SOCIO-ECONOMIC IMPACTS OF LUMPY SKIN DISEASE AND RIFT VALLEY FEVER ON THE SOUTH AFRICAN LIVESTOCK ECONOMY

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Executive Summary

Recently, South Africa has experienced episodes of lumpy skin disease (LSD) and Rift Valley fever (RVF) outbreaks in different parts of the country. LSD is caused by a virus that is spread by biting flies. Infections increase during the wet summer and autumn months when there are more flies. Calves can be infected by drinking milk from a cow which has the disease. The disease also can be spread through the saliva of infected animals when they use the same drinking trough. RVF is spread by infected mosquitoes and characterized by high rates of abortion and neonatal mortality, primarily in sheep, goats and cattle, but also in exotic and wild animals.

The main economic costs of a livestock disease consist of two components: additional expenditures and losses in production. Extra expenditures are in the form of treatment or prevention of a disease while a production loss implies a potential benefit that is not realized. Two surveys were conducted to estimate the extent of extra expenditures and losses in production caused by the two diseases to livestock farmers in South Africa. The first survey was undertaken in early 2013 to gauge the losses to LSD. The survey was conducted in 12 villages in Marble Hall in the Ephraim Mogale District of the Limpopo province where isolated incidents of LSD were experienced between 2010 and 2012. A total of 217 individuals were interviewed in the 12 villages. The mortality cases based on diagnosis by the office of animal health services during this period were 19 cattle valued at R123 500. However, the survey respondents reported that 68 cattle were lost to LSD, resulting in a revenue loss of R442 000. Farmers were advised to buy the vaccine and the animal health officers assisted by administering the vaccine. The vaccine cost an average of R16.76 per dose. In total, 2 891 cattle were vaccinated in the 12 villages at an estimated cost of R48 453. Data on the extent of losses in other areas of South Africa were not available.

The second survey was conducted to determine the socio – economic impacts of RVF in South Africa. 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.

Farmers incurred extra expenditures in the form of prevention (vaccination), control (dipping) and treatment (Terramycin to stimulate the immune system). Although most of the 150 livestock farmers indicated that they vaccinated against RVF, less than half used their own funds to purchase the

vaccine. The others were provided vaccines by the state. Most vaccinated their entire herds, especially in 2010 when the disease hit hardest. Over the three years, farmers in the sample spent R480 000 (61 000 in 2014 C$) on vaccinations over the three years, with the majority of the vaccination expenditures occurring in 2010. They spent R2 million (240 000 in 2014 C$) on dipping and R18 000 (2 000 in 2014 C$) on Terramycin.

In addition to the extra expenditures, livestock farmers incurred losses in the form of mortalities, abortions, reduced production of animal products and possibly, reduction in prices from trade sanctions imposed by importing nations. 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 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.

Production losses by livestock farmers in the survey (including mortalities, abortions and reduced milk production) were found to be R296 000 in 2008 (36,000 in 2014 C$), R480 000 in 2009 (59 000 in 2014 C$), and R4.4 million in 2010 (540 000 in 2014 C$). In 2010, production losses on surveyed farms in the Eastern Cape were found to be R1.8 million (220 000 in 2014 C$), 2.5 million in the Northern Cape (300 000 in 2014 C$), and R149 000 in the Free State (18 000 in 2014C$).

Two methods were used to scale the 2010 survey results to the national level. The first method was extremely conservative and resulted in an estimated loss at the national level of R66.7 million (8.1 million in 2014 C$). A possibly more realistic scaling factor resulted in an estimated total national production loss in 2010 of R213.6 million (26.1 million in 2014 C$). These estimates are based on five types of losses reported by farmers in the survey: deaths of pregnant ewes/cows, deaths of non-pregnant ewes/cows, deaths of suckling animals, abortions, and reductions in milk produced. The estimates do not include possible losses in production of other animal products, such as hides, wool, and mohair. Also, these estimates do not account for possible reductions in prices of animals or animal products that resulted from trade restrictions during the outbreak, which might have been at least partially offset by increased domestic prices as a result of reduced supply. Data were not available to assess the extent, if any, of these types of losses. Nevertheless, the survey results reveal a substantial loss in revenues to the livestock industry in South Africa as a result of Rift Valley fever in 2008, 2009, and, especially, in 2010.

The losses reported in the RVF 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. While this study could not determine a reliable estimate of the value of a new and improved vaccine against RVF, it is obvious there is a large potential for reducing losses due to the disease if an improved vaccination protocol could be derived and implemented.

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LIST OF ACRONYMS

ARC	Agricultural Research Council
BFAP	Bureau for Food and Agricultural Policy
BMI	Business Monitor International
DAFF	Department of Agriculture Forestry & Fisheries
GDP	Gross Domestic Product
LSD	lumpy skin disease
RVF	Rift Valley fever
Stats SA	Statistics South Africa

1 INTRODUCTION

1.1 BACKGROUND

Among agricultural sectors in the world, livestock production is perceived to be growing more quickly than any other sector. World meat production and consumption is expected to rise from 233 million tons in 2000 to 300 million tons by 2020 (Delgado et al., 1999). Globally, the livestock sector plays an important role in the economies of many developing countries (Blench et al., 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 et al. (2011). Morgan and Tallard (2007) estimated that food derived items such as meat, milk and eggs in Africa contribute, 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 fertilizer 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 (Spies, 2011). About 80% of agricultural land in South Africa is suitable mainly for extensive livestock farming so that enterprise is a vital source of livelihood for many rural communities and resource poor farmers (Spies, 2011). Livestock farming is normally practiced in conjunction with other farming enterprises.

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 economic magnitude. 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 result in reduced incentives for long-term investment and production decisions.

This report investigates the economic impacts on South Africa's livestock economy of two important livestock diseases: lumpy skin disease (LSD) and Rift Valley fever (RVF). Both are notifiable diseases. LSD is a viral disease of cattle spread by biting flies. Infections increase

during the wet summer and autumn months when there are more flies. Calves can be infected by drinking milk from a cow which has the disease. The disease can also spread through the saliva of infected animals when they use the same drinking trough (DAFF, 2013).
Animals of all ages are susceptible to the disease. In pregnant animals the prolonged fever may result in abortion while the fever could result in temporary or permanent sterility in bulls if they suffered lesions on the genitals. Cows may not come into estrus for several months after contracting LSD. The lesions may persist in various stages over a course of 4 to 6 weeks. Final resolution of lesions may take 2 to 6 months, and nodules can remain visible 1 to 2 years, while permanent damage to the hide is inevitable in clinical cases (DAFF, 2013). In 2010, LSD episodes that were perceived to be serious were reported in some villages in the Limpopo province of South Africa.

