 2014

Estimation of animal losses incurred by respondents in Cacadu district

Losses in cattle herds										
Period	**Pregnant cows**	**Price (R)**	**Loss (R)**	**Non-Pregnant**	**Price (R)**	**Loss (R)**	**Abortions**	**Birth value (R)**	**Loss (R)**	**Total losses (R)**
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0
Losses in sheep herds										
Period	**Pregnant ewes**	**Price (R)**	**Loss (R)**	**Suckling lambs**	**Price (R)**	**Loss (R)**	**Abortions**	**Birth value (R)**	**Loss (R)**	**Total losses (R)**
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	00	0	0	0	0	0	300	150	45 000	45 000
Losses in goat herds										
Period	**Pregnant cows**	**Price (R)**	**Loss (R)**	**Non-Pregnant**	**Price (R)**	**Loss (R)**	**Abortions**	**Birth value (R)**	**Loss (R)**	**Total losses (R)**
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0

Estimation of animal losses incurred by respondents in Pixley Ka Seme district

Losses in cattle herds													
Period	**Pregnant cows**	**Price (R)**	**Loss (R)**	**Non-Pregnant**	**Price (R)**	**Loss (R)**	**Suckling lambs**	**Price (R)**	**Loss (R)**	**Abortions**	**Birth value (R)**	**Loss (R)**	**Total losses (R)**
2008	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0	0
Losses in sheep herds													
Period	**Pregnant ewes**	**Price (R)**	**Loss (R)**	**Non-Pregnant**	**Price (R)**	**Loss (R)**	**Suckling lambs**	**Price (R)**	**Loss (R)**	**Abortions**	**Birth value (R)**	**Loss (R)**	**Total losses (R)**
2008	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0		0	0	0
2010	951	1 200	1 141 200	8	800	6 400	2 114	300	634 200	2000	150	636 900	2 081 800
Losses in goat herds													
Period	**Pregnant cows**	**Price (R)**	**Loss (R)**	**Non-Pregnant**	**Price (R)**	**Loss (R)**	**Suckling lambs**	**Price (R)**	**Loss (R)**	**Abortions**	**Birth value (R)**	**Loss (R)**	**Total losses (R)**
2008	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0	0
2010	2	800	1 600	0	0	0	0	0	0	118	250	29 500	31 100

Estimation of animal losses by respondents in Lejweleputswa district

Losses in cattle herds										
Period	Pregnant cows	Price (R)	Loss (R)	Non-Pregnant	Price (R)	Loss (R)	Abortions	Birth value (R)	Loss (R)	Total losses (R)
2008	0	6 300	0	8	4 800	38 400	2	350	700	39 100
2009	14	6 500	91 000	9	6 000	54 000	43	380	16 340	161 340
2010	13	7 500	97 500	1	6 500	6 500	25	400	10 000	114 000
Losses in sheep herds										
Period	Pregnant cows	Price (R)	Loss (R)	Non-Pregnant	Price (R)	Loss (R)	Abortions	Birth value (R)	Loss (R)	Total losses (R)
2008	0	0	0	0	0	0	0	0	0	0
2009	100	1 200	120 000	17	800	13 600	0	0	0	133 600
2010	2	1 200	2 400	8	850	6 800	161	150	24 150	33 350
Losses in goat herds										
Period	Pregnant cows	Price (R)	Loss (R)	Non-Pregnant	Price (R)	Loss (R)	Abortions	Birth value (R)	Loss (R)	Total losses (R)
2008	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0
2010	2	1 000	2 000	0	0	0	0	0	0	0

APPENDIX 5

ESTIMATION OF ANIMAL LOSSES AT DISTRICT LEVEL

Estimation of animal losses in Chris Hani district

Mortalities (pregnant animals)					$(L + R) = p\,id\ ie\,e\,vl$		
Description	**Period**	**District (p)**	id	(ie)	e	vl (R)	$L + R$ (R)
Sheep	2008	1 224 872	0	0	0	0	0
	2009	1213 664	0	0	0	0	0
	2010	1 188 919		<0.0001	50	1 200	3 392
Cattle	2008	174 990	0	0	0	0	0
	2009	171 544	0.0013	<0.0001	9	10 000	1 090
	2010	170 342	0.0010	<0.0001	7	10 000	513
Goats	2008	69 953	0	0	0	0	0
	2009	67 389	0	0	0	0	0
	2010	66 750	0	0	0	0	0

