UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Livestock Traceability Systems in Swaziland and Namibia: Towards an Impact-for-Sustainable-Agriculture Framework

---

Tania Prinsloo

Submitted in fulfilment the requirements for the degree

Philosophiae Doctor

in the

Department of Informatics

Faculty of Economic and Management Sciences

University of Pretoria

Supervisor: Prof. Carina de Villiers

September 2017

Declaration

I, Tania Prinsloo, hereby declare that the thesis titled

Livestock Traceability Systems in Swaziland and Namibia: Towards an Impact-for-Sustainable-Agriculture Framework

Is my own work and that sources consulted have been fully acknowledged and referenced in accordance with departmental requirements.

I declare that this work has not been presented to any other university for assessment purposes.

Tania Prinsloo

September 2017

Abstract

Food security and food safety go hand-in-hand, where consumers of meat products demand to know whether the meat products they have bought are safe for human consumption. Livestock traceability systems are now mandatory if one wants to export meat, especially after recent food scares and the risk of eating meat from cattle with Bovine Spongiform Encephalopathy (BSE), more commonly known as mad cow disease. Europe has a beef shortage and imports large quotas of meat from developing countries, such as Swaziland and Namibia, but their strict regulations and legislation make the effectiveness of the two countries' traceability systems non-negotiable.

Swaziland upgraded their paper-based system to a modern computerised system, called the Swaziland Livestock Information and Traceability System (SLITS), started tagging communal farmers' cattle free of charge in 2010 and implemented SLITS fully in 2014. The system is widely adopted and the success of the project is seen throughout Swaziland. Namibia expanded their traceability system, the Namibian Livestock Identification and Traceability System (NamLITS) to trace the cattle of communal farmers in the Northern Communal Areas (NCAs), an area excluded from any exporting of meat products because of the high risk of exposure to foot-and-mouth disease. Their cattle were ear-tagged and captured on NamLITS, ensuring that full traceability is in place.

The new, expanded NamLITS and upgraded SLITS systems enabled the researcher to investigate the impact that traceability systems have on communal farmers, the benefactors of the two traceability systems. Two visits to Namibia and four visits to Swaziland were made, where the rich traceability culture was experienced, key stakeholders and system developers interviewed and questionnaires completed by the Swazi veterinary assistants and the Namibian animal technicians, the first point of contact with the communal farmers, but also fulfilling the role of key informants. Creating sustainable projects remained important to the researcher, and the element of sustainability became interwoven with the impact of the traceability systems on communal farmers.

This thesis explores all the aspects of the data gathered, keeping in mind all the legislative requirements of traceability and its different aspects, and combines the two key elements of development projects, sustainability and making a real impact into a single framework, called the impact-for-sustainable-agriculture framework.

This new framework is then applied to two case studies, concluding that the more layers of the three-layered framework one understands to be of importance and implements, the greater the probability of creating sustainable agricultural projects.

Two case studies are discussed in parallel to create a consistent approach. The different layers are discussed in separate sections, enabling the reader to follow the build-up of the evidence to support the final framework. The thesis concludes by highlighting the main theoretical contributions: the design and application of the new framework; the methodological contributions in the data collection process, the documentation of the evidence and the final full picture of both countries, and the practical contributions: the witnessing of a rural dipping event, cattle dehorning and branding, attending a meeting with a group of anxious animal technicians in the midst of a foot-and-mouth disease outbreak in the NCAs, and telling the story of the communities from the perspective of having been there. Finally, possible future research aimed at investigating traceability systems in other parts of Southern Africa and applying the proposed framework to other developmental projects is suggested, as well as further enhancements to the proposed framework.

Key words: Traceability, SLITS, NamLITS, sustainability, impact assessment, impact-for-sustainable agriculture framework.

Dedication

To Simon, my loving husband, who had the courage to challenge me.
I dedicate this thesis to you.

Acknowledgements

As is true for any journey, one cannot complete it without support. I would like to extend my sincere gratitude to the following people:

- My supervisor, Professor Carina de Villiers: You had patience with me beyond my own understanding, you encouraged me when I felt like giving up, and you supported all my unique, crazy ideas, with guidance and good advice. Thank you for not giving up on me, for being more than a mentor, for sometimes counselling and often motivating me. You introduced me to meaningful conferences, where I gained confidence in my research, you sponsored me to attend the IST Africa conference, and you were always positive. If it had not been for you, I would not have reached the end; my sincerest thanks are due to you for everything you did and meant to me.
- The former head of the Department of Informatics, Professor Alta van der Merwe: You asked me why on earth I wanted to do research in Swaziland and Namibia when I lived and worked in Gauteng, and immediately after that arranged a flight for me to go to Namibia. You were a problem-solver, and whenever I needed any help, you jumped in right away. Thank you for giving me a deadline, and believing in me. And also for giving me the time I needed to complete the thesis. You are an inspiration, and I admire your go-getter attitude.
- Our dean, Professor Sunil Maharaj, for giving me special Chancellor's leave for the first semester of 2016.
- Ms Joyce Jordaan and Ms Janet van Niekerk for their assistance in the statistical analysis of the questionnaires.
- Professor Cheryl McCrindle, my muse, my mentor, my inspiration. You changed the way I approach my research, gave me encouragement and enthusiasm, you made a life-long impact. Thank you very much.
- Staff members in our Department who encouraged me and gave meaningful advice.
- My husband, Simon Prinsloo, for really believing in my abilities, for financial and emotional support and for rewarding hard work. You are my rock, my friend, my confidant, and the love of my life. Thank you for everything; you transformed me into the academic that I was born to be. And finally, thank you for introducing me to the fascinating world of traceability.
- My dad, Steve de Lange, for being more than supportive, for proof-reading my work before I sent it to my supervisor, for being extremely positive and for just being there for me.
- My mother, Christine de Lange, for countless talks, drying my tears, and for setting an example to finish what one starts. Thank you for all your help in transcribing my interviews; it was an immense help!

- My parents-in-law, Louis and Lettie Prinsloo, for travelling with me to Swaziland to gather data.
- The following people who influenced my research:
    - Mr Fanie Erasmus, for the interviews and advice. My first informal discussion was with you and Simon, and it made me believe in what I was about to embark on.
    - Mr Merwe Fourie, for showing me how a Toughbook and RFID reader work, and for taking me to the farm to experience branding and dehorning of cattle. You also helped a great deal in finding the right people to be interviewed and arranging visits to the Namibian Meat Board, in meeting the animal technicians in the Northern parts of Namibia, and even the Acting Permanent Secretary of the Namibian Ministry of Agriculture.
    - Dr Kamwi, Dr Bishi, Dr Luvalha, Dr Kaseke and Mr Nehemia, for all the help and assistance to make my trip to the Northern parts of Namibia possible.
    - Dr Sihle Mdluli in Swaziland, who gave me so much background information on SLITS; you are the project champion and you helped with the distribution of some of the questionnaires in Swaziland. You became a friend and you play an enormous role in the success of SLITS. I admire your hard working nature, your friendliness and above all, your time spent on my research data gathering.
    - Mr Samson, who took me to a rural dipping event, who acted as a translator, and who drove me to various remote places.
    - Dr Dlamini, the head of the State Veterinary Services, for his time and his convictions about the success of the traceability system.
    - All my other family members and friends for just being there.
- Finally, my Lord and Saviour, for strength throughout my journey.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

BSE	Bovine Spongiform Encephalopathy
C4D	Communications-for-Development
CCA	Central Competency Authority
CCIA	Canadian Cattle Identification Agency
CJD	Creutzfeldt-Jakob disease
COOL	Country-of-Original Labelling
DNA	Deoxyribonucleic Acid
DVS	Director of Veterinary Services
EU	European Union
EUREPGAP	European System Related to Good Agricultural Practice
FAO	Food and Agriculture Organisation of the United Nations
FMD	Foot-and-Mouth Disease
GDP	Gross Domestic Product
GFSI	Global Food Safety Initiative
GLOBALGAP	Global Partnership for Good Agricultural Practice
HACCP	Hazard Analysis and Critical Control Points
IAASTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
ICT4Ag	Information and Communication Technology for Agriculture
ICT4D	Information and Communication Technology for Development
IFAD	International Fund for Agricultural Development
IMF	International Monetary Fund
ICIS	International Conference on Information Systems
IS	Information Systems
ISO	International Organisation for Standardisation
LCA	Life Cycle Assessment
MDGs	Millennium Development Goals
NAIS	National Animal Identification System
NamLITS	Namibian Livestock Identification and Traceability System
NCA	Northern Communal Area
NIKMAS	National Indigenous Knowledge Management System
NLIS	National Livestock Identification System
OECD	Organisation for Economic Cooperation and Development
PESTeL	Political, economic, social, technological and legal
PDO	Protected Designation of Origin

PGI	Protected Geographical Indication
RCBTS	RFID Cattle/Beef Traceability System
RFID	Radio Frequency Identification
SAM	Sustainable Agroecosystem Model
SBA	Stock Brands Act
SDGs	Sustainable Development Goals
SGS	“Sistema de Gestion Sanitaria”
SLITS	Swaziland Livestock Information and Traceability System
SMI	Swazi Meat Industries
SNL	Swazi National Land
SWAPO	South West African People’s Organisation
TAM	Technology Acceptance Model
TBT	Technical Barriers to Trade
TDL	Title Deed Land
TSE	Transmittable Spongiform Encephalopathy
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USAID	United States Agency for International Development
USD	United States Dollar
VCF	Veterinary Cordon Fence
WHO	World Health Organisation

1. Chapter 1: Introduction

Research is to see what everybody else has seen, and to think what nobody else has thought.
Albert Szent-Gyorgyi

1.1. Background

At the 2010 Summit on the Millennium Development Goals the first goal set was to eradicate extreme hunger and poverty. It is evident that this ambitious goal is still far from having been attained, with the 2015 deadline to halve, between 1990 and 2015, the proportion of people who suffer from hunger (United Nations, n.d.). The world needs sustainable food production to guarantee both food security and food safety, but is facing an increase in food demands and a decrease in land available for food production (Hobbs, 2007). Rural people in Africa still suffer from poor health, lack of education, underdeveloped markets, poor infrastructure and poor communication (Carney & Britain, 2003). In Sub-Saharan Africa, many countries experience high levels of poverty and hunger, stagnant agricultural production and rising food shortages (Wik, Pingali, & Broca, 2008), with no per capita increase in agricultural output. If one reduces rural poverty, an overall poverty reduction is achieved in that country (World Bank, 2007).

Food security and food safety remain important issues, and developing countries in Southern Africa have been playing a significant role in exporting safe meat to Europe and other parts of the world. Commercial farmers benefit mostly from exporting their meat, but recent initiatives aim to empower rural farmers to become exporters too. Swaziland started ear-tagging communal farmers' cattle in 2012, free of charge, and captured all livestock in a centralised, electronic database called SLITS (Mdluli, 2012). Namibia is currently targeting the Northern Communal Areas (NCAs) to allow these previously quarantined areas to export, strictly controlling and monitoring disease outbreaks, especially foot-and-mouth disease. The animals are also ear-tagged and captured on NamLITS, the predecessor of SLITS (Fourie, 2013). Communal farmers, both in Swaziland and Namibia, are now in the unique position to gain from selling their livestock for slaughter. For the purpose of the study, a communal farmer is defined as a farmer that lives in shared communal grazing areas, and the communal grazing serves as the main feed resource base for livestock (Food and Agricultural Organization, n.d.).

To ensure sustainable Information and Communication Technology (ICT) for agricultural development, a number of critical success factors have to be incorporated into one's project, such as simple and clear project objectives, including socially excluded groups, an understanding of the local political context, focusing on self-sustainability and building local partnerships (Pade, Mallinson, & Sewry, 2009). The role of the project champions is key to achieving the desired outcome, seeing that they put themselves “on the line in order to drive projects forward” (Renken & Heeks, 2013). Together the three pillars of sustainability – the economic, social and environmental pillars (Kahn, 1995), the sustainable livelihoods with the emphasis on helping people reach their potential (Carney & Britain, 2003) and the measuring of the impact of the new technology on the communal farmer in terms of an impact assessment framework (Heeks & Molla, 2009) – form a holistic approach to sustainability, sketching a clear picture of the necessary ingredients to create a successful project.

1.2. Purpose and aim of the thesis

Europe has a beef shortage and food security is high on their list of priorities. Legislation enforced by developed countries has made it increasingly difficult for poorer countries to adhere to the standards of beef exports to Europe to guarantee food safety. This leads to thousands of dollars being spent on implementing livestock traceability systems, money often funded by the developed communities themselves. There are numerous rules and regulations for a country to adhere to in order to become an exporter, including preventative quarantine measures when moving cattle, as well as reactive quarantine measures in the case of disease outbreaks. Southern African countries, including Botswana, Namibia and Swaziland, have been exporting quotas of meat to Europe, adhering to strict regulations and laws. Initially commercial farmers were targeted, but in recent years the role that communal farmers can play has become more evident and measures were put in place to assist communal farmers as well to become role players in this market. Livestock traceability systems cater for communal farmers, with ear-tagging initiatives, quarantine measures for certain regions and assistance to export to other countries (Schultz, 2013).

Swaziland implemented their traceability system called the Swaziland Livestock Information and Traceability System (SLITS) in 2012. A similar initiative was implemented in another Southern African country, Namibia, where the Namibian Livestock Identification and Traceability System (NamLITS) was expanded to include the previously excluded NCAs, starting in 2010, where more than half of Namibia’s cattle are found. During the research Swaziland was visited four times and Namibia twice, and the events diarised.

The impact of new technology on the lives of communal farmers is central in this study, and introduces a conceptual framework built around the success of both traceability systems to investigate what makes certain agricultural projects sustainable, and to summarise the findings in a new framework that can be applied to other agricultural initiatives and projects.

1.3. Problem statement

In view of recent developments in the tracking and tracing of livestock in the world, the once excluded communal farmers of Swaziland and Namibia now have the potential to export their meat to other countries. This can have a huge impact on the future of livestock traceability in growing economies. The problem is no research have been done on whether the communal farmer benefit from livestock traceability systems. Is this just another idea that looks worthwhile, but is not realised in practice? The impact of livestock traceability on communal farmers is included as part of the study by reviewing the potential impact of them.

Another problem is to identify a specific framework by which ICT-linked agricultural development projects can remain sustainable. The success of any ICT development project relies on "its ability to remain sustainable" (Pade et al., 2009). One possible way of measuring sustainability is by designing a framework encompassing different elements of sustainability and the impact of new technology on a certain population group. A key element is to use cases that have shown potential to be sustainable over a number of years.

A second problem is how to determine the impact of livestock traceability systems in Swaziland and Namibia's communal farming communities. In order to do so, the impact of these systems would have to be examined from various angles, including the roles and tasks of governments, the European Union (EU), commercial farmers, the export quotas and food safety. A possible solution to this problem could be to build a framework that explores the interaction of these factors. Communal farmers are included as part of the study by reviewing the potential impact of the new revenue stream, and how it can change their lives as the beneficiaries of the systems.

1.4. Main research question

The main research question examined in this thesis is the following:

What framework can be designed to evaluate the introduction of ICT-linked livestock traceability on communal livestock farmers in Swaziland and Namibia?

The proposed framework is discussed by breaking down the main research question as follows:

1.5. Secondary research questions

The following secondary research questions are asked in terms of the main research question:

1.5.1. Question 1: How could ICT-linked livestock traceability be designed and implemented to be sustainable in each country?

This question is sub-divided into two questions:

- Under what conditions are livestock traceability systems sustainable in Swaziland?
- Under what conditions are livestock traceability systems sustainable in Namibia?

Without creating sustainable projects that can continue after external funding has been withdrawn any initiative fails, resulting in yet another statistic. The world wants to invest in successful projects and this secondary research question aims to determine the specific elements of the traceability systems that make it a success.

Livestock traceability systems are expensive and time-consuming to implement, and buy-in is needed from various stakeholders, especially the people who aim to benefit most from the initiative, in this case communal farmers of Swaziland and Namibia. The study will explore the direct as well as indirect impact that livestock traceability systems have on communal farmers.

1.5.2. Question 2: How could the impact on communal farmers be examined and evaluated?

First, a framework is suggested as an approach to draw conclusions from.

Second, an approach for evaluating the impact of communal farmers could be an economic analysis done on data obtained after the implementation of the ICT-linked traceability system, in one or both countries.

The following breakdown also forms part of this research question:

- What is a communal farmer?

One needs to understand what is meant by a communal farmer compared to a commercial farmer in this context.

- Why does the communal farmer have a role to play?
- What is the impact of livestock traceability systems on the communal farmer in Swaziland?
- What is the impact of livestock traceability systems on the communal farmer in Namibia?

Both these questions are explored in their specific contexts, with the aim of identifying specific developmental impacts on the communal farmer.

1.6. Assumptions and limitations

The following assumptions were relevant:

1. It was assumed that the communal farmers of Swaziland and Namibia would cooperate in gathering the relevant facts and data.
2. It was also assumed that all the parties involved would have a contribution to make as key informants.

3. Furthermore, it was important to assume that the results presented would be accurate, bearing in mind that communal farmers cannot be questioned directly as they speak native languages. This obstacle was overcome by using the Swazi veterinary assistants and the Namibian animal technicians to act as key informants, as they not only play a role in the community, speak the native language and are involved in dipping events, but also a reliable source of information, given that they are trusted and respected in their communities.
4. Not all animal technicians and veterinary assistants could answer questions or complete questionnaires; therefore the study would have to rely on generalisation.
5. The analysis of the data was done with the help of statisticians, and accepted as true, verified and accurate.