RVF is spread by infected mosquitoes and characterized 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. Between 2008 and 2010, South Africa experienced varying outbreaks of RVF.

1.1 PROBLEM STATEMENT

Given the vital role played by livestock farming as a source of livelihood for many rural communities and resource poor farmers and its contribution of more than 40% to the total agricultural GDP, it is important understand the true impact of these disease. Such information is crucial to justify efficient and effective policies for disease prevention and control.

Despite the knowledge that the LSD AND RVF outbreaks affected farmers negatively, the extent of this impact on farmers' herds, marketable income and livelihoods is not known. Without understanding the true impact of these 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 LSD and RVF can be more adequately judged with a more accurate accounting of the overall costs of the disease.

1.2 OBJECTIVES OF THE STUDY

The goal of this study is to assess the economic impacts of LSD and RVF that resulted from recent outbreaks on emerging and commercial livestock farms in South Africa. The specific objectives are to:

- Describe and estimate the extent of disease prevention and control measures practiced by livestock farmers in South Africa;
- Estimate the financial losses incurred by livestock farmers in South Africa as a result of LSD in the Limpopo province in 2011 and RVF outbreaks in 2008-2010; and
- Estimate the projected value of new and superior vaccines to the South African livestock economy.

The scope of this study is limited to estimating total overall losses to the South African livestock industry as a result of the two diseases. This study does not estimate profits or losses to specific sectors of the South African livestock industry, individual livestock farms or how any individual producers might have reacted to the financial stresses. Furthermore, this study does not examine changes in equity values of farms, realized or not, that might have occurred during the disease outbreaks. To estimate the extent of reduction of profits (or losses) in the industry, substantially more data on costs of production would have to be obtained. This study does not delve into this issue. The livestock industry in South Africa is extremely complex with frequent sales transactions of animals of various ages, sizes and conditions. Very detailed studies would be required to make reliable estimates of losses to individual farms.

2 RESEARCH METHODS AND DESIGN

2.1 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. Questionnaires were developed for farmer interviews. The LSD questionnaire was developed in consultation with two animal health practitioners from Marble Hall. Subsequently, the questionnaire was adjusted and some general questions such as reasons for keeping livestock and data on prevailing animal diseases were removed. These were addressed through focus group meetings. The RVF questionnaire was pre-tested on eight livestock farmers in the Free State province. Subsequently the questionnaire was adjusted to incorporate lessons learned during the pilot survey. An animal health practitioner from each of the three provinces also was interviewed as a key informant 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.

2.2 LUMPY SKIN DISEASE SURVEY

2.2.1 Survey area

Early in January of 2013 a meeting was held with the Senior Animal health Technician of the Department of Agriculture, Forestry and Fisheries (DAFF) in Ephraim Mogale district to introduce the study and also to solicit the support of the office during the survey.

Communal livestock farmers in Marble Hall were selected on advice of the project leader as they were already involved with other project activities in the area. Ephraim Mogale Local Municipality, formerly known as Greater Marble Hall Local Municipality, is a local municipality within the Sekhukhune District Municipality, in the Limpopo province (Figure 1)

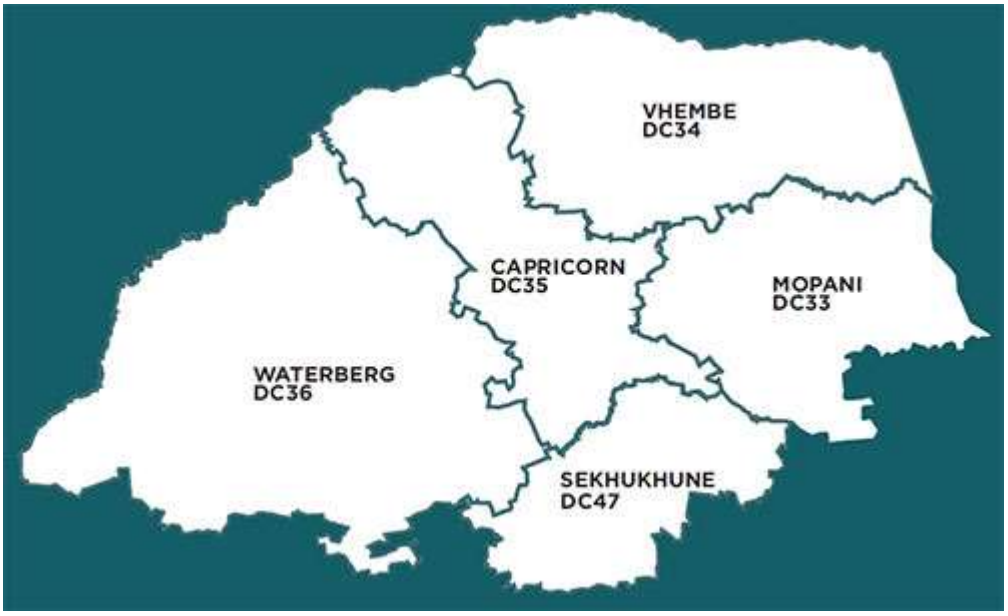

Figure 1: District municipalities of Limpopo province

Source: Limpopo Local Government

Twelve villages where there were incidences of LSD were selected on advice of the local animal health practitioners. The survey was conducted between February and March of 2013. The dates of interviews were aligned with dipping days and farmers' meetings. All farmers who were willing to participate in the study were interviewed. Table.1 indicates the selected study sites, gender and the number of respondents (n) in each village.