Estimation of animal losses in Chris Hani district

Mortalities (Non-pregnant animals)					$(L + R) = p\ id\ \ ie\ e\ vl$		
Description	**Period**	**District (p)**	$\boldsymbol{id}$	$(\boldsymbol{ie})$	$\boldsymbol{e}$	$\boldsymbol{vl}$ **(R)**	$\boldsymbol{L + R}$ **(R)**
	2008	1 224 872	0	0	0	0	0
	2009	1213 664	0	0	0	0	0
Sheep	2010	1 188 919	0	0	0	0	0
	2008	174 990	0	0	0	0	0
	2009	171 544	0.0013	<0.0001	9	4 800	523
Cattle	2010	170 342	0.0002	<0.0001	1	6 500	1
	2008	69 953	0	0	0	0	0
	2009	67 389	0	0	0	0	0
Goats	2010	66 750	0.0047	<0.0001	22	650	1 480
Mortalities (Suckling animals)					$\boldsymbol{(L + R) = p\ id\ \ ie\ e\ vl}$		
Description	**Period**	**District (p)**	$\boldsymbol{id}$	$(\boldsymbol{ie})$	$\boldsymbol{e}$	$\boldsymbol{vl}$ **(R)**	$\boldsymbol{L + R}$ **(R)**
	2008	1 224 872	0	0	0	0	0
	2009	1213 664	0	0	0	0	0
Sheep	2010	1 188 919	0.0362	0.0013	1 600	300	27 788 959
	2008	174 990	0	0	0	0	0
	2009	171 544	0	0	0	0	0
Cattle	2010	170 342	0	0	0	0	0
	2008	69 953	0	0	0	0	0
	2009	67 389	0	0	0	0	0
Goats	2010	66 750	0	0	0	0	0

Estimation of animal losses in Chris Hani district

Abortions				$(L+R) = p\,id\ ie\,e\,vl$			
Description	**Period**	**District (p)**	id	(ie)	e	vl (R)	$L+R$ (R)
Sheep	2008	1 224 872	0	0	0	0	0
	2009	1213 664	0.0054	0.0002	238	150	45 731
	2010	1 188 919	0.0362	0.0013	1 600	150	13 894 480
Cattle	2008	174 990	0.0029	0.0001	20	350	419
	2009	171 544	0.0025	<0.0001	17	380	279
	2010	170 342	0.0013	<0.0001	10	400	60
Goats	2008	69 953	0	0	0	0	0
	2009	67 389	0	0	0	0	0
	2010	66 750	0	0	0	0	0

Estimation of animal losses in Cacadu district

Abortions				$(L+R) = p\,id\ ie\,e\,vl$			
Description	**Period**	**District (p)**	id	(ie)	e	vl (R)	$L+R$ (R)
Sheep	2008	1 224 872	0	0	0	0	0
	2009	1213 664	0	0	0	0	0
	2010	1 188 919	0.0446	<0.0001	300	150	602 499
Cattle	2008	174 990	0	0	0	0	0
	2009	171 544	0	0	0	0	0
	2010	170 342	0	0	0	0	0
Goats	2008	69 953	0	0	0	0	0
	2009	67 389	0	0	0	0	0
	2010	66 750	0	0	0	0	0

Estimation of animal losses in Pixley Ka Seme district

Mortalities (Pregnant animals)					$(L + R) = p\, id\, ie\, e\, vl$		
Description	**Period**	**District (p)**	id	(ie)	e	vl (R)	$L + R$ (R)
Sheep	2010	2 139 223	0.0302	0.0004	951	1200	1 141 200
Cattle	2010	37 316	0	0	0	0	0
Goats	2010	94 100	0.0005	0.0008	2	800	3
Mortalities (Non- pregnant animals)					$(L + R) = p\, id\, ie\, e\, vl$		
Description	**Period**	**District (p)**	id	(ie)	e	vl (R)	$L + R$ (R)
Sheep	2010	2 139 223	0.0003	<0.0001	8	800	0
Cattle	2010	37 316	0	0	0	0	0
Goats	2010	94100	0	0	0	0	0
Mortalities(Suckling lambs/ calves)				$(L + R) = p\, id\, ie\, e\, vl$			
Description	**Period**	**District (p)**	id	(ie)	e	vl (R)	$L + R$ (R)
Sheep	2010	2 139 223	0.0670	0.0009	2 114	300	1 324 891
Cattle	2010	37 316	0	0	0	0	0
Goats	2010	94100	0	0	0	0	0
Abortions				$(L + R) = p\, id\, ie\, e\, vl$			
Description	**Period**	**District (p)**	id	(ie)	e	vl (R)	$L + R$ (R)
Sheep	2010	2 139 223	0.1346	0.0019	4 246	150	38 045 718
Cattle	2010	37 316	0	0	0	0	0
Goats	2010	94100	0.0474	0.0013	118	250	164 897