The following limitations should be mentioned:

1. Legislation in terms of food safety and traceability highlight only some of the most prominent laws and regulations.
2. Traceability systems used worldwide are briefly discussed in the literature review in Chapter 2; however, not all traceability systems are discussed, and only a short summary of the main elements of a country's specific traceability system is provided. The summary is not extensive as it provides only the context in terms of the evolution of traceability systems.
3. The study also explores the impact on the communal farmer after the traceability systems have been introduced.
4. ICT success stories are discussed, but it is mostly summarised, as the literature is very wide and there are simply too many examples to ensure that all aspects are addressed.
5. The study is limited to livestock traceability systems in Swaziland and the Northern areas of Namibia.
6. Not all the resources in the two countries were researched exhaustively.
7. The study was conducted over a number of years, from 2011 to 2016, and previous years' data was gathered through literature that was deemed accurate.
8. Where no data could be gathered because of lack of time or resources, the researcher relied on previous years' literature.
9. A binomial scale consisting of "Yes" and "No" responses is used instead of the more traditional Likert-scale in the questionnaires.
10. Information relating to rural farmers in Swaziland and Namibia could not be gathered directly from the farmers themselves, as the farmers speak their own languages, but it was believed that the necessary information would become evident through observation, gathering data from case studies and distributing questionnaires to the officials that visited the rural areas on a frequent basis, are well-known and trusted in their communities and act as key informants..

1.7. Brief chapter overview

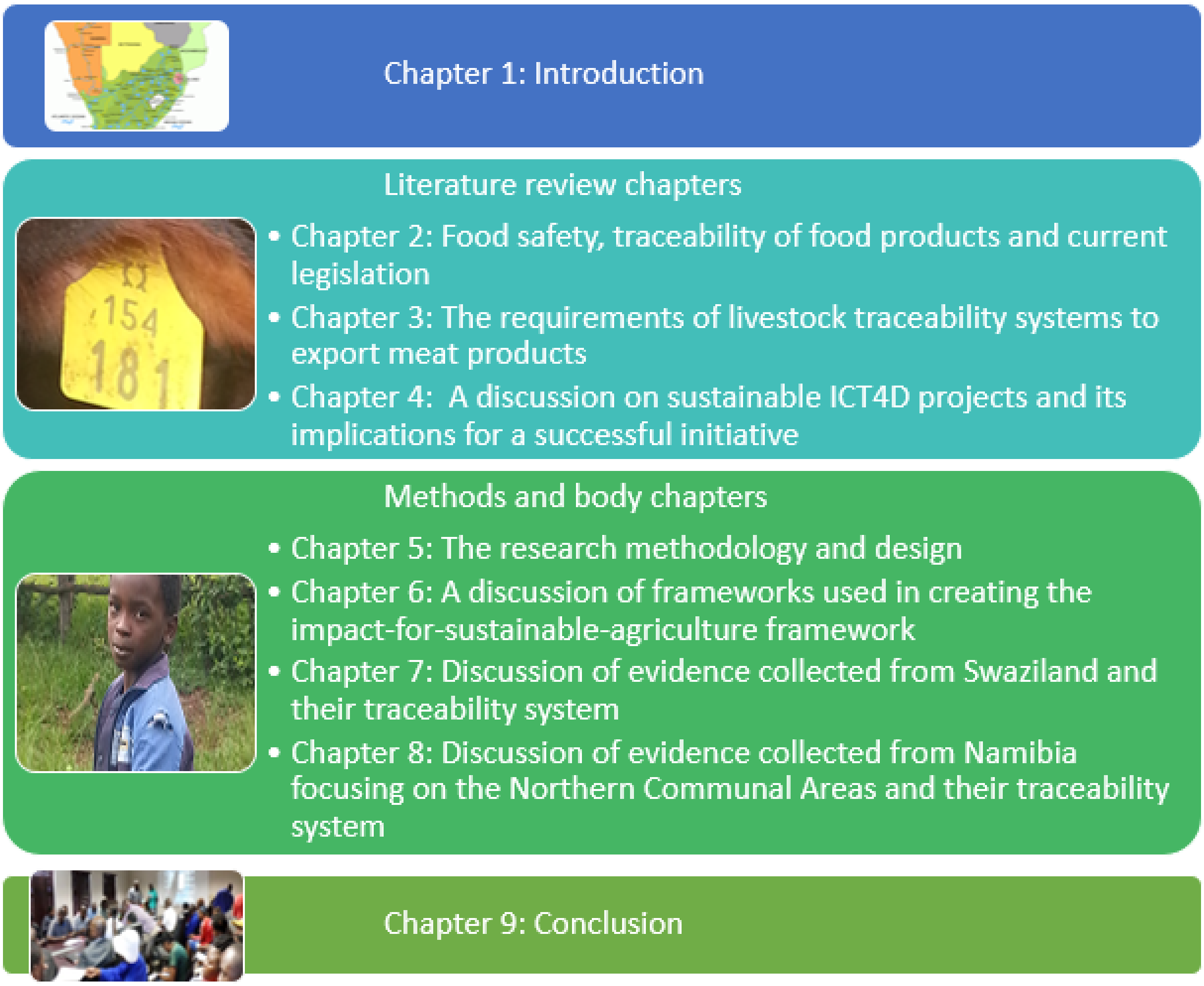


Figure 1. Chapters forming part of this thesis

This introductory chapter is followed by three literature review chapters, firstly looking at food safety and the need for traceability and current legislation, secondly at all the requirements that a traceability system needs to incorporate, and thirdly discussing sustainability and critical success factors of successful developmental projects, or reasons why the projects failed. The methods and case study sections follow, and in Chapter 5 the research methodology and design are discussed, followed by Chapter 6, the design of the proposed framework. The next two chapters explain the evidence gathered in Swaziland and Namibia, especially as it applies to the proposed framework. Chapter 9 concludes the thesis by reflecting on the research problem and research questions, summarising contributions and suggesting future research.

1.8. Research methods

The research design is a combination of four different instruments of information. The first source used is case study data, where visits to Namibia and Swaziland set the scene for communal farmers and their environment. These also provided the researcher with first-hand experience of the different geographical areas, the people and culture and the impact that these factors have on communal farmers.

The second instrument used was personal interviews with role-players in Swaziland and Namibia. The interviews were conducted from 2012 to 2015 and were transcribed and used as reliable sources. The interviews were a combination of structured, semi-structured and informal discussions. There were eight interviews in total. The interviewees ranged from animal technicians and veterinary assistants, to government officials, and also included the developers of both the Swaziland and Namibian livestock traceability systems.

The third instrument was a questionnaire, specifically aimed at animal technicians and veterinary assistants, to capture as much as possible information relating to communal farmers, and how they interact with the traceability system. The questionnaire was designed to capture qualitative data by means of asking the participants open-ended questions, but also to capture quantitative data to validate key findings statistically. The quantitative data was illustrated as cross-tabulation graphs, along with the Chi-Square test results obtained from using the software package SPSS.

The final instrument comprised documents from both the Namibian Meat Board and the Swaziland Meat Industries, supplying accurate and current information.

The research design consisted of a proposed framework, with three different existing frameworks used as the basis for the new framework. The three frameworks were used as building blocks, looking through three lenses: the first being the pillars of sustainability, the second the agriculture-for-development agenda policy framework, and the third an impact assessment framework model – the communication-for-development model – adjusted to accommodate the new technology that was introduced. The three building blocks were used to propose a new framework, called the impact-for-sustainable-agriculture framework.

1.9. Significance of this study

This study contributes to the ICT4D body of knowledge in the following three areas:

1.9.1. Theoretical contributions

This study makes a theoretical contribution in that it combines a number of frameworks into a single, new framework, called the impact-for-sustainable-agriculture framework, and combines unique features and aspects of three existing frameworks.

1.9.2. Methodological contributions

The data collection process, with the number of visits to Swaziland and Namibia, creates a unique way of looking at livestock traceability systems, with the different instruments, the case studies, interviews and questionnaires together forming a complete picture of the environments in which communal farmers live and work daily through observations and questionnaires completed by trusted members of their communities acting as key informants.

1.9.3. Practical contributions

The practical contribution lies in the fact that events were witnessed, people were talked to and opinions asked and documented, making it more than just a theoretical study.

1.10. Conclusion

This chapter lays the foundation for the thesis, and briefly touches on the main elements to follow in the next chapters. The background to the research is sketched, with the purpose and aim of the thesis outlined. The research problem is then identified, clearly indicating assumptions and limitations. The research questions are outlined, and the chapter concludes with a short summary of the research methods. The next chapter introduces the first literature review chapter, and starts with a definition and explanation of traceability systems, and what has led to the need for tracking and tracing livestock meat products.

2. Chapter 2: Food safety, traceability of food products and current legislation

EU regulations are more complex than the moratorium – there's also traceability and labelling regulations. Michelle Gorman

2.1. Introduction

This chapter starts with a brief introduction to current development goals and challenges faced in the world's agricultural sector. The focus then shifts to food security and food safety aspects and how they link to traceability systems. Traceability is then defined, with specific reference to livestock traceability. Legislation and certification are addressed, showing the complexity of adhering to all laws and regulations. Traceability systems and their implementation worldwide follow, providing the background of how traceability and associated systems have evolved over the last three decades, thus concluding Chapter 2.

2.2. Development Goals

The Millennium Development Goals Report of 2015 has set out to achieve eight goals, the first of which is to "eradicate extreme hunger and poverty" (United Nations, 2015).

These are the remaining seven goals:

MDG 2: Achieve universal primary education.

MDG 3: Promote gender equality and empower women.

MDG 4: Reduce child mortality.

MDG 5: Improve maternal health.

MDG 6: Combat HIV/AIDS, malaria and other diseases.

MDG 7: Ensure environmental sustainability.

MDG 8: Develop a global partnership for development.

The report indicates that Sub-Saharan Africa has a population of which 41% lived on less than $1.25 per day in 2015, the lowest in the world. One in seven children is underweight, and the poorest of poor remains undernourished. The United Nations Educational, Scientific and Cultural Organisation (UNESCO) lists seventeen Sustainable Development Goals (SDGs), the first of which is to ensure "no poverty" and the second "zero hunger" (UNESCO, 2015). It is against this backdrop of poverty and hunger that the world is aiming to supply enough food for future generations. The agricultural sector is under constant pressure to fulfil the basic need of sufficient food for the world's populace.

2.3. Modern-day pressures on the agricultural sector

The agricultural sector had the immense task of feeding more than 7.3 billion people in 2015 (Population Reference Bureau, 2015), a number estimated to reach 9.19 billion in 2050 (Thornton, Jones, Ericksen, & Challinor, 2011). Agriculture as a whole is facing several challenges, with climate change at the top of the list (Devendra, 2012; Ildikó & Rădulescu, 2015; Kotir, 2011; Thornton et al., 2011). The average world temperature is increasing by as much as 4°C (Thornton et al., 2011), an increase that will reach its full impact by 2050, but likely to happen even sooner. What happens beyond 2050? Climate change has become an undeniable challenge and it has the following effects on agriculture:

2.3.1. Land use

Smallholder farms are decreasing, land is degrading and farming practices are becoming unsustainable, land prices are increasing and farming income growth inadequate, failing to reach the poor (Jayne, Chamberlin, & Headey, 2014). Public expenditure in agriculture decreased from 7.1% in 1980 to 6.3% in 2005 in Sub-Saharan Africa, with other expenditures, excluding education, health, transport, social security and defence, increasing from 40.1% to 55.1% in the same period (Fan, Omilola, & Lambert, 2009), leaving one with the impression that Sub-Saharan Africa is inadequately concerned with the threats of inefficient land usage.

2.3.2. Crops

Only certain crops, including cotton, maize and soybean have been genetically modified to withstand the impact of climate changes (Anderson, Harrigan, Rice, & Kleter, 2016). The rising temperatures and insufficient water supply affect growth, leaf formation and flowering in crops (Devendra, 2012). Keeping these challenges in mind, efficiency measures, such as accurately measuring rainfall, effective use of nutrients and enhancing labour practices can aid in using resources optimally (Keating et al., 2010).

2.3.3. Animals

Animal welfare decreases in areas where there is insufficient feed or poor health caused by diseases, and certain selective breeding practices result in "congenitally harmed animals" (Garnett et al., 2013). In poorer countries, a large portion of the population owns animals for their own consumption, but not enough is being done to address the issues of heat stress on the animals, insufficient availability of feed resources and control of disease outbreaks (Devendra, 2012).

2.3.4. Water

There are only so many freshwater resources available in the world, with water quality declining (Rockström, Barron, & Fox, 2003). As the world population is increasing, more freshwater is needed for human consumption, thus necessitating improved infrastructure to supply water to the poor (Nchuchuwe & Adejuwon, 2012). The effect of the worst drought in 50 years is devastating the agricultural sector as a whole in Sub-Saharan Africa (McFerron, Almeida, & Davison, 2016).

2.3.5. Urbanisation

Urban areas have better infrastructure, employment opportunities, and access to health services (Nchuchuwe & Adejuwon, 2012), making them more attractive to younger people. According to Muhammed (2007), governments are not investing as sufficiently in agriculture as they should, but rather in agricultural trade, resulting in the primary agricultural sector being in decline.

Other challenges include the following:

1. The urgent need for sustainable development (Carney & Britain, 2003; Garnett et al., 2013; Movileanu, 2011; Ohlsson, 2010; Ringius, Downing, Hulme, Waughray, & Selrod, 1996; Stephen, 1996).
2. Meeting the challenge to provide a healthy diet for the poor (Saghir, 2014).
3. A lack of eco-efficiency and wastage of scarce resources (Keating et al., 2010).
4. Eradicating soil erosion (Iglesias, Quiroga, Moneo, & Garrote, 2012; Keating et al., 2010).
5. Severe drought in wide areas, not only limited to Africa (Cheeseman, 2015; Kampragou et al., 2015).

Agriculture faces a three-fold challenge: there needs to be an increase in agricultural production, it needs to reduce inequality, and it must do so in a way that prevents resource degradation (Bharucha, 2013). Food security is measured by assessing whether a country has enough food to meet the dietary requirements of its inhabitants and also has a strong focus on the supply of food products (Pinstrup-Andersen, 2009), keeping in mind that it drills down to community, household and individual level (Leroy, Ruel, Frongillo, Harris, & Ballard, 2015). Figure 2 shows the global loss of net primary production of agricultural land, clearly highlighting Southern and Central Africa as the primary areas of concern. The overall degradation of soil worldwide is estimated at 38%, but Africa suffers the most from soil degradation, with a percentage as high as 65% (Carney & Britain, 2003). Swaziland situated in the south western region of Africa, shown in Figure 2 is at a very high risk.

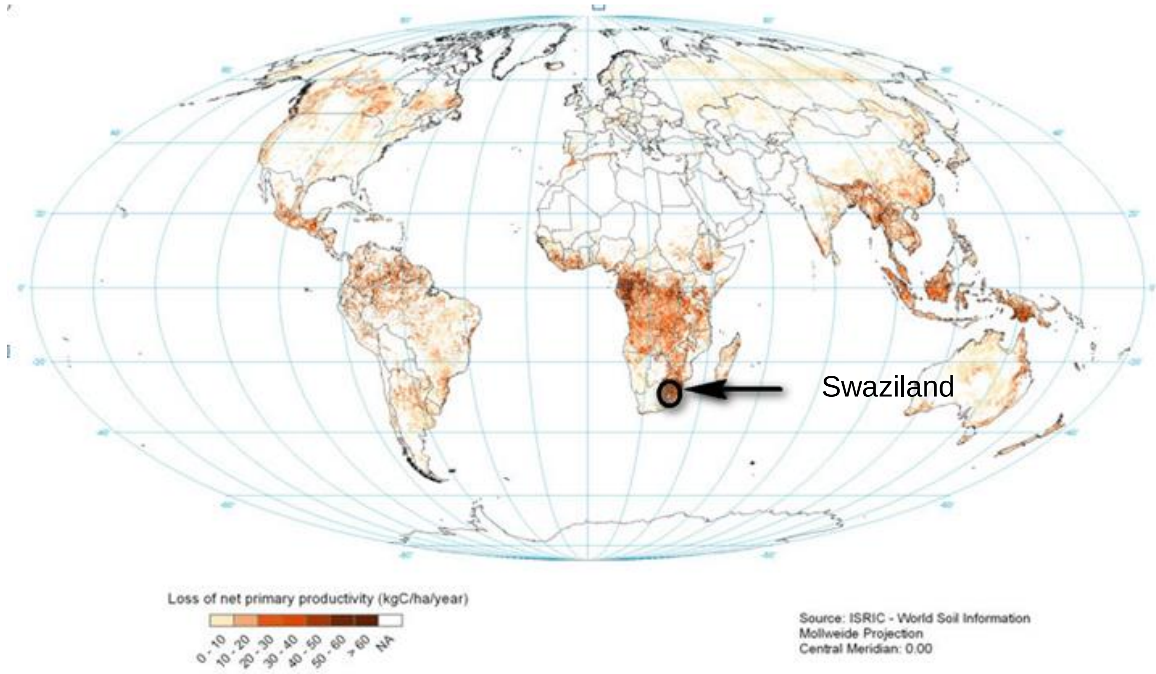


Figure 2. Global loss of net primary productivity in degrading areas, 1981–2003 (Adopted from FAO (2008))

One has to take into account all the challenges currently experienced, but keep in mind that the world needs food security in tandem with food safety.