Table 1 : Study sites and respondents in lumpy skin disease survey

Village	Number of female respondents	Number of male respondents	Total (n)
Doornlagte	8	13	21
Keerom	0	6	6
Makgatle	13	19	32
Malebitsa	8	8	16
Matatadibeng	14	2	16
Mmotoaneng	1	9	10
Moanapjane	2	12	14
Moomane	16	12	28
Rakgoadi	6	5	11
Spitspunt	9	9	18
Tsantsabela	16	9	25
Tsimanyane	12	8	20

2.2.2 Description of questions asked

The purpose of the study is to profile the impact of LSD on livestock communal farmers in Marble Hall. Data gathered through use of the questionnaire (Appendix A) include; demographic details, source of income, animal diseases experienced during 2010 to 2012, the nature of losses incurred as a result of the diseases, ranking of diseases in terms of economic losses, losses to LSD and general expenditure on livestock activities.

To gain an understanding of the profile of the farmers, respondents were asked to indicate their age and source of income. Farmers were asked to list the names of diseases they experienced during 2010 to 2012. To establish if LSD was a disease of concern for communal livestock farmers, respondents were asked to list the nature of losses they incurred as a result of the diseases they experienced. Farmers were then asked to rank the diseases in terms of economic importance.

To understand the socio-economic impact of LSD, farmers were asked to list the extra costs and losses in production they experienced due to the LSD outbreak, as well as indicate the post-outbreak impact of LSD on animal productivity. To gauge if farmers could afford to pay for the LSD vaccine, farmers were asked to indicate their annual expenditures on livestock.

2.3 RIFT VALLEY FEVER SURVEY

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 (Figure 2). 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.

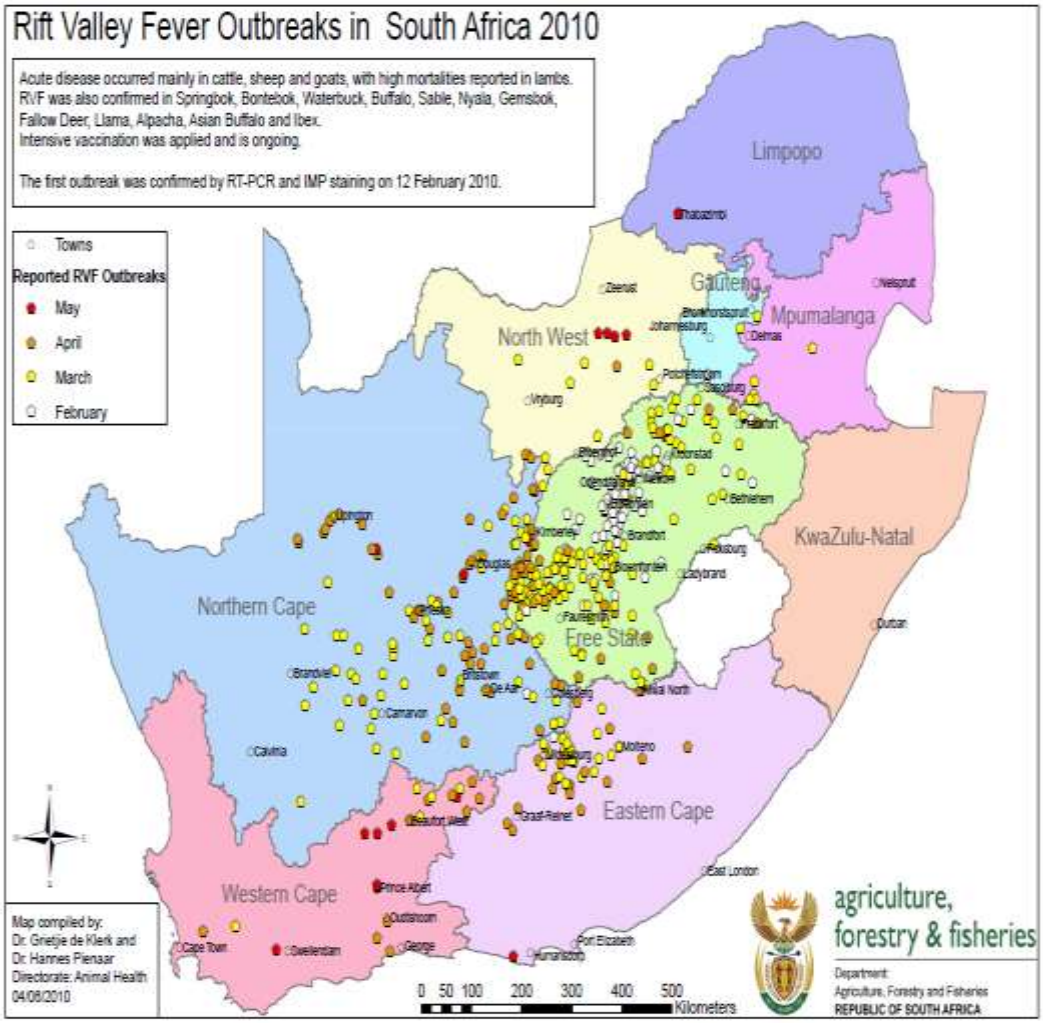

Figure 2: RVF map on 2010 outbreaks

Source: DAFF, 2010

2.3.1 Farm survey

A list of 266 livestock farmers (N) in the selected towns with information on type of livestock farming was obtained from the respective animal health practitioners. Within towns, farmers with contact details were stratified by type of livestock they kept. To ensure randomness in the sample, 75% of farmers from each stratum were selected and within each stratum, simple random sampling was applied to select 50% of the farmers. From each stratum, the first 10 farmers who were available and willing to participate in the study were interviewed using the revised questionnaire (Appendix B). Table 2 indicates the selected study sites and the number of respondents (n) in each province. The total sample size was 150 livestock farmers from all areas selected in the study.

Table 2: 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
		Hofmeyer 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

2.3.2 Description of questions asked

The purpose of this study is to estimate the socio-economic impact of RVF on livestock farmers in three provinces of South Africa.

Data gathered using the questionnaire included demographic details, livestock activities, animal health practices, production and management practices, prevention of RVF, as well as the impact of the outbreaks on livestock production and marketing activities.

Questions pertaining to the location (province, district, local municipality and town) of the farmer were included in the questionnaire. One of the specific objectives of this study is to establish if there is any correlation between the demography of respondents and the impact of RVF. Hence, part one of the questionnaire contained 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.