Estimation of animal losses in Lejweleputswa district

Mortalities (Pregnant animals)					$(L + R) = p\ id\ ie\ e\ vl$		
Description	**Period**	**District (p)**	id	(ie)	e	vl **(R)**	$L + R$ **(R)**
	2008	254 570	0	0	0	0	0
	2009	253 614	0.0353	<0.0001	100	1200	423 579
Sheep	2010	249 805	0.0007	<0.0001	2	1 200	3
	2008	453 073	0	0	0	0	0
	2009	451 824	0.0053	<0.0001	14	6 500	6 756
Cattle	2010	449 123	0.0049	<0.0001	13	7 500	6 241
	2008	104 397	0	0	0	0	0
	2009	101 127	0	0	0	0	0
Goats	2010	96 132	0.0060	<0.0001	2	1000	24
Mortalities (Non-pregnant animals)					$(L + R) = p\ id\ ie\ e\ vl$		
Description	**Period**	**District (p)**	id	(ie)	e	vl **(R)**	$L + R$ **(R)**
	2008	254 570	0	0	0	0	0
	2009	253 614	0.0060	<0.0001	17	800	1 387
Sheep	2010	249 805	0.0028	<0.0001	8	850	154
	2008	453 073	0.0030	<0.0001	8	4 800	931
	2009	451 824	0.0034	<0.0001	9	6 000	1 657
Cattle	2010	449 123	0.0003	<0.0001	1	6 500	2
	2008	104 397	0	0	0	0	0
	2009	101 127	0	0	0	0	0
Goats	2010	96 132					

Estimation of animal losses in Lejweleputswa district

Abortions					$(L+R) = p\, id\, ie\, e\, vl$		
Description	**Period**	**District (p)**	id	(ie)	e	vl (R)	$L+R$ (R)
	2008	254 570	0	0	0	0	0
	2009	253 614	0	0	0	0	0
Sheep	2010	249 805	0.0568	<0.0001	161	150	24 507
	2008	453 073	0.0008	<0.0001	2	350	1
	2009	451 824	0.0163	<0.0001	43	380	11 444
Cattle	2010	449 123	0.0095	<0.0001	25	400	2 367
	2008	104 397	0	0	0	0	00
	2009	101 127	0	0	0	0	0
Goats	2010	96 132	0.0060	<0.0001	2	1 000	24
Mortalities (Suckling lambs/ calves)				$(L+R) = p\, id\, ie\, e\, vl$			
Description	**Period**	**District (p)**	id	(ie)	e	vl (R)	$L+R$ (R)
Sheep	2010	2 139 223	0.0670	0.0009	2 114	300	1 324 891
Cattle	2010	37 316	0	0	0	0	0
Goats	2010	94100	0	0	0	0	0
Abortions				$(L+R) = p\, id\, ie\, e\, vl$			
Description	**Period**	**District (p)**	id	(ie)	e	vl (R)	$L+R$ (R)
Sheep	2010	2 139 223	0.1346	0.0019	4 246	150	38 045 718
Cattle	2010	37 316	0	0	0	0	0
Goats	2010	94100	0.0474	0.0013	118	250	164 897

APPENDIX 5

STATISTICAL ANALYSIS RESULTS

Correlation Results between Animal Losses and Selected Variables

Variables	**Overall correlation**		**Eastern Cape**		**Northern Cape**		**Free State**	
	R	P values	R	P values	R	P values	R	P values
District municipality	-0.146	0.074	0.078	0.602	-0.185	0.259	-0.083	0.513
Age	-0.193	**0.018**	-0.071	0.637	**-0.333**	**0.038**	-0.132	0.298
Race	0.464	< **0.0001**	**0.524**	**0.000**	**0.430**	**0.006**	0.216	0.086
Gender	-0.088	0.282	-0.158	0.288	-0.105	0.524	-0.083	0.513
Education	0.313	< **0.0001**	**0.347**	**0.017**	**0.348**	**0.030**	0.212	0.093
Farming experience	0.050	0.547	0.258	0.079	0.020	0.904	-0.094	0.459
Land tenure system	0.298	**0.000**	**0.426**	**0.003**	**0.361**	**0.024**	0.126	0.320
Type of farming	0.001	0.986	0.165	0.267	-0.092	0.578	0.100	0.430
Land size	0.677	< **0.0001**	**0.485**	**0.001**	**0.749**	< **0.0001**	-0.161	0.203
Production system	-0.023	0.776	0.019	0.901	-0.080	0.627	**NC**	NC
Cattle	-0.067	0.415	-0.145	0.332	-0.076	0.647	0.007	0.956
Number of cattle	0.180	**0.027**	**0.293**	**0.046**	**0.462**	**0.003**	0.101	0.425
Sheep	-0.188	**0.021**	-0.071	0.637	-0.200	0.223	**-0.320**	**0.010**
Number of sheep	0.573	< **0.0001**	**0.412**	**0.004**	**0.800**	< **0.0001**	**0.358**	**0.004**
Goats	-0.016	0.846	**0.375**	**0.009**	-0.014	0.932	-0.154	0.225
Number of goats	0.104	0.204	0.079	0.596	**0.352**	**0.028**	0.104	0.415
Year started vaccination	0.060	0.462	0.177	0.233	0.176	0.284	0.147	0.246
Did you vaccinate all animals	-0.104	0.203	-0.235	0.112	0.060	0.716	0.063	0.620