2.4. Food security

In 2008 the world experienced an economic recession that not only led to higher food prices, but also increasing hunger rates (McMichael & Schneider, 2011). The Food and Agriculture Organisation of the United Nations (FAO), the Organisation for Economic Cooperation and Development (OECD), the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), the International Fund for Agricultural Development (IFAD), the World Trade Organisation, Oxfam and other organisations make it their goal to expand agricultural outputs. These organisations have different focus areas, but the one central goal is to safeguard food security. However, their definition of food security implies it is only for a small minority of the population, an argument made by McMichael and Schneider (2011). The authors further argue that worldwide agricultural trade is encouraged, with developed countries trading computers, designer handbags, and even motor vehicles for agricultural products from developing countries. Food prices continue to increase, and the agricultural sector has to keep up with the rising demand. Although international organisations make promises to poor countries, protecting them from unfair trade, limiting the dumping of cheap agricultural excess products, and monitoring one-sided competition (Sasson, 2012), promises are not always kept. Over 800 million of the current population is classified as either being hungry or malnourished (McGuire, 2015).

The United State Agency for International Development (USAID) defines food security as follows:

"Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life." (World Food Summit, 1996).

The definition focuses on three dimensions – with food availability and access grouped together in this scenario – according to Riely, Mock, Cogill, Bailey, and Kenefick (1999):

Food availability and food access

Availability and access implicitly include sufficient quantity and quality, safety of food, cultural preferences and acceptability of the food products (Leroy et al., 2015).

Food utilisation

Food needs to be utilised to ensure optimal bodily absorption, and the nutrients to be ingested to ensure the body functions normally (Leroy et al., 2015). Food for household consumption needs to be socially acceptable and the food must be safe (Connolly-Boutin & Smit, 2015). Beef, for example, contains several nutrients necessary for a balanced diet. It contains zinc, iron, selenium, vitamin B12 and is an important source of protein. It forms part of a balanced meal, but over seven billion people today lack access to meat as part of a balanced diet (Pereira & Vicente, 2013). Child undernourishment due to a lack of iron in their diets results in a reduction of intellectual capacity of up to 15% children (Pachauri et al., 2009). Individual households need enough nutrients according to gender, age, level of physical activity and growth, but also include people's lifestyles, their cultural, social and economic relationships, as explained by Chen and Kates (1994).

In Figure 3 the dimensions of food security are shown, with stability reached if the three dimensions are met. The outcomes of food security aim to sustain human health.

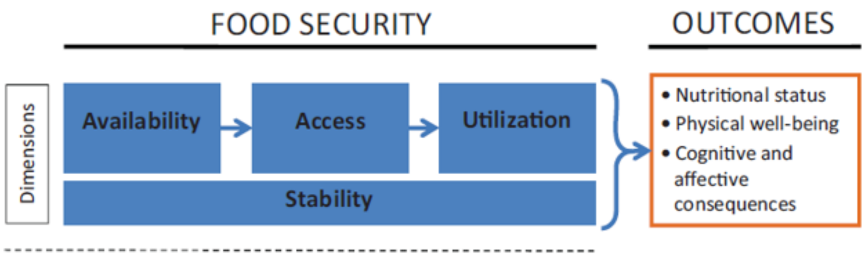


Figure 3. The complex nature of food security, highlighting the different dimensions (Adopted and adapted from Leroy et al. (2015))

The need for food security as well as the importance of food safety for human consumption poses a threat to global food supply, with the next section focusing on food safety issues over a period of four decades.

2.5. Food safety

Food safety has a significant impact on the welfare of people worldwide. In the Food Safety Handbook (Schmidt & Rodrick, 2003), the authors list a number of relevant definitions, listed below:

"Safe food means food that has been handled properly, including thorough washing of fish and poultry that will be cooked and anything to be eaten raw."

"Safe food means food prepared on clean and sanitised surfaces with utensils and dishes that also are cleaned and sanitised."

"Food that is within its shelf life and has been stored and distributed under proper temperature control."

"Food that is not contaminated."

"Safe food means purchasing fresh chicken and not having the package leak or drip juice, making them wonder about the integrity of the initial seal."

For the purpose of this thesis, the accepted definition of food safety is food that is safe for human consumption. In developed countries people generally suffer from mild foodborne-diseases, but in developing countries people die as a result of infant diarrhoea, typhoid fever, liver infections and cholera (Käferstein & Abdussalam, 1999). There is an increase in foodborne diseases because of the increase in global trade of food products, as well as the ease of international travel (Käferstein, Motarjemi, & Bettcher, 1997). Bacteria, fungi and viruses cause most foodborne diseases (Käferstein & Abdussalam, 1999). For example, Europe faced a large number of food safety scares, with Salmonella causing food poisoning first recorded in 1988 (Knowles, Moody, & McEachern, 2007). Salmonella is a microbiological substance found in raw eggs, cheese, meat from chicken and other farm animals (Yeung & Morris, 2001). Different variations of Salmonella and E. coli are still found at varying levels in food products today. Contaminants of food, resulting from the mismanagement of crops and harvesting activities, chemical changes from processing food or chemical changes from storage of food products (Schmidt & Rodrick, 2003) have been detected since 1989; these include pesticides, benzene in bottled water, carbon dioxide irregularities in Coca-Cola products, the contamination of olive oil, Nitrofen in wheat products and dioxins in animal feed (Knowles et al., 2007).

Genetically modified food products were distrusted at first but their advantages soon became evident, including being able to withstand infestations caused by pests and diseases, as well as drought conditions, growing faster and costing less, and having an improved nutritional value (Schmidt & Rodrick, 2003). The GLOBALGAP certification is a worldwide recognised standard, regulating crop-based products, fruit and vegetables and other farm-based activities (Schmolke, 2008), and is a prerequisite for countries to export citrus products to Europe (Ndou, 2012).

The direct correlation between animal diseases and fatalities in humans has resulted in very strict governance of any imported meat (Jin, Skripnitchenko, & Koo, 2004). Repeated occurrences of food safety incidents involving the health of humans and animals have devastated the world on several occasions (Van de Brug, Lucas Luijckx, Cnossen, & Houben, 2014). The poultry sector suffered the dioxin crisis, the pork sector the Medroxy Progesterone Acetate (MPA) crisis and the beef sector Bovine Spongiform Encephalopathy (BSE) (Jin et al., 2004). BSE, also referred to as “Mad Cow Disease” is the most well-known example. The first recorded case of BSE was in England in 1986, displaying similar symptoms to Transmittable Spongiform Encephalopathy (TSE), also known as scrapie, found in sheep (Harremoës et al., 2001).

BSE is a generative disorder that affects the central nervous system of cattle; it is a chronic condition, and there is no cure (Karesh & Cook, 2005) and all infected animals die from going “mad”. In England, the effect of BSE devastated the meat industry, with more than 1 000 new cases of infected cattle per week in 1993, thus infecting 160 000 cows, more than half of England’s dairy herd (Donnelly, Ferguson, Ghani, & Anderson, 2002). There was no way of separating the infected herds from the non-infected, as all animals received the same feed, which contained meat and bone meal, and England had no choice but to slaughter almost their entire cattle population, costing the country between 12 and 15 billion sterling in gross domestic product (GDP). At the time government officials suspected that BSE could pose a health risk to humans, but were reluctant to make the knowledge available to the general public, issuing a vague statement in 1988 that stated that there was no evidence of BSE infecting humans, but that it could not be dismissed at that point. (Harremoës et al., 2001). Other countries including Ireland, Switzerland, Portugal, France, Germany, Israel, Poland and Greece suffered the same fate as England on a smaller scale (Donnelly et al., 2002). People eating BSE infected meat can develop Creutzfeldt-Jakob disease (CJD) and 150 human fatalities have occurred since 1995 (Karesh & Cook, 2005).

In December 2004, a single case of BSE was detected in America, resulting in export losses of approximately $2.6 billion (Hileman, 2004). In Table 1 the course of the BSE outbreak is broken-down into the actions taken and the actual time-frame is provided.

Time frame	The BSE story as it unfolded
Mid-1970s	United States ban scrapie-infected sheep and goat meat from cattle food chain.
1979	UK Royal Commission on Environmental Pollution recognises risks of pathogens in animal feed and recommends minimum processing standards in rendering industries.
1986	First cases of BSE are officially acknowledged.
1988	First documented official acknowledgement that BSE may be transmissible to humans.
1988	Southwood Committee is set up and recommends that clinically affected cattle should not go into human and animal food.
1989	Ruminant feed ban, slaughter and destruction of affected cattle and specified bovine offal (SBO) ban.
1995	Almost 50 % of the abattoirs checked are found to be failing to comply with the SBO ban.
1995	Evidence that BSE may cause Creutzfeldt-Jakob disease (CJD)
1996	At last, experiments start to determine whether cattle fed on rations deliberately infected with scrapie would get BSE.
1996	BSE crisis, after a new variant of CJD emerged in the United Kingdom and consuming BSE contaminated food was considered the most probable cause.
1998-2000	The Phillips Inquiry is launched and its 16-volume report is published. Its conclusions do not seem sufficiently rigorous on judging government actions over time. These conclusions state that appropriate policy decisions had been taken, although not always timely or adequately implemented or enforced.

Table 1. BSE: early warnings and actions (Adopted and adapted from Harremoës et al. (2001)

Food safety became an increasingly important issue. There had been other food safety scares in the world in the past decade, and people not only distrusted governments, but in most cases overreacted, partly caused by over-hyped media attention (Hilton & Hunt, 2011). For example, severe acute respiratory syndrome (SARS) spread from Guangdong, China to at least 37 countries in 2003 (Smith, 2006).

The virus was traced to a palm civet, a small mammal found in Guangdong, but ferrets, badgers and raccoon dogs also carry the virus (Karesh & Cook, 2005). SARS eventually infected only about 10 000 people, of which 1 000 infections proved fatal (Hilton & Hunt, 2011).

The Avian flu virus, found in chickens in Hong Kong in 1997, resulted in flu-like symptoms, with 18 documented deaths (Joffe & Lee, 2004). Cases of foot-and-mouth disease (FMD) in England and classic swine fever (hog cholera) in the EU made consumers aware of the risks of international trade of livestock products (Hall, Ehui & Delgado, 2004).

FMD is a highly contagious disease found in cloven-hoofed animals, and is often spread from buffalo to livestock in Southern African countries, specifically Namibia, Botswana, Zimbabwe and South Africa that need to be aware of the risk of contamination (Vosloo, Knowles, & Thomson, 1992). Infected animals are either vaccinated or slaughtered, but because any FMD outbreak is contained as soon as possible, the morbidity rate is not accurately estimated, but transference of the disease from animals to humans is extremely rare (Davies (2002). The disease outbreaks and associated fear strengthened the belief that food could be unsafe. As a result, people started distrusting food that was freely available.

From the examples above, and many other examples not discussed in this thesis, it is clear that food safety is one area where consumers are not willing to take any risks, and insist on transparency and protection from infected animal products harmful to humans. The direct correlation between animal diseases and fatalities in humans has resulted in very strict governance of any imported meat with laws such as the Codex Principles for Food Import and Export Inspection and Certification and the European General Food Law to ensure food safety. Countries had to start implementing livestock traceability systems, an initiative that started in 2001 (Jin et al., 2004).

Disease	Productivity impact	Trade impact	Human health impact	Vector (Ease of movement)	Geographic distribution
BSE	None during 4 - 5 year incubation period. Fatal thereafter.	Complete restriction of exports.	Fatal if contracted.	Ingestion (low dispersion)	562 cases in 20 countries (2005).
FMD	Reduced weight gain in adult cattle. Spontaneous abortion.	Restricted to lower-value export markets.	Insignificant (rarely transmitted to humans).	Airborne; contact with infected animals or materials (high dispersion).	Over 3 000 outbreaks in 53 countries (2004).
Avian flu	Fatal in poultry: mortality rate over 90%.	Complete restriction of exports of non-processed meat.	Flu-like symptoms.	Faecal contact; contact with infected birds (high dispersion among fowl).	Reported in 51 countries in 2006.

Table 2. Impact of animal diseases (Adopted and adapted from Winter-Nelson and Rich (2008))

2.6. Defining traceability

Traceability forms the basis of modern-day food safety systems (Ekuam, 2009) and has become increasingly important to consumers. Traceability partners must identify the supplier and the consumer of any food product (GS1, 2010) while differentiating between the external traceability of trading partners and the internal traceability within a company's own operations. As part of an integrated supply chain, a traceability system should include product traceability, as well as process, disease, genetic and measurement traceability (Opara, 2002). The GS1 Global Traceability Standard, widely used in fresh product markets, has to ensure that if any food products are unsafe for human consumption, they can be recalled by the accurate backward tracing of the contaminated food products (GS1, 2010).

In the fresh produce supply chain, all the role-players and their key activities are outlined. The process of accurate traceability starts with the farmer, then moves to the packer, distributor, and retail store. The secondary role-players include the supplier of the packing material and seeds and the regulating bodies. Figure 4 (GS1 (2010) graphically summarises the produce supply chain.

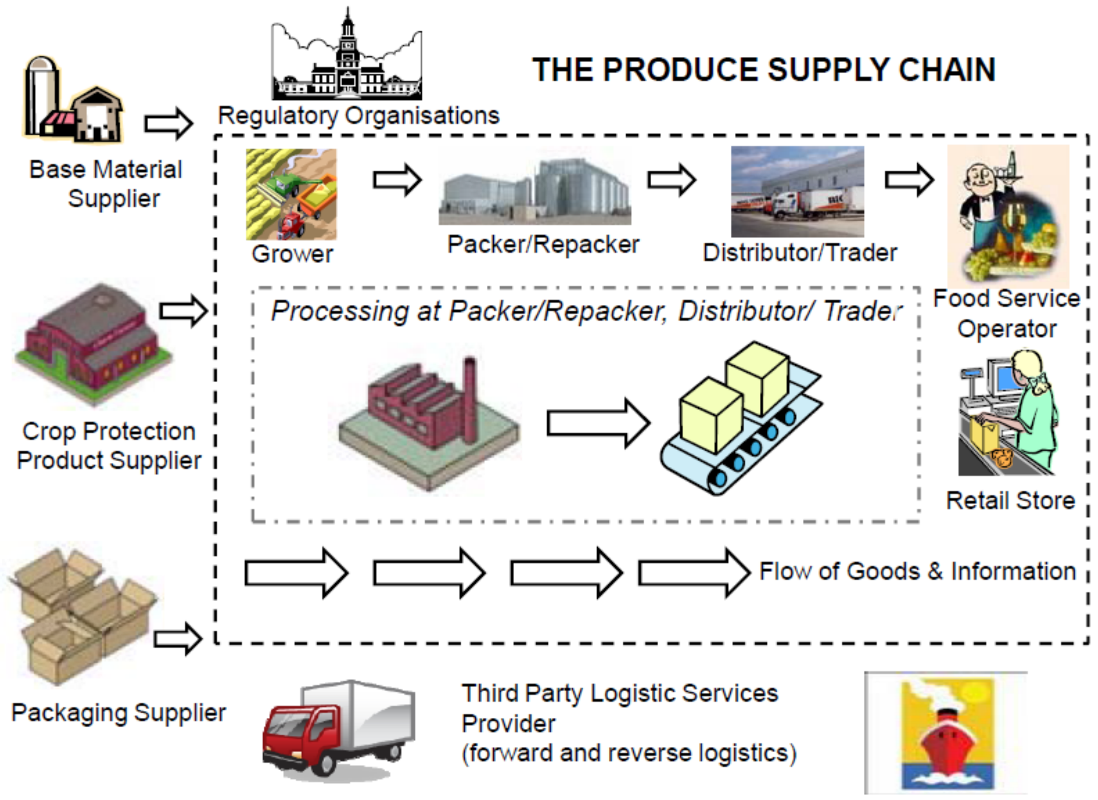


Figure 4. The fresh produce supply chain (Adopted from GS1 (2010))

2.7. Defining livestock traceability

Traceability is defined as the ability to "track" food products (Germain, 2003; Schwägele, 2005; Storøy, Thakur, & Olsen, 2013). In terms of livestock tracking, it is done through a detailed food label, reflecting the animal's history captured on a traceability system, also identifying the country of origin, place of birth, place of slaughter and where the meat was processed (Hobbs, 2003) . Traceability includes "tracing" food products backward (Germain, 2003; Schwägele, 2005; Storøy et al., 2013) from the consumer to the retailer, the distributor, the processing company and back to the producer. The transparency of the process enables the retailer and distributor to identify meat products from specific producers in the event of a food safety crisis (Hobbs, 2003). Figure 5 has been adapted from Schwägele (2005) where tracking sends information forward and tracing sends the same information backward to the origin:

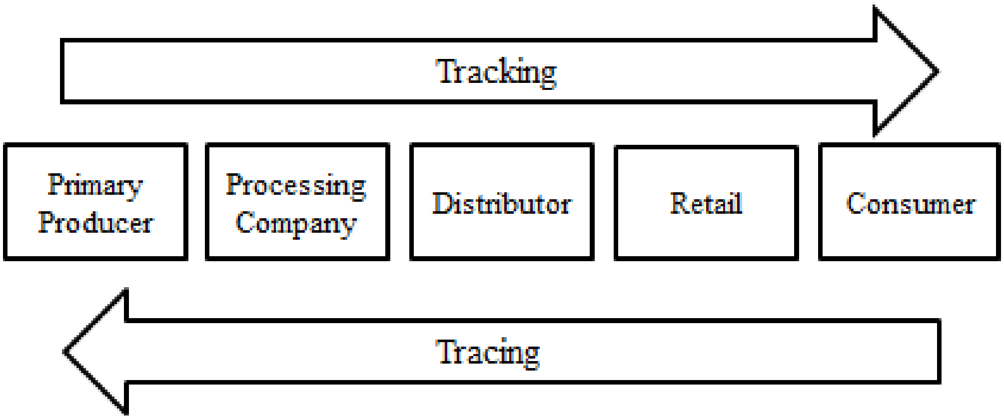


Figure 5. Tracking and tracing along the food chain (Adopted and adapted from Schwägele (2005))

In a study conducted by Hobbs (2003) in Canada, the author sold meat sandwiches to consumers, and the consumers had to pick between a sandwich containing normal beef, but could upgrade to a more expensive sandwich containing information regarding the safety and origins of the beef, and could pay even more if the consumer would be assured that the animal was treated in a humane way. The 104 consumers involved in this experiment led the author to believe that she could sell sandwiches at 40% more than the normal price, and that the consumers were willing to pay more for the reassurance concerning traceability and the humane treatment of animals. What was an interesting finding of the experiment, was that people value food safety and traceability, but most consumers also wanted reassurance that the animal was treated humanely. In other studies in France and Germany, consumers prefer country-of-origin labelling (COOL) to the brand, price or fat content (Loureiro & Umberger, 2007).