Parts 2 - 5 of the questionnaire dealt 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 information on production systems, type of livestock kept, as well as the outlets they use for marketing of their livestock and livestock products.

To understand if the size of farm was associated with RVF outbreak impact and whether farmers with open water surfaces (where mosquitoes breed) were affected differently compared to those without, part 2 of the questionnaire included questions on their land tenure system and water sources. Part 3 investigated whether or not RVF affected the animal types differently and also had questions to establish whether or not farmers with large herds of livestock adopted different strategies to minimize their losses compared to those with small herd sizes. Farmers were asked to provide data on type, as well as number of animals kept.

Part 4 of the questionnaire had 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, as well as whether or not they usually vaccinate their animals and apply biosecurity measures.

Part 5 deals 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 also asked where they purchased their vaccines and if they hired somebody to administer the vaccine. Those data were useful to address the issue of efficacy and also for determining the cost of vaccination.

Part 6 of the questionnaire investigated the impact of RVF. To determine the costs of the outbreak, farmers were asked to identify which year they incurred animal losses. Information on the number of mortalities and abortions was requested, as well as type and nature (pregnancy, gender, age and type of breed) of animal lost. Questions related to any other capital losses incurred also were asked. 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, farmers were asked to specify the quantities marketed from 2007 to 2012. To understand the impact of RVF on livestock numbers, farmers were asked information on herd size, calving/lambing rate and mortality rate from 2008-2012.

Livestock farmers were asked to estimate their own income loss and costs incurred as a result of the 2010 RVF outbreaks. Farmers also were afforded an opportunity to provide their

comments on the outbreak, such as what could have been done better and by whom to minimize the losses.

2.4 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). Additional expenditures could be in the form of treatment or prevention of a disease, while a production loss implies a potential benefit that is not realized (McInerney et al., 1992).

To gather data on costs incurred at the farm level and to capture the variability in costs amongst farms regarding the control measures that were executed, the cost survey analysis approach was used. This approach involves gathering data 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 amongst farms regarding the control measures that are executed. Although the survey approach is clouded by non-response bias, it still offers the best opportunity for obtaining direct relevant data.

To conduct the financial costs of the RVF outbreaks at farm level, this study adapted the deterministic economic model used by Velthuis et al. (2010) to measure the financial costs of Bluetongue virus outbreaks in the Netherlands in 2006 and 2007.
The basic model produced by Velthuis et al. (2010) is as follows:

$$L = \Sigma i \Sigma j \, Pij + Tij + Di + Mij$$

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 entered into the relevant 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 equals 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; these were felt a year or two later, following the outbreak. It was also 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 data to estimate such 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 labor 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 as having incurred any costs for diagnostics. According to the ARC – Onderstepoort Veterinary Institute, 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 through use of private veterinary practitioners; however there were no substantial data 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 equals the cost of dipping or spraying with dip and VC equals the cost of vaccination

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

where ad equals the number of animals dipped and pd the price of dip per animal. During the survey 9% of farmers indicated a weekly use of deadline as a repellent for a period of two months, which means the repellant was applied on approximately 8 days.

The survey revealed that no additional labour and private veterinary services were utilized by farmers for 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 district and provincial level the following formula used by Bennett (2003) to estimate the direct costs of 30 endemic livestock disease in Great Britain was adapted.

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

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

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

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

2.5 STATISTICAL PROCEDURES

To inform effective policy making in the control and prevention of RVF, a relationship between animal losses and demographic characteristics, livestock activities, animal health, production and management activities as well as prevention of RVF in the selected study areas was explored. The significance of the relationship between farmers who incurred animal losses and the specific variables was tested with the$\chi 2$ ($Chi^2_{df=1}$) 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).

Pearson correlation tests were performed between revenue losses, livestock activities and prevention of RVF to determine if losses to RVF were correlated with animal health care programs and management practices used by livestock producers. The significance of the correlations was tested at the 5% significance level. All data analysis was performed using SAS/STAT statistical software (SAS, 1999

3 RESULTS AND DISCUSSION

3.1 LUMPY SKIN DISEASE

3.1.1 Reasons for keeping livestock

Focus group discussions were used to compile a set of reasons why the communal farmers in the Limpopo province keep livestock, which assisted in the design of the questionnaire that was used in the survey. In villages where there was a fair representation of both genders, the groups were split according to gender. The most cited reasons for keeping livestock in order of importance were;

(i) Investment for emergencies
(ii) To pay school fees
(iii) For business purposes
(iv) Culture and rituals
(v) To make traditional attire

Women tended to list points iv and v as most important, probably because of the traditional attire often worn by women that is compulsory for certain rituals.

Of 217 respondents in the survey, only 12 (6%) indicated that livestock sales provided their main source of income, 151 (70%) derived their livelihood from state grants such as old age pensions and child grants, 24 (11%) earned a monthly salary, 15 (7%) earned their income from business activities and 15 (7%) received most of their income from remittances (Table 3).

Table 3 : Source of income

Source of income	**Number of respondents**	**Percent**
Business	15	7
State grants	151	70
Livestock sales	12	6
Salaries	24	11
Remittances	15	7
Total	**217**	**100**

Source: Survey results

3.2.2 Demographic characteristics of respondents

Sixty percent of sampled farmers were above 60 years of age, followed by 15% of those between 51and 60 years of age, 13% between 41 and 50, 9% between 31and 40 and 3% were between 21 and 30 years of age (Table 4). The mean average age was 59.

Table 4: Age distribution of respondents

Age	Number of respondents	Percent
21-30	7	3
31- 40	20	9
41- 50	27	12
51-60	33	15
>60	129	60
Total	**217**	**100**

Source: Survey results

Participation and ownership of livestock by women remains a challenge in South Africa. However, nearly half (43%) of the 217 sampled farmers were female (Table 5).

Table 5: Gender distribution of respondents

Gender	Number of respondents	Percent
Female	93	43
Male	124	57
Total	**217**	**100**

Source: survey results

The majority of sampled farmers have a low level of education: 78 (36%) had no schooling while 106 (50%) had less than grade 12, 21 (10%) had grade 12 and 9 (4%) had some tertiary education (Table 6).