NC= not calculated as there was only one production used by the interviewed farmers

Statistical results for proportion difference and difference between totals

Description	Category	Animal losses	No losses	$Chi^2 df=1$	P	Poisson (Z)	P
Age	<=45	14	13	0.04	0.8474	0.1925	0.4237
	46-54	14	21	1.40	0.2367	1.1832	0.1184
	55-64	9	34	14.53	0.0001	3.8125	0.0001
	65-70	9	18	3.00	0.0833	1.7321	0.0416
	>70	1	17	14.22	0.0002	3.7712	0.0001
Gender	Female	1	12	9.31	0.0023	3.0509	0.0011
	Male	46	91	14.78	0.0001	3.8446	0.0001
Race	Black	22	93	43.83	0.0000	6.6208	0.0000
	White	25	10	6.43	0.0112	2.5355	0.0056
Education	No school	**3**	**12**	5.40	0.0201	2.3238	0.0101
	<grade 12	14	59	27.74	0.0000	5.2669	0.0000
	Grade 12	7	14	2.33	0.1266	1.5275	0.0633
	Tertiary	23	18	0.61	0.4349	0.7809	0.2174
Farming experience	<15	12	41	15.87	0.0001	3.9835	0.0000
	15-25	19	35	4.74	0.0295	2.1773	0.0147
	>25	16	27	2.81	0.0934	1.6775	0.0467
Land tenure system	11	11	57	31.12	0.0000	5.5783	0.0000
	7	7	14	2.33	0.1266	1.5275	0.0633
	29	29	32	0.15	0.7009	0.3841	0.3504
Type of farming	Livestock	38	97	25.79	0.0000	5.0779	0.0000
	Mixed	9	6	0.60	0.4386	0.7746	0.2193

Description	Category	Animal losses	No losses	Chi²df=1	P	Poisson (Z)	P
	<500	12	23	3.46	0.0630	1.8593	0.0315
	500-3000	17	49	15.52	0.0001	3.9389	0.0000
Land size	>3000	18	31	3.45	0.0633	1.8571	0.0316
	0	11	52	26.68	0.0000	5.1655	0.0000
	1-100	7	32	16.03	0.0001	4.0032	0.0000
	101-1000	12	12	0.00	1.0000	0.0000	0.5000
Sheep herd size	>1000	17	7	4.17	0.0412	2.0412	0.0206
	<25	9	56	33.98	0.0000	5.8296	0.0000
	25-50	13	22	2.31	0.1282	1.5213	0.0641
	51-100	12	16	0.57	0.4497	0.7559	0.2248
Cattle herd size	>100	13	9	0.73	0.3938	0.8528	0.1969
	0	28	58	10.47	0.0012	3.2350	0.0006
	1-50	6	23	9.97	0.0016	3.1568	0.0008
Goat herd size	>50	9	15	1.50	0.2207	1.2247	0.1103
	05	**0**	**5**	5.00	0.0253	2.2361	0.0127
	16	1	5	2.67	0.1025	1.6330	0.0512
	27	20	48	11.53	0.0007	3.3955	0.0003
RVF prevention	38	26	45	5.08	0.0241	2.2549	0.0121

[1]$Chi^2_{df=1}$ = Chi Square test for equal proportions

[2]Poisson (Z) = Normal approximation for equal response totals $H_0{:}T_1=T_2$

[5] No farming by then

[6] Did not vaccinate livestock against RVF

[7] Did not vaccinate all livestock against RVF

[8] Vaccinated all livestock against RVF