Imported meat products have the label showing the country of origin, as shown in Figure 6. The rest of the animal history can be found by scanning the barcode. The EU also implemented other food labelling policies such as the following:

- Protected designation of origin (PDO)
- Protected geographical indication (PGI)
- Country-of-origin labelling (COOL)

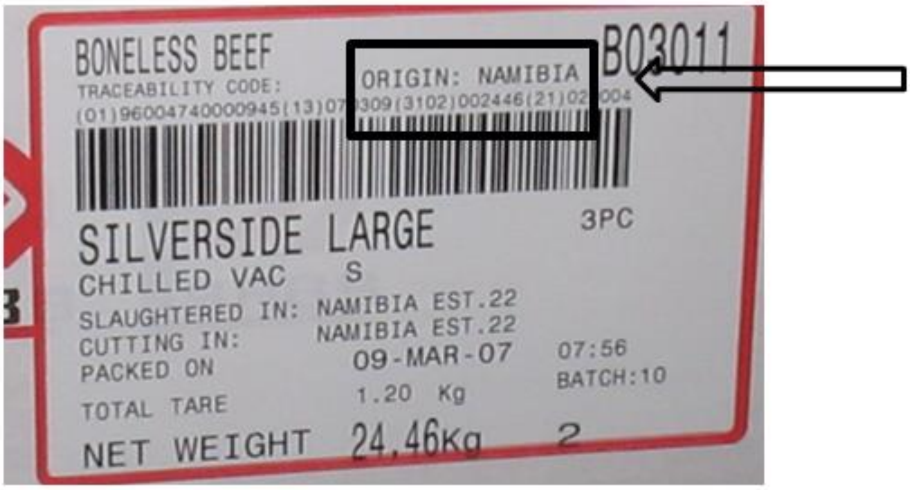


Figure 6. An example of a label showing Namibia as the country of origin

Europe's quest for safe and secure meat comes at a substantial cost, with expensive traceability systems having to be implemented, often funded by the EU (Times Higher Education, 2003). In 2002 the EU enforced the General Food Law, prescribing that all meat be traceable to its origin (European Commission, 2007). Table 3 and 4 outline the formal definitions of traceability according to governing bodies and legislation.

Legislation / standard code	Name	Definition of food traceability	Main aim
Regulation (EC) No. 178/2002 of the European Parliament and of the Council of 28 January 2002	The General Food Law	"The ability to follow the movement of a food through specified stage(s) of production, processing and distribution."	(i) Outlines the general principles and requirements of food law. (ii) Establishes the European Food Safety Authority. (iii) Provides procedures in matter of food safety, i.e. among other things, the implementation of traceability systems in the food and feed supply chains in Europe.

Table 3. European legislation and definition applicable to traceability (Adopted and adapted from the European Commission (2002))

Legislation / Standard code	Name	Definition of traceability	Main aim
ISO 22000:2005	Food safety management systems – Requirements for any organisation in the food chain.	**The ISO definition:** "The ability to trace the history, application or location of an entity by means of recorded identifications."	ISO 22000:2005 specifies requirements for a food safety management system where an organisation in the food chain needs to demonstrate its ability to control food safety hazards in order to ensure that food is safe at the time of human consumption.
ISO 22005:2007	Traceability in the feed and food chain – general principles and basic requirements for system design and implementation.		ISO 22005:2007 gives the principles and specifies the basic requirements for the design and implementation of a feed and food traceability system. It can be applied by an organisation operating at any step in the feed and food chain.

<table>
<tr><th>Legislation / Standard code</th><th>Name</th><th>Definition of traceability</th><th>Main aim</th></tr>
<tr><td>CAC/GL 20 – 1995</td><td>Codex Principles for Food Import and Export Inspection and Certification.</td><td rowspan="3">The Codex definition:
“The ability to follow the movement of a food through specified stage(s) of production, processing and distribution.”</td><td>Food inspection and certification systems should be used wherever appropriate to ensure that food, and their production systems meet requirements in order to protect consumers against foodborne hazards and deceptive marketing practices and to facilitate trade on the basis of accurate product description.</td></tr>
<tr><td>CAC/GL 26 - 1997</td><td>Codex guidelines for the Design, Operation, Assessment and Accreditation of Food Import and Export Inspection and Certification Systems.</td><td>These guidelines provide a framework for the development of import and export inspection and certification systems consistent with the Principles for Food Import and Export Inspection and Certification. They are intended to assist countries in the application of requirements and the determination of equivalency, thereby protecting consumers and facilitating trade in foodstuffs.</td></tr>
<tr><td>CAC/GL 60 - 2006</td><td>Codex principles for Traceability/Product Tracing as a tool within a Food Inspection and Certification System.</td><td>This document elaborates a set of principles to assist competent authorities in utilising traceability/product tracing as a tool within their food inspection and certification system.</td></tr>
</table>

Table 4. International legislation, definitions and standards applicable to traceability (Adopted and adapted from ISO 22000:2005 (2005); ISO/TS 22003:2007 (2007); European Commission (1995); European Commission (1997); European Commission (2006))

2.8. Traceability legislation

Traceability needs to be regulated because of the potential risks contaminated food products pose to human health. Certain legislative codes and laws are applicable worldwide, while others are region- or country-specific. The legislation discussed below is well-known and widely used, but the list is not comprehensive as there are many other examples of legislation applicable to food safety and traceability, but not as well-known or documented.

2.8.1. CODEX Alimentarius Commission

The CODEX Alimentarius Commission was established by WHO and FAO in 1963, ensuring fair trade, coordinating food safety standards and quality, and is undertaken globally by governmental as well as non-governmental organisations (Ndou, 2012). The Codex International Food Standards, Guidelines and Code of Practice have been accepted by 99% of the world population (FAO, 2016), and the industry generates 200 billion dollars annually. The CODEX has been adopted in every continent, and is also known as the “Food Code”. It is regarded as a global reference point for consumers, protecting public health and fair practices in the food trade (FAO, 2016). It is a standard that is seen as a benchmark, with certain countries exceeding the requirements of the CODEX, but other countries failing to adhere to its minimum requirements. These countries include South Africa, Albania and Sri Lanka (Beghin, 2015).

2.8.2. The International Organisation for Standardisation (ISO)

ISO, consisting of more than 19 000 international standards, ensures consistency in terms of its requirements, guidelines and specifications for products, services, materials and processes (ISO, 2016). ISO standards help to enable developing countries and organisations to gain entry to new markets and ensure fair global trade. ISO 22000 deals specifically with Food Safety Management, and ISO 22005:2007 with Traceability in the Feed and Food Chain. There are also many other ISO standards applicable to the international food trade.

2.8.3. The Hazard Analysis and Critical Control Points (HACCP)

The HACCP system manages the animal disease-associated trade risks, but is not exclusively a food safety tool or applicable only to abattoirs or meat processing plants, as is widely believed (Thomson et al., 2013). HACCP is an area preventative measure, identifying and controlling any hazard that can potentially harm the consumer (Ndou, 2012). The measure prevents the hazard from occurring, and manages food packing and processing throughout the supply chain (Mortimore & Wallace, 1998). HACCP is a technique that relies on people to implement it successfully, and training is required.

2.8.4. The Technical Barriers to Trade (TBT)

There are numerous compulsory technical regulations and requirements on the trading of goods and agricultural products that affect trade patterns, and the World Trade Organisation (WTO) members agreed on the TBT and the Application of Sanitary and Phytosanitary Standards (SPS) (Calvin & Krissoff, 1998), paving the way to resolving potential disputes of product standards (Maskus & Wilson, 2001). The TBT ensure that there is no unwarranted discrimination against certain countries where products indeed do comply with all requirements of fair trade (Fliess, Gonzales, & Schonfeld, 2008).

2.8.5. Global Partnership for Good Agricultural Practice (GLOBALGAP)

Europe has fallen victim to the BSE outbreak, and implemented very strict measures to prevent similar outbreaks in future. GLOBALGAP has been required since 2005 if one wants to export any food products to Europe (Bain, 2010), and is in essence a farm management system. GLOBALGAP replaced the European System Related to Good Agricultural Practice (EUREPGAP), which was formed in 1997 (Kariuki, Loy, & Herzfeld, 2012), and resulted in the formation of other practices such as CanadaGAP, similar to GLOBALGAP, but specifically applicable to Canada (Hobbs, 2014). Initiatives were put in place to assist developing countries to adhere to the requirements of GLOBALGAP to avoid exclusion from overseas markets, with donor programmes assisting areas in Sub-Saharan Africa, Latin America and Asia (Holzapfel & Wollni, 2014). GLOBALGAP is a “pre-farm-gate standard”, including all aspects of managing the farm, starting with any inputs, such as seeds, all farming activities, until the products leave the farm (Kalfagianni & Fuchs, 2012), even the welfare of the animals and workers’ health and safety (Hobbs, 2014). GLOBALGAP is not directly visible to the consumer, as it is a business-to-business label (Ndou, 2012) and a mandatory practice used in all global food trade.

2.8.6. The Global Food Safety Initiative (GFSI)

GFSI is an initiative driven by retailers to improve food management systems, attempting to reduce duplication and consolidate private food safety standards (Hobbs, 2014). The GFSI was launched in 2000, and key to its priorities is setting a benchmark for food safety standards such as the British Retail Consortium, Safe Quality Foods (SQF) and International Food Standards (IFS), improving cost efficiency throughout the food supply chain (Ndou, 2012).

As is evident in the legislation discussed above, the regulatory role has only increased, and is still being adjusted and improved daily. Legislation serves only to emphasise to what lengths consumers, farmers, retailers and distributors will go to sell safe food products and to remain a global competitor.

Legislation has resulted in set minimum requirements, with role-players needing to obtain documentation to prove adherence, leading to the need for formal certification of their activities.

2.9. Certification

Certification as defined, followed legislation and traceability standards:

> Certification *"is the procedure by which official certification bodies and officially recognised bodies provide written or equivalent assurance that foods or food control systems conform to requirements. Certification of food may be, as appropriate, based on a range of inspection activities which may include continuous on-line inspection, auditing of quality assurance systems and examination of finished products"* (European Commission, 2006).

Countries became aware of all the benefits of traceability for trade, and economic and social development (Lewandowski & Faaij, 2006) and started the process of enforcing traceability certification. To become a certified meat exporter, one has to adhere to several key conditions, with tracking and tracing of meat products as a minimal requirement. In Chapter 3 the comprehensive scope of traceability systems is discussed; however, it is necessary first to look at where traceability systems are implemented and used.

2.10. Livestock traceability worldwide

As early as 1985 food safety concerns paved the way for the "Guidelines for Consumer Protection", established by the UN General Assembly and from there the CODEX Alimentarius evolved (Regattieri, Gamberi, & Manzini, 2007). In 1999 a White Paper titled "Action Plan on Food Safety" was published (Van der Meulen & Van der Velde, 2004), paving the way for the EU to introduce the General Food Law in 2002, enforcing traceability in the EU from 1 January 2005 (Regattieri et al., 2007). As a result, countries worldwide started adopting traceability systems. A few short summaries are provided below to provide some background on the reach and use of traceability systems in countries around the world.

2.10.1. North America

United States of America

In December 2003 a single case of BSE was found in Washington (Jin et al., 2004), leading to a significant reduction in beef consumption in the country. The US National Animal Identification System (NAIS) is regarded as being superior to the 2002 COOL system, and aims to lessen the impact of BSE (Loureiro & Umberger, 2007), although no single traceability system is currently mandatory (Monjardino de Souza Monteiro & Caswell, 2004).

Canada

The Canadian Cattle Identification Agency (CCIA) was one of the first industry-wide traceability systems introduced in 2001 (Hobbs, Bailey, Dickinson, & Haghiri, 2005). In May 2003 a case of BSE was discovered, but the system could not accurately trace the history of the animal (Hobbs, Bailey, Dickinson & Haghiri, 2005). The CCIA captures all animal health details, but does reach further than the abattoirs, and is inferior to the Japanese and EU systems (Monjardino de Souza Monteiro & Caswell, 2004).

2.10.2. South America

Brazil

In Brazil cattle traceability is done only for imports from prominent countries, such as the Americas and Britain; however, the country uses the Life Cycle Assessment (LCA) practices, and these are a prerequisite in the industry (Ruviaro, Barcellos, & Dewes, 2014). All cattle on farms and feedlots had to be identified by December 2007, with information such as the animal's month of birth, farm of origin, movement and sanitary data stored on an electronic database (Monjardino de Souza Monteiro & Caswell, 2004).

Argentina

Argentina still experiences FMD outbreaks and the difficult economic conditions limit their traceability efforts (Monjardino de Souza Monteiro & Caswell, 2004) The Argentina Animal Health Information System, called "Sistema de Gestion Sanitaria" or SGS was launched in 2007, and complies with most traceability requirements, except for animal diet verification (Schroeder & Tonsor, 2012).

2.10.3. Asia

Japan

After the BSE scare of 2001, traceability became mandatory on domestic beef products (Germain, 2003). Japan had great success in enforcing a traceability system consisting of ear-tagging, Deoxyribonucleic Acid (DNA) sampling and keeping record of all animal health and feeding information (Meuwissen, Velthuis, Hogeveen & RBM, 2003). The "farm-to-table" traceability system uses a ten-digit cattle identification number (Germain, 2003). With laws such as The Beef Traceability Law, Japanese consumers are able to obtain traceability information directly from the internet (Clemens, 2003).

China

The Radio Frequency Identification (RFID)-based cattle/beef traceability system (RCBTS) is used throughout the supply chain and complies with all traceability requirements (Feng, Fu, Wang, Xu, & Zhang, 2013).

2.10.4. Europe and the UK

In 2002 the General Food Law came into effect (Germain, 2003) and as a result all EU member countries now have to comply with mandatory traceability systems (Dalvit, De Marchi, & Cassandro, 2007). The General Food Law is very specific in terms of how it has to be applied to food and feed, including aspects such as traceability throughout production, processing and distribution; the ability to track and trace all animals and other business partners; and labelling specifications (Germain, 2003). Europe uses an affordable, cheap and reusable ear-tag to identify an animal with an identification code, and the code is maintained for the animal after slaughter and for every cut of meat (Dalvit et al., 2007). The Automatic Identification and Data Capture (AIDC) manages the electronic data to ensure accurate information of the “food-to-farm” chain (Schwägele, 2005). Europe is very strict regarding meat imports because of BSE scares, and trade only with partners complying with all their regulations, even if the trading countries are not legally required to fulfil all the EU requirements (Coulibaly & Liu, 2006).

2.10.5. Australia and New Zealand

Both Australia and New Zealand apply features in their traceability systems similar to those used in Europe (Ramessar, Capell, Twyman, Quemada, & Christou, 2008).

Australia

Australia implemented a voluntary traceability system called the National Livestock Identification System (NLIS) in 1999, and all ranch owners agreed to implement NLIS from July 2004. The system uses an ear-tag or rumen bolus, with precise data on the individual animal and geographical location (Monjardino de Souza Monteiro & Caswell, 2004).

New Zealand

New Zealand is the world’s largest exporter of mutton and lamb, and employs the COOL regulations, with traceability available only to high-value markets, willing to cover the associated costs (Clemens & Babcock, 2004).

2.10.6. Africa

Various traceability systems are used throughout Africa, but those in Southern Africa, Botswana and Namibia have been used the longest and are well-known. A comprehensive study has been conducted on the traceability systems of both Namibia and Swaziland, and are elaborated on further as the study unfolds in the results section.

Botswana

The Livestock Identification and Traceability System (LITS) makes use of rumen boluses, with an embedded RFID microchip. The information captured on these boluses contains the owner's name, a unique identification number of the animal, the brand and its position, the sex and colour of the animal and a record of where the animal is kept, and is captured and stored in the LITS database (Moreki, Ndubo, Ditshupo & Ntesang, 2012). Other identification methods are now also used, including conventional ear-tags and hot iron branding (Moreki, Ndubo, Ditshupo, & Ntesang, 2012), as the rumen bolus was not as effective and reliable as was hoped. In Botswana there are both internal and external difficulties with the implementation of LITS. Internally, paperwork often does not meet the requirements and not all meat is properly labelled. Externally, it is difficult to ensure that all requirements are met due to inconsistencies with the manner in which data is recorded (Boy, (n.d)). In 2011 Botswana did not have a comprehensive system in place to document the traceability of exported meat products and subsequently the Central Competency Authority (CCA) suspended all exports to the EU on 27 January 2011 (European Commission, 2011). The main reasons for the suspension were lack of community buy-in and the ineffective use of the rumen bolus (Moreki et al., 2012). Botswana underwent another rigorous audit in 2013 and managed to lift the suspension (European Commission, 2013), with the following concerns raised by the commission:

> *"A number of deficiencies which were identified, in particular related to the discrepancies between the registration of animals in the Livestock Identification and Traceability System (LITS) compared with the actual animals present at livestock holdings, or those who died or were slaughtered as well as the absence of official controls on the registration of cattle and no supervisory controls on movements weaken the reliability of the system."*

Other countries have seen the benefits of such systems and followed in their footsteps, one of them being Swaziland, with its improved version of SLITS, implemented in 2013.