Table 6: Level of education

Level of Education	Female respondents	Male respondents	Total
No school	41 (53%)	37 (47%)	78 (36%)
< grade 12	44 (40%)	65(60%)	109 (50%)
Grade 12	6 (29%)	15 (71%)	21(10%)
Tertiary	3 (33%)	6 (67%)	9 (4%)
Total	**93**	**124**	**217**

Source: Survey results

The 217 respondents collectively owned 2,448 cattle, 58 sheep and 871 goats. About 50% of the respondents owned between 0-8 head of cattle, 29% between 9-16 cattle, while 21% owned more than 16 cattle (Table 7). Women owned about 88% of all sheep and 41% of goats.

Table 7 : Distribution of cattle numbers

Number of cattle	Female	Male	Total
0-8	49 (45%)	59 (55%)	108 (50%)
9-16	26 (41%)	38 (59%)	64 (29%)
>16	18 (40%)	27 (60%)	45 (21%)

Source: Survey results

The annual expenditures by farmers on livestock activities included expenditures on vaccines, animal herders, and feed and supplements. Of the 217 respondents, 201 (85%) indicated that they incur annual expenses to look after their livestock. The expenditure patterns on livestock activities were grouped into four categories as depicted in Table 8 below.

Table 8 : Annual expenditure on livestock activities

Expenditure (R)	Female	Male	Total
0	15 (47%)	17 (53%)	32 (15%)
100-500	34 (49%)	35 (51%)	69 (32%)
501-1500	37 (42%)	51 (58%)	88 (41%)
>1500	7 (25%)	21 (75%)	28 (13%)

Source: Survey results

3.1.2 EXPENDITURES ON LIVESTOCK

About 31% of respondents indicated that they did not spend any resources on vaccines, while 69% indicated that they incur annual expenses to ensure good health for their livestock (Table 9). The common practice in this area is that farmers in each village contribute a fixed monthly amount towards the purchase of selected vaccines by the farmers group. Farmers are individually responsible for the purchase of any vaccine that is not on the selected list.

Table 9 : Annual expenditure on vaccines

Expenditure (R)	Female	Male	Total
Free	36 (58%)	31 (46%)	67 (31%)
100- 250	16 (36%)	28 (64%)	44 (20%)
251-500	26 (43%)	34 (57%)	60 (28%)
>500	15 (32%)	31 (67%)	46 (21%)

Source: Survey results

About 68% of respondents indicated that they do not usually spend any of their resources on livestock feeds and supplements (Table 10).

Table 10 : Annual expenditures on feeds and supplements

Expenditure (R)	Female	Male	Total
Free	68 (46%)	79 (54%)	147 (68%)
100-250	3 (20%)	12 (80%)	15 (7%)
251-500	14 (58%)	10 (42%)	24 (11%)
>500	8 (26%)	23 (74%)	31 (14%)

Source: Survey results

The communal grazing fields are distant from the dwelling areas and, as a result, the majority of farmers (60%) who are not able to look after their livestock make use of livestock herders. The expenditure patterns on animal herders are shown in Table 11. Farmers group themselves into manageable numbers and negotiate an accepted number of livestock and a monthly care rate with the herder.

Table 11 : Annual expenditures on animal herders

Expenditure (R)	Female	Male	Total
0	34 (40%)	52 (60%)	86 (40%)
100-250	22 (46%)	26 (54%)	48 (22%)
251-500	34 (49%)	35 (51%)	69 (32%)
>500	11 (21%)	11 (79%)	14 (6%)

Source: Survey results

Farmers were asked to list the animal diseases that were prevalent in the area and the nature of animal losses incurred due to each disease. They were then asked to rank the diseases in order of animal losses. In terms of animal losses, Heartwater disease was ranked as number 1, followed by botulism, 3-day stiff sickness (bovine ephemeral fever) and LSD.

3.1.3 Losses to LSD

Isolated incidents of LSD were experienced between 2010 and 2012. The mortality cases, based on diagnoses commissioned by the office of animal health services during this period, included 19 cattle valued at R123 500. A combined total number of 68 cattle were reported as losses due to LSD. Using an average price of R6 500 per animal, the total loss is estimated at R442 000. Farmers were advised to buy the vaccine and the animal health officers assisted by administering the vaccine. The vaccine cost an average of R16.76 per dose. In total, 2 891 cattle were vaccinated at an estimated cost of R48 453.

3.2 RIFT VALLEY FEVER

3.2.1 CORRELATION BETWEEN REVENUE LOSSES, DEMOGRAPHIC VARIABLES AND LIVESTOCK ACTIVITIES

Significant relationships were established between RVF losses and demographic variables (Table 12). A significant correlation between animal losses and age was established. The correlation was significant at age categories of 55-64, 65-70 and those with more than 70 years of age. 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 young white farmers. Sheep were the main animal species that was affected by the RVF outbreaks. White farmers that were less than 45 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. Consequently, average revenue losses incurred by farmers that were less than 45 years of age were estimated at R37 409, R148 071 and R5 997 in Eastern Cape, Northern Cape and Free State respectively.

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 correlation ($p<0.0001$) was found between level of education and revenue losses. On average, farmers with tertiary education incurred revenue losses of about R 86 769 which was forty times higher than R2 133 incurred by farmers with no education.

Contrary to expectations that farmers with greater farming experience would have lower animal losses from RVF, the results from the survey showed the opposite. Farmers with more than 15 years of farming experience were the most affected. White farmers with more than 15 years of farming experience kept large herds of sheep, which are the most vulnerable species to RVF. Average revenue losses incurred by farmers with 15 to 25 years of farming experience were estimated at R33 152, R106 083 and R15 167 for farmers in Eastern Cape, Northern Cape and Free State respectively.

Statistically significant relationships were found also between RVF losses and natural resources. A highly significant relationship was found between the impact of RVF and land tenure system. Those who operated on freehold land were more affected by RVF than were those who operated on leased land and communal land. Farmers who operated on free hold system incurred average revenue losses of about R70 219 followed by those on leased land and communal system at R7 039 and R1 784 respectively.

Another significant relationship was established between the size of the farm land and the impacts of RVF. This correlation was also significant in Eastern Cape and Northern Cape provinces. Farmers with large farms were mostly sheep farmers, hence farmers in these two provinces incurred higher revenue losses compared to those in the Free State province. Average revenue losses incurred by farmers with more than 3 000 ha of land were estimated at R65 719 and R83 044 for farmers in Eastern Cape and Northern Cape respectively. There were no

farmers with such land size in Free State. A statistical significant correlation was established also between open water sources and RVF impacts. This relationship was found to be significant in Eastern Cape where 68% of farmers had 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. Average revenue losses incurred by farmers who kept livestock only were estimated at R31 144, R67 208 and R5 922 for farmers in Eastern Cape, Northern Cape and Free State respectively. 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. Average revenue losses incurred by farmers who did not vaccinate all their livestock were estimated at R50 726 which is double R24 377esimated to have been incurred by those who vaccinated all their livestock.

Table 12: 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 system used by the interviewed farmers

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

Extra expenditure ($Ti.j + Mi.j$)

The number of animals treated at district level was estimated by multiplying the number of animals at district level by the percentage of animals treated by the respondents at their own cost. The estimated number of animals treated at district level was then multiplied by the cost of treatment per animal to estimate the associated expenditure. The number of animals at district level was obtained from DAFF (2014 b). The extra costs incurred by farmers consist of two elements: vaccine costs and control costs Table 13).

Vaccine costs

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. Table 3 presents a summary of expenditures incurred by farmers from the two districts of each province. These estimations exclude the free vaccines provided by the state for smallholder farmers.

Control costs

During the survey farmers were asked to indicate which control measures they applied to minimise 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, only 13 (9%) indicated that they tried to control the spread of the virus by using insecticidal dip to repel insects. 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.

In addition to use of dip as a repellent, eight farmers (5.33%) from the Northern Cape and Free State provinces indicated that they used antibiotics (LA Terramycin) to boost the immune

system of their animals. 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.

Table 13: Estimation of expenditures incurred by farmers in the two districts of each province during 2008–2010 RVF outbreaks

Description	**Eastern Cape**	**Northern Cape**	**Free State**
Vaccine costs (2014 Rand)	12 512 074	7 116 591	2 150 506
Control costs (2014 Rand)	23 894 340	10 070 051	7 900 978
TOTAL (2014 Rand)	**36 406 414**	**17 186 642**	**10 051 484**

Source: Own estimation

Estimation of animal production losses ($\boldsymbol{Pi.j}$)

Farmers reported animal losses 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 (Table 14). Prices for the respective types of animal losses were obtained by consulting industry experts and these were in accordance with the prices reported by farmers during the survey. Milk prices were obtained from the Abstract of Agricultural Statistics published in 2014 (DAFF, 2014a). Due to data limitations, milk production losses were only estimated at district level.

Table 14 : Three Province summary - Gross losses from Rift Valley fever, 2010 (in 1,000 current Rand and 2014 C$)

Province	Description	Pregnant	Non Pregnant	Suckling animals	Abortions	Milk	Total Rand	2014 C$
	Sheep	60	0	480	285		825	1 01
	Cattle	70	7	0	4	880	961	118
	Goats	0	14	0	0		14	1.7
Eastern Cape	**Total**	**130**	**21**	**480**	**289**	**880**	**1 800**	**221**
							0	0
	Sheep	1 141	7	634	637		2419	296
	Cattle	8	7	0	0		14	1.7
	Goats	2	0	0	30		31	3.8
Northern Cape	**Total**	**1 150**	**13**	**634**	**666**		**2 464**	**301**
	Sheep	2	7	0	24		33	4.1
	Cattle	98	7	0	10		114	13.9
	Goats	2	0	0	0		2	0.2
Free State	**Total**	**102**	**13**	**0**	**34**		**149**	**18.2**
3 Province Total		**1 382**	**47**	**1 114**	**990**	**880**	**4 413**	**540**

Source: Survey Results

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 had been 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 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.

During the 2008–2010 outbreaks, the ARC biotechnology laboratory at OVI received several samples from the three provinces to test for RVF. Of the RVF diagnostics, 85, 213 and 351 were positive in the Eastern Cape, Northern Cape and Free State provinces respectively (Table 15). 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. In our 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. To estimate provincial economic losses, it is assumed that all farms that reported losses in the same town constitute a single outbreak. Using the foregoing assumption, the scaling factor to obtain an estimate of losses to the provincial livestock economy is the number of positive diagnostics in each province divided by the assumed number of outbreaks from the survey in each province. Thus, the upscaling

factor is 28 (85/3), 71(213/3) and 88(351/4) for the Eastern Cape, Northern Cape and Free State respectively (Table 15).

Table 15: Estimation of animal losses to 2008–2010 Rift Valley fever 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 15). Northern Cape Province incurred the majority of losses (R174.9 million). The estimated revenue losses incurred by livestock farmers in Northern Cape Province are two and four times higher than the total 2008–2010 losses in the Eastern Cape and Free State province, respectively.

Scaling-up: Estimation of total national loss to rift valley fever in 2010

The farm survey was conducted in two municipalities in each of three provinces. Since the main emphasis of the survey was to collect data on extra costs of production losses of those who suffered from RVF, the survey was deliberately conducted in areas where it was known that a high rate of disease incidence was incurred. No attempt was made to randomly select provinces or districts within provinces. While this method enhanced the collection of cost and loss data, it does not make it easy to estimate the overall financial impacts on the livestock industry at the national level.

However, RVF is a reportable disease and in 2010, "a total of 484 outbreaks were reported" in South Africa (Pienaar and Thompson, 2013). These officially reported outbreaks provide a way to make conservative and reasonable estimates of the total financial impacts of the disease on the national livestock economy. In our survey, 32 farms reported impacts of the disease in 2010. If each of these cases is considered a separate outbreak, the scaling factor to obtain an

estimate of losses to the national livestock economy would be 484/32 = 15.125, which would mean that our survey included 1/15.125 of all the outbreaks in the country. This is the first of two factors (called Scalar A, below) that we use to scale the survey results to the national level.

No data are presently available on the average number of farms that are included in each of the outbreaks reported by Pienaar and Thompson (2013). It seems unreasonably conservative to assume that each farm that experienced a loss due to RVF in 2010 is considered a separate outbreak. For a second scalar factor (called Scalar B, below), we assumed that all farms that reported losses in the same town be considered a separate outbreak. The 32 farms in the survey that reported losses in 2010 were in ten different towns; thus, we assume they accounted for ten separate outbreaks. Using this assumption, the scaling factor to obtain an estimate of losses to the national livestock economy would be 484/10 = 48.4.