Swaziland

Swaziland also had an insufficient system in place, but improved their computerised system called SLITS in 2012 to remain competitive in the exporting market. The main aim of SLITS is two-fold: firstly to enable animal identification using brand marks and ear-tags and secondly to computerise the Veterinary Services (Ministry of Agriculture: Swaziland Livestock Identification and Traceability System). Traceability needs to adhere to certain rules and regulations, leading to strict legislation.

Namibia

In 2004 Namibia introduced NamLits to remain an exporter of meat to the EU and other countries. It involves ear-tagging as well as branding of the animal. This system enables animal technicians to prevent stock theft by finding the legitimate owner of the animal on NamLITS database and returning the animal to him or her. It further enforces better movement control and allows for more efficient system governance (eTransform Africa, 2012). The RFID ear-tags used are placed on both ears and the information is read into the NamLits database. The centralised database tracks the animal movements and ensures that the relevant requirements for European Union exports are met. It captures the details of the owner and provides the farmer with a specific animal branding symbol. There is strict legislation in place to regulate animal branding, with the Stock Brands Act 24 of 1995 focusing on registration, branding, transfer and cancellation of ownership, investigations, prohibitions and offences, and penalties. The Stock Brand Act Regulations of 2004 certify that all documentation be kept, including the stock brand areas on the animals, forms of branding and methods of imprinting.

2.11. Conclusion

The literature discussed in this chapter provides one with a detailed description of how and why traceability evolved by briefly touching on agricultural pressures in ensuring food security and food safety, recent food safety scares, the definition of traceability, and more specifically livestock traceability systems. Legislation and standards are followed by certification, and the chapter ends by briefly discussing different countries and their implementation of traceability systems.

In Chapter 3 all the formal requirements of becoming a certified exporter of livestock products are elaborated on to provide an overall picture of the complex nature of tracking and tracing livestock, a difficult task that is often underestimated.

3. Chapter 3: The requirements of livestock traceability systems to export meat products

Our twenty-first century economy may focus on agriculture, not information. - James Howard Kunstler

3.1. Introduction

A livestock traceability system has to ensure that meat products are safe for human consumption. In this chapter all the aspects required of a traceability system are discussed, from capturing livestock movements, unique animal identification, animal health, to controlling disease outbreaks. The chapter starts by listing all the required aspects, breaking them down into finer detail, and explaining the importance of every aspect as it pertains to food safety. The chapter ends with a short discussion of how a successful traceability system provides farmers with new markets in which to sell their meat products, and how traceability systems link to the Millennium Development Goals.

3.2. Requirements of a livestock traceability system

There are several aspects one has to keep in mind to implement a livestock traceability system successfully. Authors such as Greene (2010), Regattieri et al. (2007), Siena et al. (2008) and Verbeke (2001) agree that a traceability system has various facets to address when it is implemented, such as unique identification of an animal and meat products, processing information, animal movements and animal health. Figure 7 below is a summary of the goals of a traceability system, as illustrated by Greene (2010).

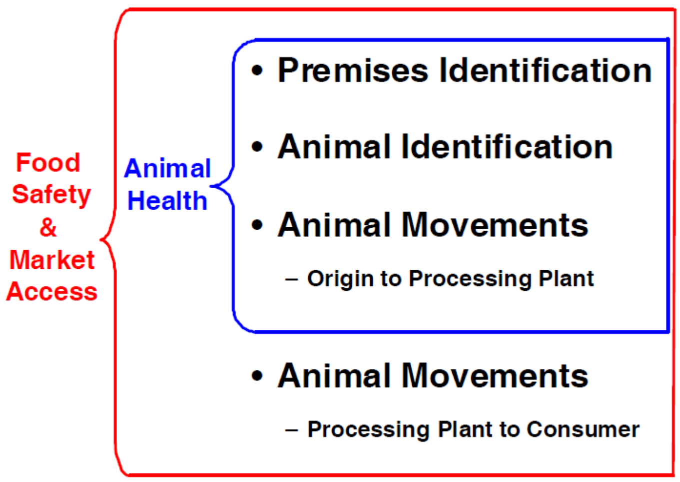


Figure 7. Animal identification goals with traceability (Adopted from Greene (2010))

To break a traceability system down into smaller parts, it should address the following aspects (Boy, n.d.):

1. The tracking of animal movement, showing the exact location of an animal at a given time, including the animal products anywhere in the world.
2. The unique identification of animals, the animal's origin, the sex and age of the animal, the name of the breeder, where it came from and when it was moved.
3. Monitoring animal health to prevent and predict future health problems.
4. Controlling diseases and disease outbreaks effectively with contingency plans.
5. Managing nutrition and yield for safe meat of a high standard.
6. Ensuring the safety of meat products to markets worldwide.

Figure 8 illustrates the components graphically:

Figure 8. The different components of a traceability system

3.2.1. Tracking animal movement

The red meat value chain is more complex than one tends to think. Animals need to be tracked from the original farm to the feedlot and then the abattoir, but all meat products from the animal, including the processing of the meat, hides and skins must be tracked from the abattoir to the wholesaler, retailer and finally the consumer.

The data of the movement of the animal is kept in the traceability system, and is updated as movements occur. The following needs to be in place when moving an animal, before it is slaughtered (Fourie, 2012):

- Whenever an animal is moved from the original farm to the new farm, the documentation, including the movement permit and the updated movement register, must accompany the animal. This is also the case if moving an animal from the original farm to a livestock auction. The movement register must reflect if the animal is sent to a feedlot or an abattoir.
- The tracking of animal movements is very important to comply with the 90/40 day rule. This rule implies that an animal cannot be slaughtered within 90 days after entering the country, or 40 days since its last move from farm-to-farm, farm-to-auction or farm-to-abattoir.
- All the information is stored in a centralised database for auditing purposes and to comply with the set requirements. Proof of compliance is required in cases of EU audits.

To illustrate the complexity of controlling animal movement, an example is given from NamLITS. This system has three ways of capturing animal movements in its database; the farm-to-farm movement, the farm-to-auction movement and the farm-to-abattoir movement. The different procedures are explained in Figures 9, 10 and 11.

Farm-to-farm movement

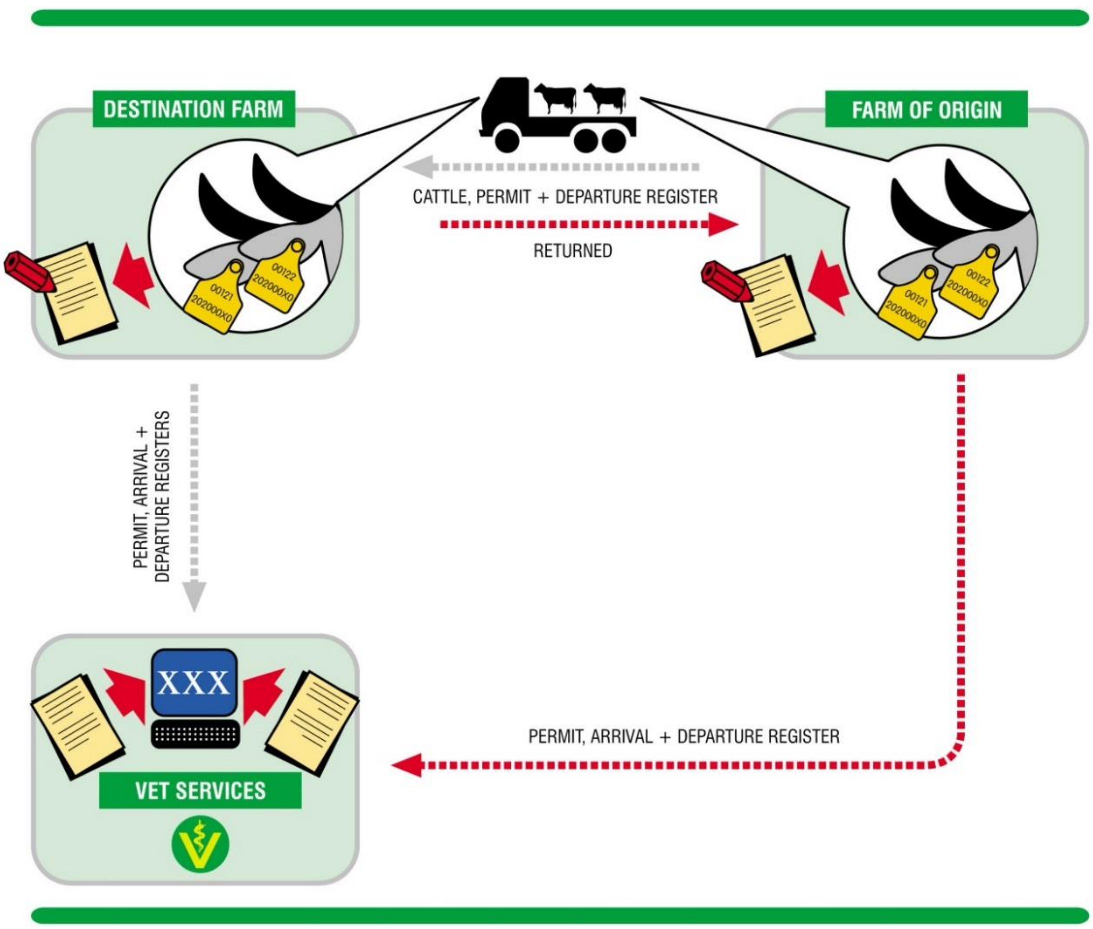


Figure 9. The process of moving an animal from one farm to the next with a movement permit (Adopted from Engelbrecht (2012))

Farm-to-farm movement entails the following:

1. The farm of origin verifies the tags against the permits when the cattle are being loaded.
2. The cattle, permits and departure registers are sent to their destination farm.
3. The destination farm verifies the tags when the cattle are being off-loaded.
4. The destination farm then sends back the permits and registers.
5. The farm of origin sends the permits and departure register to the Director of Veterinary Services (DVS).
6. The destination farm sends the permit, arrival and departure registers to DVS.

The traceability system also needs to ensure that the cattle are moved only once, thereby adhering to the 90/40 day rule.

Farm-to-auction movement

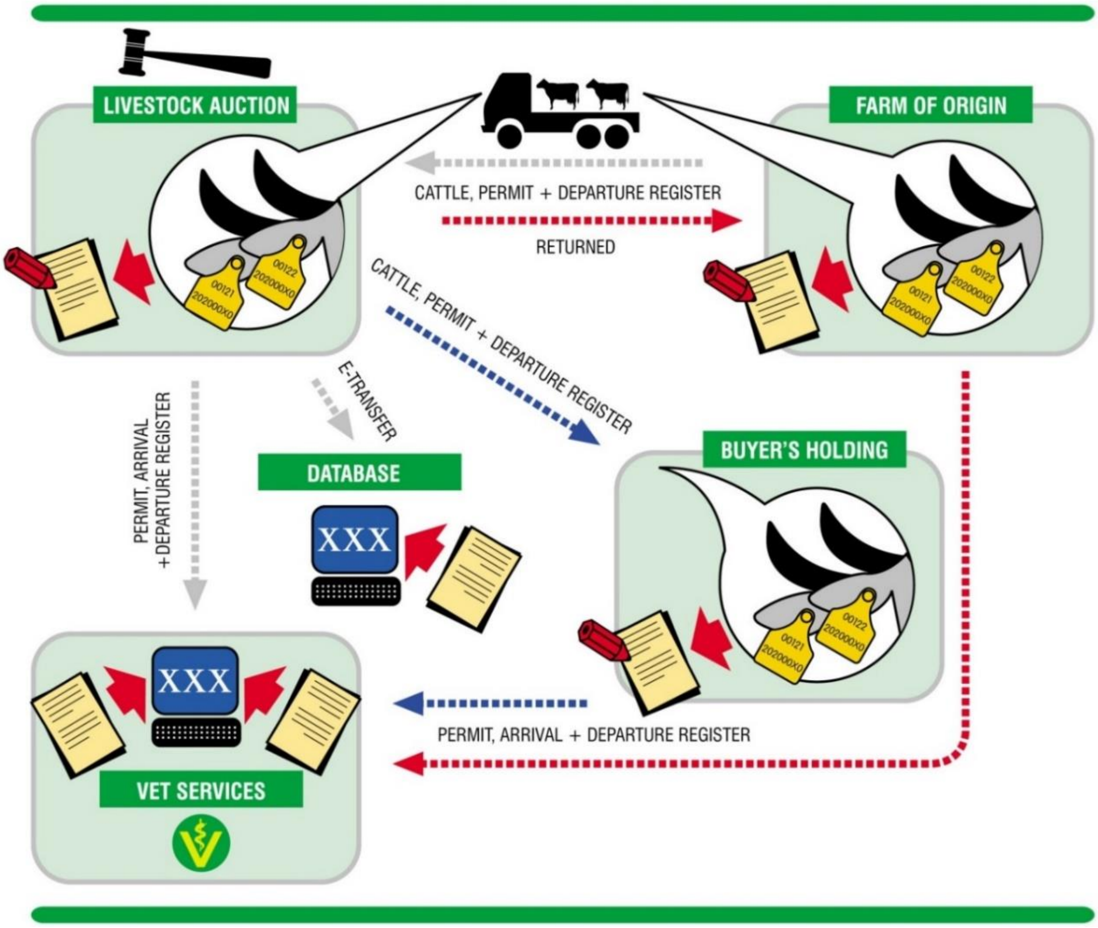


Figure 10. Farm-to-auction movement of cattle, illustrating the detailed documentation required (Adopted from Engelbrecht (2012))

Livestock are often sold on auctions in Namibia. The procedure to move cattle from a farm to an auction works as follows:

1. The farm of origin verifies the tags against the permits when the cattle are loaded at the original farm.
2. The cattle, permits and departure registers are sent to the auction.
3. At the auction, the tags are verified when the cattle are being off-loaded.
4. From the auction, the cattle, permits and departure registers are sent to the buyer of the cattle.
5. The farm of origin sends the permits and departure register to the DVS.
6. The buyer sends the permit, arrival and departure registers to the DVS.

The 90/40 day rule applies to the movement of cattle from the original farm to the buyer.

Farm-to-abattoir movement

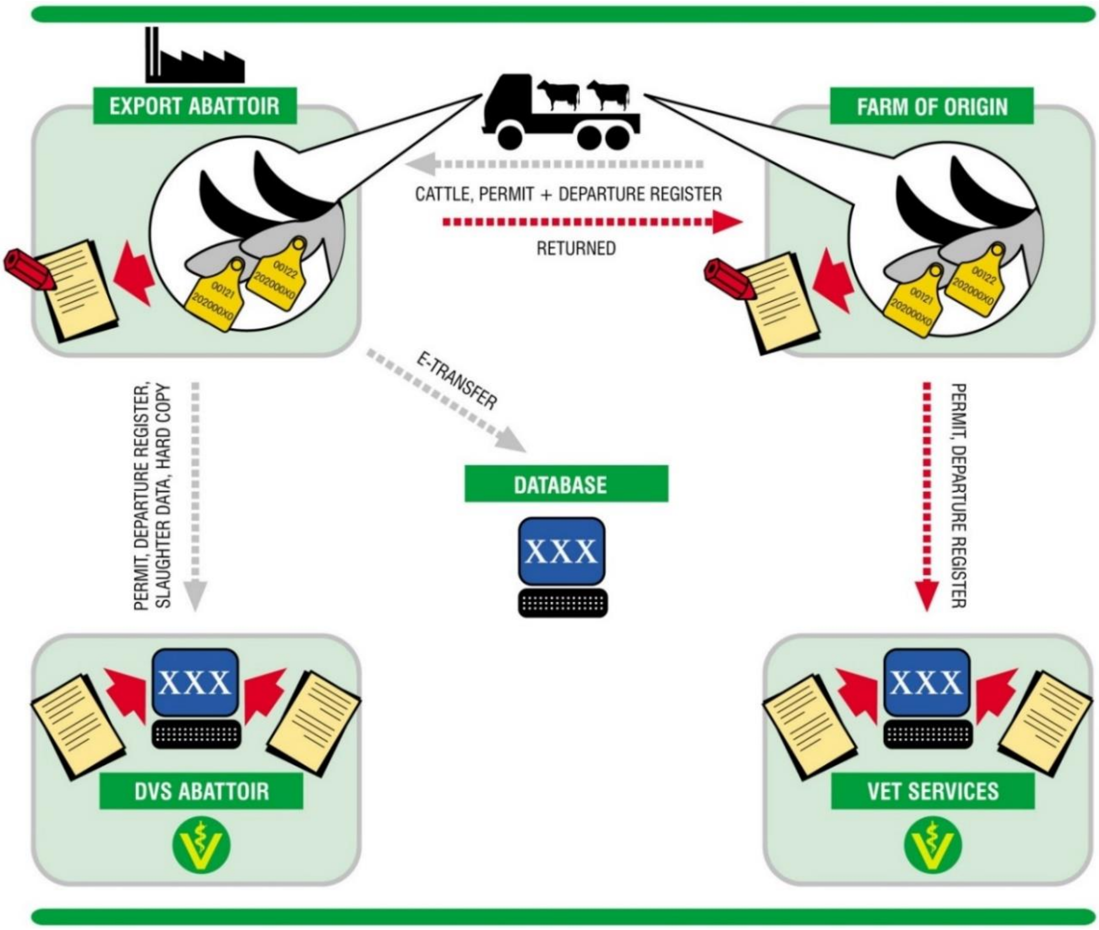


Figure 11. Farm-to-abattoir movement of cattle, and its documentation required (Adopted from Engelbrecht (2012))

Note: DVS Abattoir = Director of Veterinary Services Abattoir

To move cattle from the original farm to the abattoir involves the following:

1. The farm of origin verifies the tags against the permits when the cattle are loaded at the original farm.
2. The cattle, permits and departure registers are sent to the export abattoir.
3. The export abattoir verifies the tags when the cattle are being off-loaded.
4. The destination farm then sends the permit and departure register to Veterinary Services.
5. The export abattoir sends the details to the NamLITS database.
6. The export abattoir sends the permit, departure register and slaughter data hard copies to the DVS.

Everything, including adhering to the 90/40 day rule, is captured on the database.

Figures 9, 10 and 11 illustrate the overall comprehensive, complex paper trail and database that must record all the movements of animals.

It is not a simple task, and the process must still carry on after the animal has been slaughtered. Complete traceability of meat products as the animal is slaughtered in the abattoir entails handling one carcass at a time, putting all the meat into a single container, and then transporting the container to “single-carcass lots” (Smith, Pendell, Tatum, Belk, & Sofos, 2008), where bar-coded tags are placed on all retail cuts. The importer and consumer can trace the animal movement, as well as the movement of different meat cuts. Keeping track of the movement of meat is often referred to as the “farm-to-fork” traceability approach (Brown & Van der Ouderaa, 2007; Duffy, Lynch, & Cagney, 2008; Mogensen et al., 2015; Weiss, 2012).

3.2.2. Unique identification of animals

For effective traceability, all animals must be uniquely identifiable. The animal’s owner must also be identifiable with either a unique farm identifier, or area identifier such as a dip tank or crush pen area. The various ways of identifying a farmer or region differ among traceability systems.

In Swaziland, for example, the dip tank area is indicated on the yellow, plastic ear-tag, just below the Swazi shield, as well as on the hind leg, where the animal is branded with the specific dip tank number. If the animal is moved from one dip tank to another, it is branded on the other hind leg, and then on the shoulders, if moved again.

In Namibia the farm is uniquely identified through the branding of the animal, where every farmer uses a hot iron to brand his or her farm identifier on the animal’s hind leg. Hot iron branding is a method by which an iron, with identifying symbol or combination of symbols is heated, and then held on the skin of the animal to cause a scar. Brand irons are usually made from mild steel alloys

(Caja, Ghirardi, Hernández-Jover, & Garín, 2004), no more than 4 mm wide, with a smooth, flat surface. Animals are branded at a young age, from about three to six months. The ear-tag used in Namibia has only the number of the specific animal and the Namibian symbol, making the animal brand the only way of identifying ownership.

The animal itself also needs to be uniquely identified, not only to prove ownership, but also to control disease outbreaks by isolating infected animals (Moreki et al., 2012). Animal branding started more than 3 800 years ago where valuable animals such as horses were marked (Bowling et al., 2008). Similarly, all animals captured in a traceability system must be uniquely identifiable. Today, popular methods include inserting a rumen bolus, conventional RFID ear-tags and hot iron branding, although various other forms of animal identification exist. According to Caja et al. (2004) methods used include the following:

1. Caustic branding, using acids or caustic soda
2. Freeze branding
3. Paint branding
4. Ear notching
5. Tattooing
6. Natural character identification, for example body marks
7. Optical identification
8. Nose prints
9. DNA fingerprints

(Caja et al., 2004)

Key characteristics of every animal, such as the owner's name, the area where the animal is born, how and where the animal is branded, the sex of the animal, the colour/s of the animal and the date are captured on a traceability system (Oladele, 2011).

The rumen bolus

Botswana, one of the best examples in Southern Africa, started its first phase of animal identification in 2001 with the use of a rumen bolus, roughly the size of a small carrot, inserted into individual cattle, a reusable device costing $2.50 in 2010 (Oladele & Jood, 2010). All the data is captured in a database by reading the data with an RFID reader, and the data is sent to an extension officer's office computer (Oladele, 2011).

- *Advantages*

A rumen bolus is tamper-proof, safe to use and reusable (Moreki et al., 2012), making it virtually impossible to identify an animal twice, thus ensuring that no animal is captured more than once in the traceability system's database.

- *Disadvantages*

Botswana failed their audit conducted by the European Commission in January 2011, mainly because of problems pertaining to the use of the rumen bolus (European Commission, 2011). Botswana introduced ear-tags on the 1st of January 2013, and the suspension was lifted (Moreki et al., 2012). Table 5 highlights the main disadvantages of the rumen bolus and figure 12 illustrates it.

Disadvantage	Source
Shortage of boluses during insertion	Oladele (2011)
Most LITS equipment was designed for the programme and is not easily available on the market	Fanikiso (2009)
Frequent breakdown of equipment due to rough terrain on farming areas	Fanikiso (2009); Oladele (2011)
Limited suppliers of LITS equipment and boluses (usually, sourced from outside the country)	Fanikiso (2009)
LITS system is mostly public sector driven	Fanikiso (2009)
Poor health status of cattle	Oladele (2011)
Injury/death of animal in the bolus insertion process	Oladele (2011)
Keeping cattle without brands or ear marks	Oladele (2011)
Lack of collaboration and communication	Oladele (2011)
Inadequate transport and manpower to insert bolus	Oladele (2011)
Inadequate information	Oladele (2011)
Poor support from the private sector service providers	Fanikiso (2009)
Relatively poor support infrastructure, e.g., metal crushes	Oladele (2011)
Lack of knowledge in some technical areas	Oladele (2011)
Trekking cattle to crushes is tedious	Oladele & Jood (2010); Oladele (2011)
Cost of bolus is high	Oladele (2011)
Most farmers are conservative and weary of introducing innovations	Oladele (2011)
Setting up the tracing equipment takes time	Oladele & Jood (2010)
Bolus insertion requires a great deal of labour from farmers	Oladele & Jood (2010)
Bolus insertions at loading kraals (cattle enclosures) delay the loading of cattle	Oladele & Jood (2010)

Table 5. A summary of challenges to the livestock traceability implementation in Botswana (Adopted and adapted from Moreki et al. (2012))

Figure 12. An example of a rumen bolus used in Botswana

Ear-tags

Ear-tags are the most widely known method of cattle identification (Caja et al., 2004). Ear-tags can be made either from metal or plastic, they are pre-numbered, they come in different sizes, and are inserted with specific pliers (Dahlborn et al., 2013). Usually a small ear-tag is inserted in the one ear, and can include an RFID chip, and the bigger ear-tag is inserted in the other ear, with the animal number clearly indicated on the bigger ear-tag.

- *Advantages*

The ear-tags are easy to apply, cheap, have no side effects on animals, and are clearly visible (Dahlborn et al., 2013). They are quick to apply, show no problems during or after application, and are easy to read (Kowalski et al., 2014); the plastic ear-tag is durable and animals from any age can be tagged.

- *Disadvantages*

Tags can get lost if not properly inserted (Pinna, Sedda, Moniello, & Ribó, 2006) and in cases of theft, the animal's ears are cut off, making identification more difficult, although the branding of the animal can be used to identify it.

3.2.3. Monitoring animal health

Animal health is crucial to the success of any traceability system because disease outbreaks lead to the loss of animals and revenue. The regular dipping events in Swaziland are documented by capturing the animal's details in the register and transferring them to the central database. If any animal is absent from a dipping event, the details surrounding the absence must be documented. Reasons for the animal's absence vary from when an animal has strayed off to another area, when an animal is sick or injured and therefore stayed away from the dipping event, or when the animal died. The animal could also have been sold. In cases of death, the animal's owner has to supply a reason. The reason for the animal's death is very important, as it can supply information on a possible disease outbreak. The animal's ear-tag details need to be kept, enabling the tag to be deregistered and the animal's death captured in the database (Mdluli, 2012). Animal health can serve as a valuable source of input when dealing with disease outbreaks. Regular updates to any traceability system are important to ensure accuracy and reliable information.

3.2.4. Disease control

Namibia is at high risk of FMD outbreaks, due to exposure from Zambia and Botswana, where buffalo cross the borders and are the carriers of FMD (Schultz, 2013). The exposure to buffalo is very difficult to restrain, as Schultz (2013) points out, with the area above the Namibian Red Line, also known as the Veterinary Cordon Fence (VCF), at high risk of exposure. The Red Line acts as an imaginary line where the communal farmers north of the Red Line could previously not export beef because of the risk of exposure to FMD (Kumba, 2003).

If a buffalo is spotted in the North East of Namibia, that area is quarantined for twenty-one days. If the disease is transmitted to other game or livestock, the area can be quarantined for up to six months (Fourie, 2013). Figure 13 shows the VCF as well as the high-risk areas for foot-and-mouth disease.

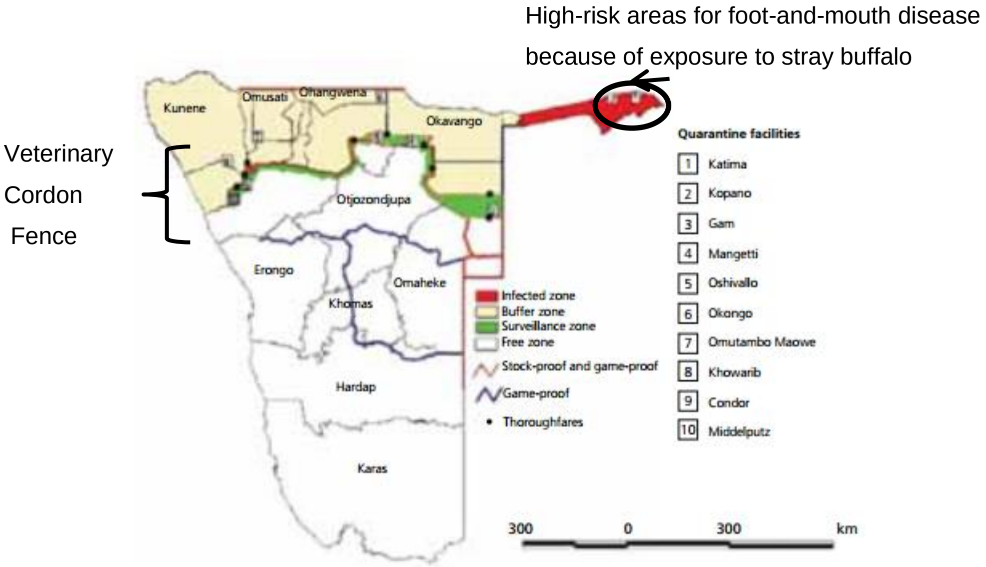


Figure 13. Foot-and-mouth disease zones and fences in Namibia (Adopted and adapted from Hubschle (2005))

Communal farmers need to contain disease outbreaks effectively to minimise the quarantine area. The outbreak area will be the focal point. With the help of Google Maps and NamLITS, the areas in direct contact with the focal point can be traced back or traced forward, where they typically share resources such as drinking water. In this way the contamination radius is identified and the areas of contamination can be quarantined. If areas beyond the traced areas have been exposed, it will lead to a bigger area being quarantined, where a game fence will typically serve as the boundary of the contamination. If it goes beyond the game fence, the entire country will be quarantined. Figure 14 shows how the radius of the disease outbreak is determined and Figure 15 illustrates how forward and backward tracing is used to contain the infected area.

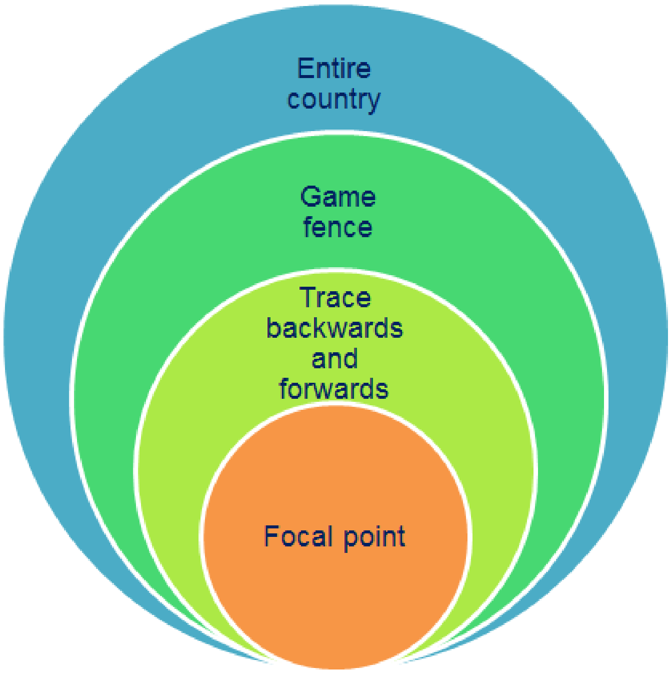


Figure 14. Managing disease outbreak events

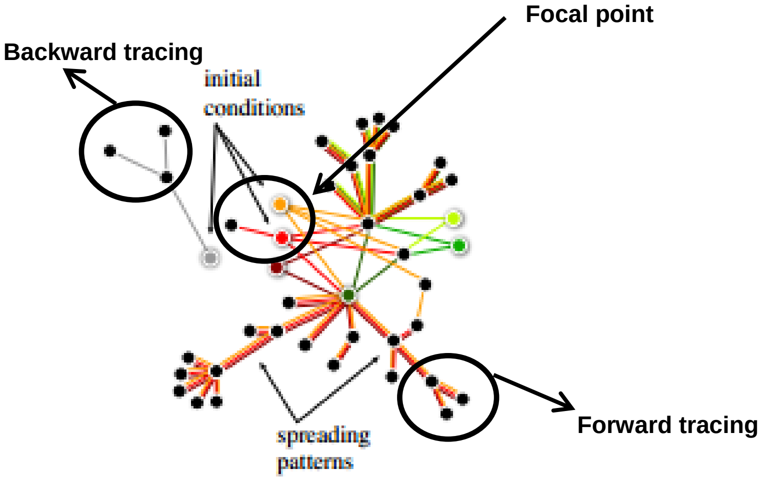


Figure 15. A disease outbreak showing spreading patterns. (Adopted and adapted from Bajardi, Barrat, Savini, and Colizza (2012))

Disease outbreaks cannot be predicted, and even if they have been identified and contained, there are different ways of addressing the outbreak. Worldwide, the following four ways of controlling diseases have been implemented (Scoones & Wolmer, 2003):

Export zones with vaccination

Cattle are vaccinated twice a year in areas where buffalo are present. Animals are contained by fences, which restrict movements (Vosloo, Bastos, Sangare, Hargreaves, & Thomson, 2002). Further measures can include veterinary health inspections, veterinary supervision of high-risk areas to monitor diseases and frequent examination of animals (Bengis, Kock, & Fischer, 2002).

Compartmentalisation

Cattle need to be kept in mini-zone areas, typically farm fences or game fences. Containing animals is difficult in the NCAs, as cattle graze freely. Another important part of compartmentalisation is the successful implementation of a livestock traceability system, as is currently in place in Namibia, with NamLITS becoming operational in 2005.

Commodity-based trade

The focus is not on the infected animal, but rather ensuring that the final product is safe for human consumption. In cases of livestock with FMD, deboned beef and matured beef pose no threat to human health (Rich & Perry, 2011). Technological modernisation and market development can strengthen this movement (Scoones & Wolmer, 2006).

Managing beef supply for local trade

Beef still needs to adhere to food safety standards and a steady supply of animals for local markets needs to be ensured.

The different ways of addressing disease outbreaks are important because not all diseases impact humans as one might anticipate. Consumers should be aware of the risks.

Managing beef supply for local trade can be done at a relatively low cost because as one moves to compartmentalisation and export zones with vaccination, the cost of disease control increases dramatically because of the high value of exporting to countries in the EU or Norway (Scoones & Wolmer, 2003). If disease outbreaks can be anticipated, one can address the threat in the way grazing of the animals is managed and assist in managing nutrition and yield.

3.2.5. Managing nutrition and yield

Consumers have little confidence in meat products. Reasons include the use of illegal growth hormones, antibiotic use, feed contaminated by dioxin, which is a by-product when manufacturing feed, and the use of genetically modified (GM) feed (Roosen, Lusk, & Fox, 2003). Not all antibiotics are harmful, for example coccidiostats and histomonostats are permitted to assist in killing protozoa (Andrée, Jira, Schwind, Wagner, & Schwägele, 2010).

Protozoa causes diseases in animals and humans. However, the EU is regulating the use of antibiotics by means of the Council Regulation (EEC, 1990) as explained by Andrée et al. (2010). Unregulated use of antibiotics results in antibiotic-resistance and increased allergies (Toldrá & Reig, 2006). Growth promoters are illegal because they remain present in all products derived from the animal and lead to poorer quality meat products, which lead to health risks (Toldrá & Reig, 2006).

Andrée et al. (2010) list a number of vulnerabilities where inadequate traceability can lead to insufficient documentation regarding the animal or animal product, faulty ear-tag information, a lack of identifying all animal contaminants and a lack of information regarding the detection of contaminants. In the light of all the health risks to animals and humans, the feed of animals needs to be nutritional, yet safe for human consumption, leading to the need to identify animals uniquely.

3.3. Entry to new export markets

Importers should keep track of the imported meat, until finally reaching the overseas consumer (SAFA, 2003), throughout all stages, as is illustrated in Figure 16. The red meat value chain should have traceability throughout, but the one area where traceability can play a big role, is the import/export market, specifically the export market in this study. For the export market to grow, a holistic farm management system needs to be incorporated.