Using Scalar A, where each affected farm in the survey is considered a separate outbreak, the estimated financial losses at the national level from mortalities, abortions, and reductions in milk output in 2010 are R66.7 million (8.1 million in 2014 C$) (Table 16). Using Scalar B, where there are considered to be just ten outbreaks on the 32 affected farms in the survey, the estimated financial losses at the national level from mortalities, abortions and reductions in milk output in 2010 are R213.6 million (26.1 million in 2014 C$) (Table 16). This is in addition to the extra costs of vaccines, insect repellant dips and Terramycin used by many livestock producers throughout South Africa. Also, the losses estimated at the national level do not include identifiable, but unmeasured, costs, including reductions in the value of hides and wool and possible reductions in farm gate prices as a result of international trade barriers erected by certain importing nations. The national estimates do not include costs to the state of supplying vaccines to a high proportion of livestock producers and also do not include any estimates of value of worker time lost due to illnesses caused by RVF or loss of human lives.

Table 16: Estimated national financial losses to Rift Valley fever in 2010 using two scaling factors (in 1,000 current Rand and 2014 C$)

Description	Pregnant ewes/cows	Non Pregnant	Suckling animal	Abortions	Milk	Current Rand	2014 C$
Three Provinces	1 382	47	1 114	990	880	4 413	5397
Estimated National (A)	20 903	711	16 849	14 974	13 310	66 747	816
Estimated National (B)	66 889	2 275	53 918	47 916	42 592	213 590	26 116

Source: Own computation

3.2.3 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. About 71% of revenue losses due to RVF were incurred by sheep farmers. Given the set of speculations about the high rate of abortions and mortalities, the study compared the average revenue losses incurred by sheep farmers who were already vaccinating against RVF before 2010 with those of farmers who only started vaccination in 2010.

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 compared to those who vaccinated only in 2010 and also that state animal health practioners who assisted small-holder farmers with administration of the vaccine applied correct vaccine protocols.

Sheep farmers with sheep herds of 1-100,101-1000 and more than 1000 who vaccinated only during the 2010 outbreaks, incurred mean revenue losses of about R22 040, R50 419 and R302 220 respectively while those with same sheep herds of 1-100,101-1000 and more 1000 who were already vaccinating prior 2010 outbreaks incurred mean revenue losses of R0.00, R47 500 and R75 300, respectively (Table 17).

Another complementary finding was realised between the mean revenue losses of farmers who vaccinated on their own and those who were assisted by the state animal health practitioners. Farmers with sheep herds of 1-100,101-1000 and more than 1000 who administered the vaccine on their own (mainly white commercial farmers) incurred mean revenue losses of about R22 0400.00, R55 555 and R237 386, respectively while those who were assisted by the animal health practioners (mainly black communal and small-holder farmers) incurred mean revenue loss of about R0.00, R18 900 and R0.00 respectively.

Table 17: Comparison of revenue losses with vaccine protocols

Sheep herd	Mean revenue losses of farmers who vaccinated only in 2010 (R)	Mean revenue losses of farmers who vaccinated before 2010 (R)	Mean revenue losses of farmers who vaccinated on their own (R)	Mean revenue losses of farmers who were assisted by the state (R)
1-100	22 040	0	22 040	0
101-1000	50 419	47 500	55 555	18 900
>1000	302 220	75 300	237 386	0*

Source: Own estimation

**No black farmers had sheep herd of this size*.

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 outbreaks with some indicating to have used 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.

4 SUMMARY AND CONCLUSIONS

Recent outbreaks of two important livestock diseases in South Africa, LSD and RVF, have led to questions about the extent of financial hardship incurred by commercial and emerging cattle, sheep and goat farmers. LSD, as its name implies, is a disease where infected animals suffer from the development of large lesions on their skin and internal organs. Pregnant animals develop a fever that might result in abortions, while the fever could result in temporary or permanent sterility in bulls if lesions appear on the genitals. Cows might not come into estrus for several months after the lesions appear, thus delaying calving. RVF can cause mortalities of adult and suckling offspring, abortions, and reduced milk production in dairy cows. In addition, further financial losses can occur when traditional export markets are closed due to trade embargoes placed on live animals and animal products. Also, humans can get infected and become seriously ill, causing missed work days, and even deaths.

The objectives of this study were to:

1) Describe and estimate the extent of disease prevention and control measures practised by livestock farmers in South Africa;
2) Estimate the financial losses incurred by livestock farmers in South Africa as a result of LSD in the Limpopo province in 2011 and Rift Valley fever outbreaks in 2008-2010 in three other provinces (Northern Cape, Eastern Cape and Free State); and
3) Estimate the projected value of new and superior vaccines to the South African livestock economy.

Two surveys of livestock farmers in South Africa were conducted to estimate the extent of extra expenditures and losses in production caused by the two diseases to livestock farmers in South Africa. The first survey was undertaken in early 2013 to estimate the farm-level losses to LSD. That survey was conducted in 12 villages in Marble Hall in the Ephraim Mogale District of Limpopo where isolated incidents of LSD were experienced between 2010 and 2012. A total of 217 individuals were interviewed in the 12 villages. The second survey was conducted to estimate the socio– economic impacts of RVF in South Africa. The survey included 150 livestock farmers in the Eastern Cape, Northern Cape and Free State provinces.

Two municipalities that were severely affected by the 2008-2010 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 municipal districts in the Free State.

Data were gathered on farmer demographics, livestock activities, animal health practices, production and management practices, expenditure patterns on livestock activities and animal losses incurred as a result of the disease outbreaks.

Interestingly, both farmer surveys revealed greater financial losses than have been reported by official sources. Mortalities caused by LSD, based on diagnoses commissioned by the office of Animal Health Services, were reported to be 19 cattle valued at R123 500. However, the survey respondents reported that 68 of their cattle were lost to LSD, resulting in a revenue loss of R442 000. The survey pertaining to RVF 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. Production losses by livestock farmers in the survey (including mortalities, abortions and reduced milk production) were found to be R296 000 in 2008 (36 000 in 2014 C$), R480 000 in 2009 (59 000 in 2014 C$), and R4.4 million in 2010 (540 000 in 2014C$). In 2010, production losses on surveyed farms in the Eastern Cape were found to be R1.8 million (220 000 in 2014C$), 2.5 million in the Northern Cape (300 000 in 2014 C$), and R149 000 in the Free State (18 000 in 2014 C$).