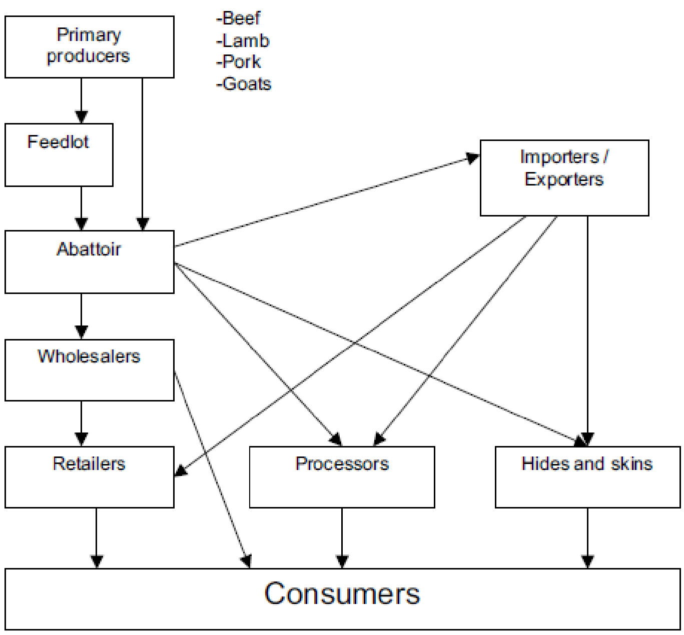


Figure 16. The red meat value chain (Adopted from SAFA (2003))

In Figure 17, an example is given of a typical communal family farm system. Low family income, deteriorating soil quality and excessive work load are identified as three of the main areas of concern in this type of farming method (Dogliotti et al., 2014).

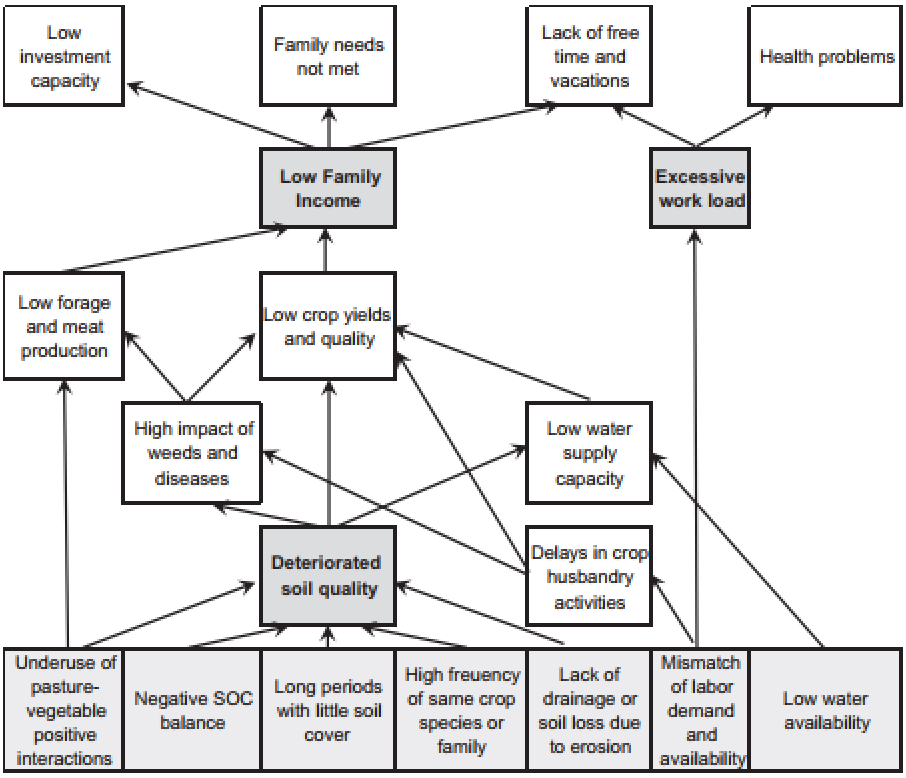


Figure 17. Problem tree summarising typical difficulties with a family farm system (Adopted from Dogliotti et al. (2014))

If one is to, however, adopt a better strategy, for example illustrating the model of the cost/benefit analysis and farm productivity, one can identify how improved inputs will lead to better outputs (Van Zyl, McCrindle, & Grace, 2008). A simple example will be if a communal farmer sells his/her cattle at a higher price as a result of traceability, the level of income of the family will rise with every animal sold. In turn, this allows the farmer to buy more animals and sell less. With more cattle, the farmer's herd is growing, allowing the farmer to sell more at a later stage when cattle are an optimal age to enable him/her to get even more money per individual animal. Suddenly, the farmer can plough back money into the farm, buying better feed, enabling to herd more cattle, even in winter times when the number of cattle per hectare decreases compared to summer months. The entire red meat value chain grows, creating employment opportunities throughout, as more cattle need to be transported to feedlots and abattoirs, more people are needed to slaughter animals and the farmer can also employ more farm workers, lessening the work load on the family members, improving living conditions by stimulating the rural economy. There are more opportunities for entrepreneurs and the country sees an overall increase in their GDP.

3.4. Aligning livestock production with the Millennium Development Goals

Traceability systems are expensive, with the growing trend to place the responsibility of food safety on the supplier, rather than the retailer (Sodano & Verneau, 2004). Namibia can export beef to Europe and South Africa quota-free, but has to deliver at least 1 350 tons of beef to Norway, as stipulated in the General System of Preference by the Norwegian government (Schultz, 2013). Traceable food products reach higher prices in European stores, and countries with reliable traceability systems become preferred suppliers (Martinez & Poole, 2004). Poorer countries can now position themselves to exploit their strategic opportunity not only to gain entry, but to grow their economy by exporting greater quantities of beef (Sodano & Verneau, 2004), and to more countries, as the demand for safe meat is only set to increase.

Livestock trading can aid in alleviating poverty in developing countries and promote food security. Reliable livestock traceability systems can pave the way for local, national and international trade; however, it would be ideal if all countries could fulfil their own meat requirements. Another millennium goal is to import meat from countries that have a low disease-risk (Rweyemamu et al., 2008). By using traceability systems the risk of disease outbreaks is dramatically lessened.

3.5. Conclusion

Traceability and its worldwide importance cannot be denied. Consumers demand to know that all meat products are safe for human consumption. This chapter aimed to illustrate the scope and reach of traceability systems, stipulating all their regulations. It concludes with ta brief discussion of the entry to new export markets for countries with adequate traceability systems, and ends the discussion by listing the technical requirements of a traceability system. In the case study chapters, traceability is applied to two case studies conducted in Swaziland and Namibia, and their unique challenges and opportunities are discussed in terms of their local contexts. The next chapter of the literature review provides background on sustainable ICT4D projects and other successful initiatives, with valuable lessons highlighted in all cases.

4. Chapter 4: A discussion on sustainable ICT4D projects and its implications for a successful initiative

Sustainable development is the pathway to the future we want for all. It offers a framework to generate economic growth, achieve social justice, exercise environmental stewardship and strengthen governance. Ban Ki-moon

4.1. Sustainability and sustainable development

The word "sustain" is defined as the ability:

> *"To provide what is needed for (something or someone) to exist, continue" (*Merriam-Webster Dictionary).

Pretty (1995) explains that to some, sustainability implies persistence and the ability to continue for a long time. Sustainability as it relates to development is hard to define. Toman (2006), Vos (2007) and (Mog (2004) argue that the term is useless because it "cannot be adequately defined" (Costanza & Patten, 1995). For the purpose of clarity, the definition of sustainability in the context of development in this thesis implies a project that can continue, even after funding is withdrawn. Sustainability evolved to sustainable development; Bossel (1999) states, "sustainability in an evolving world can only mean sustainable development". The first broadly accepted definition of sustainable development was formulated in 1987, as part of the Brundtland Report: "Sustainable development is development that meets the needs of future generations without compromising the ability of future generations to meet their own needs" (Brundtland et al., 1987). This definition was contested as being vague, because the *needs* being referred to is a subjective concept (Beckerman, 1994). A second popular definition used is from the World Bank paper "Environment, Growth and Development". It says that "economic growth, the alleviation of poverty, and sound environmental management are in many cases mutually consistent objectives" (World Bank, 1987). In 1992 the World Bank, in its Development Report, continued to focus on sustainable development, and identified four elements of development: firstly, an improved climate for enterprise; secondly integration into the global economy; thirdly investment in people and fourthly, maintenance of macro-economic stability (World Bank, 1992). In this thesis sustainability and sustainable development are treated as two sides of the same coin.

Kelly (2009) created a diagram in which the time line of sustainability is illustrated. In Figure 18 below, the diagram as well as a summary of the information feeding into the diagram as shown in Table 6 is presented.

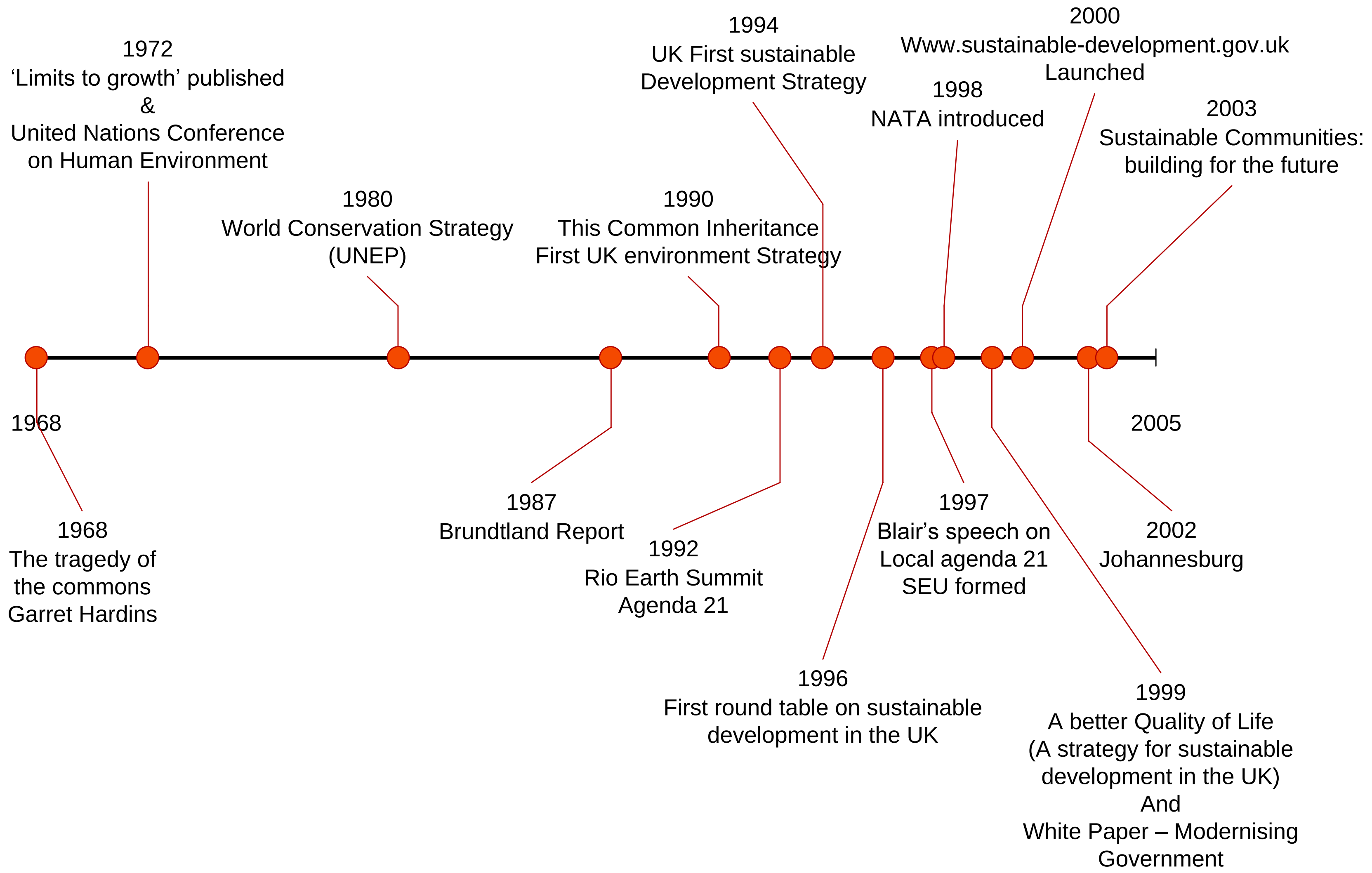


Figure 18. The origin and time line of sustainability (Adopted from Kelly (2009))

Date	Event	Description	Link/Source
1968	Tragedy of the commons	Publicised by Garret Hardins in his 1968 Science article, "The Tragedy of the Commons".	http://www.sciencemag.org/sciext/sotp/pdfs/162-3859-1243.pdf
1968	The population bomb	Paul R. Ehrlich predicted disaster in 'the population bomb' for humanity due to overpopulation and the population explosion.	Paul Ehrlich (1968) The population bomb
1971	Polluter pays the principle	OECD recommends that those causing pollution should pay the costs in a bid to unite the environment and economic elements.	http://www.oecd.org/dataoecd/48/63/19827587.pdf
1972	United Nations Conference on the Human Environment	Conference held in Stockholm in 1972. The conference theme was "Only one Earth". It produced 109 recommendations and divided the responsibilities between the existing bodies of WHO, WMO, UNESCO and FAO. UNEP was charged with coordinating the work. It considered only the environmental aspects and in particular pollution.	http://www.unep.org/Documents/Default.asp?DocumentID=97&ArticleID=1503
1972	Limits to growth paper	They concluded that: 1) If the present growth trends in world population, industrialisation, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years. The most probable result will be a rather sudden and uncontrollable decline in both population and industrial capacity. 2. It is possible to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future. The state of global equilibrium could be designed so that the basic material needs of each person on earth are satisfied and each person has an equal opportunity to realise his individual human potential.	Meadows, D.H., Meadows D. L., Randers, J. and Behrens W. W. (1972): *Limits to growth: A report for the club of Rome's Project on the predicament of Mankind.* Universe Books, New York City http://www.clubofrome.org/docs/limits.rtf
1973	OPEC oil crisis	This fuels the limits to growth debate.	
1974	CFC crisis	Rowland and Molina published in journal *Nature* that continued use of CFC gases at an unaltered rate would critically deplete the ozone layer.	www.ourplanet.com/imgversn/92/rowland.html

Date	Event	Description	Link/Source
1976	HABITAT	First global meeting to link the environment and human settlement.	http://www.unhabitat.org/ www.undp.org/un/habitat/back/van-decl.html
1980	World Conservation strategy	The phrase 'Sustainable development' or rather 'development that is sustainable' was first used. .	IUCN(1980) The world conservation strategy, IUCN, Morges, Switzerland www.iucn.org/
1984	International conference on Environment and Economics (OECD) in London	This conference concluded that environment and economics should be mutually reinforcing. This conference led to the Brundtland report.	
1987	Our Common Future / Bruntland Report World Commission on Environment and Development (WCED)	The Brundtland Commission published a seminal report, *Our Common Future*, which coined and defined the term "sustainable development," fusing environmental and economic sensibilities. The definition is: "*Economic and social development that meets the needs of the current generation without undermining the ability of future generations to meet their own needs*". This brought together the three aspects of environmental, economic and social development. *'Sustainable development is dependent on each nation achieving its full economic potential while enhancing the environmental resource base upon which development must be based'.*	*Brundtland Our Common Future.* A reader's guide by Don Hinrichsen
1987	Montreal Protocol	International agreement to adopt measures for tackling a global environment problem. It was implemented partly due to the discovery of the Antarctic ozone hole in late 1985, and the need to implement stronger measures to reduce the production and consumption of a number of CFCs and some Halogens.	http://www.unep.ch/ozone/pdfs/Montreal-Protocol2000.pdf
1988	Intergovernmental Panel on Climate Change formed (IPCC)	It was set up to assess the technical issues that were being raised. Its first report stated that global warming should be taken seriously.	http://www.ipcc.ch/

Date	Event	Description	Link/Source
1989	Lynam and Herdt's definition of sustainability	The capacity of system to maintain output at a level approximately equal to or greater than its historical average, with the approximation determined by the historical level of variability.	Lynam, J. K. and Herdt, R. W. (1989) 'Sense and sustainability: sustainability as an objective in international agricultural research', *Agricultural Economics*, Vol. 3, pp 381-398
1990	This common inheritance: Britain's Environmental Strategy	The ideas from the Bruntland report, '*Our Common Future'* were taken up in the UK's first comprehensive strategy, the White Paper on the environment, *This Common Inheritance.*	HMSO (1990) This common inheritance: a summary of the white paper on the environment. Available in the library.
1990	Definition of sustainability	Pearce and Turner (1990) … maximising the net benefits of economic development, subject to maintaining the services and quality of natural resources over time.	
1991	Definition of sustainable development	ICUN (1991). Development that improves the quality of human life while living within the carrying capacity of supporting ecosystems.	IUCN (International Union for the Conservation of Nature), UNEP (United Nations Environment Programme) and WWF (World Wild Life Fund) (1991) Caring for the earth: a strategy for sustainable living, IUCN, Gland, Switzerland.
1992	Rio Earth Summit	The Earth Summit was inspired by the Bruntland report in 1987. Between 1990 and 1992 Agenda 21 was developed to stand as a blueprint for sustainable development in the world. It considered the interaction between economic, social and environmental trends. The commission for Sustainable development (CSD) was set up to ensure that Agenda 21 would have an impact at all levels of governance. Agenda 21 recognised the role of stakeholders in implementing this blueprint.	Agenda 21 http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21toc.htm CSD http://www.un.org/esa/sustdev/csd/about_csd.htm
1992/1993	United National Framework on Climate Change (UNFCCC)	Introduced to fight global warning at Rio where it was adopted. The United Kingdom signed the *Framework Convention on Climate Change* in June 1992 at the Rio Earth Summit and ratified it in December 1993	www.unfccc.de

Date	Event	Description	Link/Source
1992	European Communities Green Paper	Green Paper on the Impact of Transport on the Environment - A Community Strategy for "Sustainable Mobility". *COM* (92) 46, 20 February 1992.	http://aei.pitt.edu/archive/00001235/01/transport_environment_gp_cOM_92_46.pdf
1993	Hardin's 3 laws of human ecology	1 – 'We can never do merely one thing' (interconnectedness of society). 2 – 'There's no away to throw to' (an effluent society). 3 – The impact of any group or nation on the environment is represented qualitatively by the relation: I = P A T (I = Impact, P = Size of population, A is the per capita affluence (measured by per capita consumption) and T is the measure of the damage done by the technologies that are supplying the consumption.	
1994	Aalborg Charter	Charter of European Cities and Towns Towards Sustainability.	http://www.aalborg.dk/engelsk/information+about+aalborg/aalborg+charter.htm
1994	Sustainable development: The UK strategy	The UK becomes one of the first countries to produce a sustainable development strategy in response to the call made at Rio.	
1994	First UK programme on climate change	After signing the Framework Convention on Climate Change (FCCC) the UK Government produced its first Programme on Climate Change, identifying its obligations and commitments to help tackle the problem of global warming.	