Two methods were used to scale the 2010 survey results of financial losses due to RVF to the national level. The first method was extremely conservative and resulted in an estimated loss at the national level of R66.7 million (8.1 million in 2014 C$). Possibly, a more realistic scaling factor resulted in an estimated total national production loss in 2010 of R213.6 million (26.1 million in 2014 C$). These estimates are based on five types of losses reported by farmers in the survey: deaths of pregnant ewes/cows, deaths of non-pregnant ewes/cows, deaths of suckling animals, abortions, and reductions in milk produced.

The estimates do not include possible losses in production of other animal products, such as hides, wool, and mohair. Also, these estimates do not account for possible reductions in prices of animals or animal products that resulted from trade restrictions during the outbreak, which

might have been at least partially offset by increased domestic prices as a result of reduced supply. Data were not available to assess the extent, if any, of these types of losses.

The losses reported in the RVF survey occurred despite the relatively high rate of vaccinations against the disease. More than 90% of survey respondents indicated they vaccinated their livestock in 2010, although less than half used their own funds to purchase the vaccine. The others were provided vaccines by the State. Most vaccinated their entire herds, especially in 2010 when the disease hit hardest. Over the three years, farmers in the sample spent R480 000 (61000 in 2014 C$) on vaccinations. Furthermore, they spent R2 million (240 000 in 2014 C$) on dipping and R18 000 (2000 in 2014 C$) on Terramycin in attempts to control biting flies and boost their animals' immune systems.

There were some other interesting findings in the survey of famers in the three provinces: Eastern Cape, Northern Cape and Free State. 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 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.

Since almost all farmers in the sample used biosecurity measures and a high percentage used a general vaccination program, little can be gleaned from the data about the benefits of vaccination against RVF. Of the 116 farmers who vaccinated all their animals, 36 reported losses and 80 did not. Of the 25 farmers in the sample who vaccinated only part of their flock (herd), 15 incurred losses and 10 did not.

However, careful analysis of the data collected in the survey failed to "tease out" any significant relationship between vaccination and either the numbers of animals lost or the value of losses. 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.

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 in 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.

Also of concern to the authors is the estimate of total national financial losses to the livestock industry as a result of RVF. 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. While realizing 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. Several commercial farms in the sample were very large.

Among those that reported mortalities were farms that contained 280 cattle and 7 000 sheep, 2 000 cattle and 10 000 sheep, 100 cattle and 6 000 sheep, and many others that were very large commercial operations. If the five largest farms that reported mortalities are removed from the data, the average number of animal deaths on the remaining 27 farms was still 51 animals. Lack of knowledge about the sizes of farms and extent of production losses in other areas of South Africa where RVF was reported in 2010 makes any estimates of losses at the national level precarious. Nevertheless, from data recorded in the farmer survey, it appears that the extent of financial losses to RVF in South Africa in 2010 has been seriously underreported.

One of the objectives of this study was to estimate the projected value of new and superior vaccines to the South African livestock economy. This became impossible to do with any precision since the vast majority of respondents to the farmer survey had vaccinated most or all of their animals.

However, by comparing mean revenue losses with vaccine protocols followed by farmers it seems clear that there is considerable scope to reduce financial losses in any future outbreak of RVF with improved vaccines and vaccination protocols.

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APPENDIX A: QUESTIONNAIRE USED IN LUMPY SKIN DISEASE SURVEY

Name:_____ DATE:_____ QUESTIONNAIRE NO._____

Village: _____ Farmer group: _____

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

1. Age in years

a) <20 ☐

b) 21-30 ☐

c) 31-40 ☐

d) 41-50 ☐

e) 51-60 ☐

f) >60 ☐

Part 2 – LIVELIHOODS

1. Sources of income for your household

a) List your sources of income
b) Rank your sources of income in order of importance and contribution to total income

Source of income	**Rank**	**Contribution to total income** Percentage

Part 3 - SOCIO ECONOMIC IMPACT OF LSD

1. Indicate which animal diseases you experienced during 2008-2012

Name of the disease	2008	2009	2010	2011	2012

2. Please indicate the direct losses you incurred during the outbreak of each the first five diseases per type of livestock

i) Direct losses incurred due to 2010 LSD outbreak

Losses	Cattle	Sheep	Goats

ii) Direct losses incurred due to

Losses	Cattle	Sheep	Goats

iii) Direct losses incurred due to

Losses	Cattle	Sheep	Goats

iv) Direct losses incurred due to

Losses	Cattle	Sheep	Goats

3. In terms of losses incurred from these diseases, which disease ranked first.

Animal disease	Rank	Weight

4. What did you do during the LSD outbreak to minimize the losses experienced?

5. What intervention/ advice did you receive during the LSD outbreak?

6. Please indicate the relative importance of the above-mentioned animal diseases in terms of the losses

Losses	LSD			

7. Costs and losses incurred during the outbreak of LSD outbreak

7.1. Please indicate the operational costs you incurred during the LSD outbreak e.g surveillances

7.2. How did the LSD outbreak affect your normal day-to-day activities?

7.3. Post-impact of LSD outbreak on cattle productivity

Impact	Cattle		Sheep		Goats	
	Before	After	Before	After	Before	After
Calving rate						
Lambing rate						
Mortality rate						
Milk production						
Hides and skin						

8. EXPENDITURE ON LIVESTOCK ACTIVITIES

8.1. Generally, how much do you spend on veterinary services /month?

	Item	Cost
Cattle		
Sheep		
Goats		
Other		

APPENDIX B: QUESTIONNAIRE USED IN RIFT VALLEY FEVER 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		Aborti	
	Pure	Crossed	Pure	Crossed	Pure	Crossed	Pure	Crossed	Pure	Crossed	Pure	Crossed	Pure	Crossed	Pure	Cr
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 informatio

	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?