Date	Event	Description	Link/Source
1995	Creation of the World Business Council for Sustainable Development (WBCSD)	It was formed in 1995 from the world international conference on environmental management (WICEM) and the Business Council on Sustainable Development (BCSD) The World Business Council for Sustainable Development (WBCSD) is a coalition of 170 international companies united by a shared commitment to sustainable development via the three pillars of economic growth, ecological balance and social progress.	http://www.wbcsd.ch/templates/TemplateWBCSD5/layout.asp?MenuID=1
1995	World summit for social development	This summit expressed a commitment to eradicate poverty.	www.un.org/esa/socdev/wssd/index.html www.unhchr.ch/html/menu5/socdev95.htm
1995	First conference of the parties (cop-1) to the FCCC (UNFCCC)	First conference for all the countries who ratified the convention from the Rio Summit.	www.unfccc.de
1996	UK Road Table on Sustainable Development first annual report		DoE (1996) UK Road Table on Sustainable Development. First Annual Report.
1997	Kyoto Climate change Protocol	Governments met in Kyoto, Japan to look at the problem of global warming. Previous agreements had tried to limit emissions of carbon dioxide to the levels they were in 1990. Many countries failed to achieve even this small reduction. The UK and Germany met these targets. At Kyoto, a new set of targets for the reduction of greenhouse gases was agreed on. By 2012 emissions of six major greenhouse gases must have been reduced to below 1990 levels for the target period 2008 - 2012.	http://unfccc.int/resource/protintr.html

Date	Event	Description	Link/Source
1997	Tony Blair statement on Agenda 21	'I want all local authorities in the UK to adopt Local Agenda 21 strategies by the year 2000': Tony Blair, New York, UN General Assembly Special Session on the Environment.	Taken from DETR (2000) Sustainable Local Communities for the 21st century. Why and how to prepare an effective Local Agenda 21 strategy
1997	Social Exclusion Unit Created	The social exclusion unit was formed in 1997 under the new labour government. Its aim is … "together, we are working to create prosperous, inclusive and sustainable communities for the 21st century – places where people want to live that promote opportunity and a better quality of life for all".	http://www.socialexclusionunit.gov.uk/
1998	Introduction of the New Approach to Appraisal (NATA)	New approach to appraisal introduced in the UK. The key criteria are: • environmental impact • safety • economy • accessibility • integration One critical part of this methodology is the use of an appraisal summary table (AST) that summarises the key economic, social and environmental impacts of a scheme.	http://www.webtag.org.uk/archive/nata/understanding/index.htm
1998	The EU White paper: Developing the citizens' network	Communication of 10 July 1998 from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions: "Developing the citizens' network – Why local and regional passenger transport is important and how the European Commission is helping to bring it about".	http://europa.eu.int/scadplus/leg/en/lvb/l24215.htm

Date	Event	Description	Link/Source
1999	A better quality of life, a strategy for sustainable development for the UK	UK Government. The strategy defines sustainable development as ensuring a better quality of life for everyone, now and for generations to come. Its four main objectives were: • Social progress that recognises the needs of everyone. • Effective protection of the environment. • Prudent use of natural resources. • Maintenance of high and stable levels of economic growth and employment.	http://www.sustainable-development.gov.uk/uk_strategy/index.htm
1999	Foresight scenarios. Actions for sustainable transport: Optimisation across modes.	This report was published by the Integrated Transportation Chain Futures Task Force (DTI). World markets, global sustainability, local stewardship and provincial Enterprise are used and consider how these four worlds would develop up to 2020 and what implications these have four certain factors spreading the three pillars of sustainability.	DTI (1999) Actions for sustainable transport: Optimisation across modes. Foresight.
1999	*Modernising Government*: White Paper	This white paper committed the UK government "to produce and deliver an integrated system of impact and appraisal tools in support of sustainable development covering impacts on business, the environment, health and the needs of particular groups in society". From this white paper the IPA – the integrated policy appraisal tool – was developed as a tool to help policy makers and improve the quality of appraisal in government. From this the Regulatory Impact Assessment (RIA) was developed which is now the main tool for integrating sustainable development into central government policy making. The RIA considers the three pillars of sustainability in the appraisal work.	IPA reference http://www.sustainable-development.gov.uk/sdig/integrating/12.htm Modernising Government White Paper: http://www.archive.official-documents.co.uk/document/cm43/4310/4310-00.htm Indicators / questions split into the three pillars of sustainability: http://www.cabinetoffice.gov.uk/regulation/economic/checklist/impacts.asp
2000	Updates UK climate change programme	The UK's climate change programme was updated in the light of the Kyoto protocol. It details how the UK is going to meet the Kyoto targets and reduce emissions in each of the sectors of the economy (DETR, 2000).	*http://www.defra.gov.uk/environment/climatechange/cm4913/index.htm*

Date	Event	Description	Link/Source
2000	Sustainable development website launch	www.sustainable-development.gov.uk launched.	*www.sustainable-development.gov.uk*
2000	Guidance document on preparing Regional Sustainable Development Networks	Guidance on preparing Regional Sustainable Development Frameworks (UK government)	http://www.defra.gov.uk/environment/sustainable/rsdf/guidance2000/index.htm
2001	Mobility 2001. World mobility at the end of the twentieth century and its sustainability	World Business Council for Sustainable Development publication. This report considered current mobility patterns in the world at the start of the 21st century and then identified those factors that were threatening future sustainable mobility. It produced a sustainability scorecard for the developed and developing world to assess measures which should be increased or decreased.	http://www.wbcsd.ch/plugins/DocSearch/details.asp?type=DocDet&DocId=MTg1
2002	Johannesburg World Summit on Sustainable Development	Johannesburg declaration on sustainable development included the following statement: *"Thirty years ago in Stockholm we agreed on the urgent need to respond to the problem of environmental deterioration. Ten years ago at the united national conference on environment and development, held in Rio de Janeiro we agreed that the protection of the environment and social and economic development are fundamental to sustainable development, based on the Rio principles".*	http://www.johannesburgsummit.org/

Date	Event	Description	Link/Source
2003	Sustainable Communities: building for the future ODPM (2003)	Housing and the local environment are vitally important. But communities are more than just housing. They have many requirements: Investing in housing alone, paying no attention to the other needs of communities, risks wasting money – as past experience has shown. A wider vision of strong and sustainable communities is needed to underpin this plan, flowing from the government's strong commitment to sustainable development. The way our communities develop, economically, socially and environmentally, must respect the needs of future generations as well as succeeding now. This is the key to lasting, rather than temporary, solutions; to creating communities that can stand on their own feet and adapt to the changing demands of modern life; places where people want to live and will continue to want to live.	http://www.odpm.gov.uk/stellent/groups/odpm_communities/documents/page/odpm_comm_022184.hcsp http://www.odpm.gov.uk/stellent/groups/odpm_communities/documents/pdf/odpm_comm_pdf_023261.pdf
2004	Mobility 2030 meeting the challenges to sustainability	World Business Council for Sustainable Development. This report followed on from the earlier 2001 and looked ahead to mobility in 2030. It produced 12 indicators for sustainable development. This report used the three pillars of sustainability as a guide for producing its indicators.	http://www.wbcsd.ch/plugins/DocSearch/details.asp?type=DocDet&DocId=NjA5NA

Table 6. Timeline of sustainability (Adopted and adapted from Kelly (2009))

Sustainability and sustainable development are well-outlined in the above-mentioned publication (Ramani, Zietsman, Gudmundsson, Hall, & Marsden, 2011), and are used by authors such as Yilmaz (2014), Turner (2012) and Bukhari and Nazish (2015). The time line continues from 2005 until 2012, and the main events are summarised in Table 7, as found in the International Institute for Sustainable Development (2012).

Date	Event	Description	Link/source
2005	Millennium Ecosystem Assessment	1 300 experts from 95 countries provide scientific information concerning the consequences of ecosystem change for human well-being.	www.millenniumassessment.org
2007	Public attention to climate change increases	Former U.S. Vice-President Al Gore's documentary, *An Inconvenient Truth* wins an Academy Award, and the IPCC's alarming forecasts about the planet's health make headlines. The IPCC and Gore share the Nobel Peace Prize.	www.ipcc.ch
2008	Increasing urbanisation	For the first time in history, more than 50 per cent of the world's population lives in towns and cities.	www.unfpa.org/pds/urbanization.htm
2009	G 20 Pittsburgh Summit	G20 nations provide guidance for a 21st century global, sustainable and balanced economy. Leaders call for phasing out fossil fuel subsidies, and seek measures that will lead to sustainable consumption, while providing targeted support for the poorest people.	http://www.cfr.org/world/g20-leaders-final-statement-pittsburgh-summit-framework-strong-sustainable-balanced-growth/p20299
2009	Copenhagen climate negotiations	A crescendo of expectations is dashed as the Conference of the Parties fails to reach an agreement on new GHG emissions reductions commitments beyond 2012. The international environmental community sees this as a watershed moment. Momentum begins to shift toward national and regional efforts to reduce emissions.	www.iisd.ca/climate/cop15
2010	More severe and erratic weather, as forecast by climate change models.	Massive, deadly heatwaves in Europe, first observed in 2003, reoccur, killing 55 000 people in western Russia and costing US$15 billion in damages. The changing patterns of drought and floods are now widespread, including Pakistan, southern China and other parts of the world.	
2011	The world population reaches 7 billion, and is increasingly interconnected.	One third of those have Internet access; 80 per cent have mobile phones. Increasing the population by 1 billion took only 12 years.	

Date	Event	Description	Link/source
2011	Climate change negotiations in Durban.	The negotiations' outcome is a step forward in establishing an international agreement beyond Kyoto – one with mitigation commitments from all major emitters, including developed countries and several major developing countries.	www.iisd.ca/download/pdf/enb12534e.pdf
2012	One of the first of the Millennium Development Goal targets is achieved.	In advance of the 2015 deadline: the percentage of the world's people without access to safe drinking water is cut in half.	www.un.org/millenniumgoals/
2012	Rio +20	Fifty years after Silent Spring, 40 years after Stockholm and 20 years after the Earth Summit, the global community reconvenes in an effort to secure agreement on "greening" world economies through a range of smart measures for clean energy, decent jobs and more sustainable and fair use of resources.	www.uncsd2012.org/rio20/

Table 7. Sustainability and sustainable development from 2005 until 2012 (Adopted and adapted from International Institute for Sustainable Development (2012))

The one very important date to take note of is 2012, when the first millennium development goal target was reached, providing more people with access to drinkable water. Sustainable development has come a long way, and is used widely, and in various forms of diagrams and frameworks. The one diagram of sustainability that is simple and used often, is the pillars of sustainability, and is adopted as part of the conceptual framework. It is discussed in the next section.

4.2. Critical success factors for sustainable development

In today's Information and Communication Technology for Development (ICT4D) context, one of the key components is sustainability. At the International ICT4D Conference hosted in Chicago in May 2015, the Catholic Relief Services invited practitioners and academics to present talks on their ICT4D theme "Increase impact through innovation". The one central point emphasised throughout the three days was the importance of sustainable projects. People want to invest time, money and effort into projects that can remain sustainable, even after the funding or other inputs have been withdrawn. Before one can discuss sustainability, one has to appreciate the complex nature of sustainability as it links to global development by further exploring ICT successes.

4.3. Examples of sustainable projects by focusing on ICT successes

4.3.1. ICT projects in general

The question of what makes an ICT project successful seems to be somewhat elusive, as it was initially a point of discussion starting with Peter Keen at the first International Conference on Information Systems (ICIS) held in 1980 (Keen, 1980). The debate continued with DeLone and McLean (1992), with their quest to find the dependent variable of IS projects. In short, they found six potential variables, all cited with extensive references from multiple sources. They are:

1. System quality
2. Information quality
3. Use
4. User satisfaction
5. Individual impact
6. Organisational impact

Further developments over the years involved the well-known Technology Acceptance Model (TAM), that include perceived usefulness, perceived ease of use and user acceptance. Davis (1989) questioned 152 employees and measuring the correlation between the variables – perceived usefulness and ease of use – against user acceptance. The scale items for perceived usefulness and perceived ease of use were then measured according to how they correlate with user acceptance, the initial identification of the scale items and then the pre-testing and analysis of the findings. Taking the results into account, usefulness were seen as being more important to users than perceived ease of use. In 2003, the model was expanded after a ten-year study, where Delone and McLean (2003) built a model, called the D&M IS Success Model, as is seen below in Figure 19, expanding the use and user satisfaction to further individual and organisational impact.

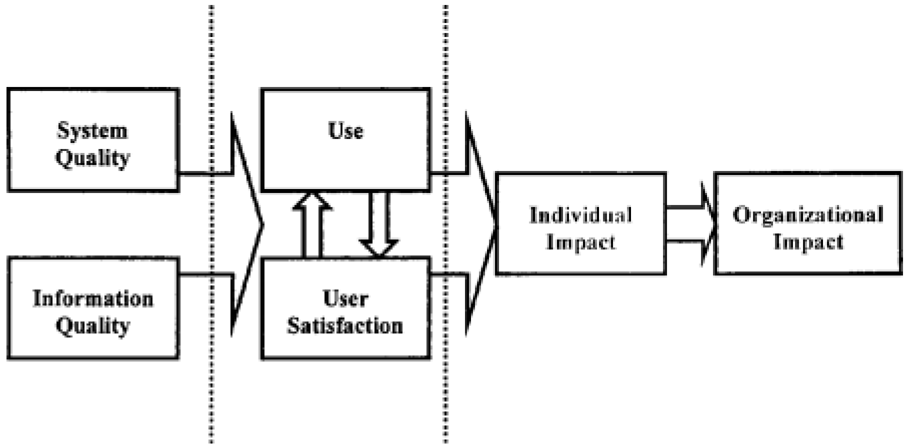


Figure 19. The D&M IS Success Model (Adopted from Delone and McLean (2003))

Chen, Boudreau, and Watson (2008) proposed a framework to take into account ecological sustainability by looking at IS through automation, transformation and information and how it led to eco efficiency and eco equity, finally leading to adoption of eco-effective practices, with a similar approach, but one more focused on ecological sustainability, with a specific goal of reaching IS researchers, educators and other role-players in the IS sphere (Malhotra, Melville, & Watson, 2010). Scholars continued their quest to find the key to IS success, with a well-known article by Erek, Schmidt, Zarnekow, and Kolbe (2009), looking at the IS Value Chain suggesting governance, the source of management, the making of all the tasks, the internal and external delivery leading to the return of resources for re-use and taking into account the stakeholders' interests. The debate to find IS success is one that is still continuing 37 years later. Petter, DeLone, and McLean (2013), aimed at finding the independent variable of IS success, listing 15 potential successful factors out of an initial 45 factors identified. The 15 factors are:

1. Enjoyment
2. Trust
3. User expectations
4. Extrinsic motivation
5. IT Infrastructure
6. Task compatibility
7. Task difficulty
8. Attitudes toward technology

9. Organisational role
10. User involvement
11. Relationship with developers
12. Domain expert knowledge
13. Management support
14. Management processes
15. Organisational competence

Some of these factors are very specific to IS implementations in organisations, but with the growing interest in the SDGs, certain success factors were identified specially relating to ICT4D projects.

4.3.2. ICT4D projects

Heeks (2002) links ICT4D success or failures to the role of local improvisation and context, specifically the sustainability of projects after external funding is withdrawn, the ability of the existing project team to continue with the project because of sufficient knowledge transfer and that there is a definite project champion driving it forward. Local sustainability in ICT4D projects remain difficult to pin down, with Jacucci, Shaw, and Braa (2006) naming limited financial support, inadequate local expertise, too narrow interventions, bias towards the project and lack of conducting a thorough pilot study as more extensive determinants of failures. Dwivedi et al. (2015) argue that one needs a number of determinants for IS success, without even including technology, where technology is only the end-result of the success. These determinants include project structure with user involvement, clear executable tasks and building trust among users, to name a few. Heeks, Subramanian, and Jones (2015) then argue the importance of taking into account the economic, political and environmental factors when creating sustainability in projects, with Foster and Heeks (2013) shifting the focus to “inclusive innovation”, looking at precursors to address potential issues, processes that involve the rural poor, the potential value to the rural poor to create adoption and innovation to improve livelihoods. The trend seems to move more towards inclusivity, where Musiyandaka, Ranga, and Kiwa (2013) successfully implemented a school computerised programme in Mashonaland in Zimbabwe, where only four factors for their success are given:

1. Sound ICT policies
2. Information exchange
3. Partnerships
4. Progressive attitude

Reasons why ICT4D development projects fail are ample, and recent literature suggest high costs and lack of government planning (Masiero, 2016), capable people being scarce, with technology only as successful as the capable people driving the project (Marais, 2015), cultural differences (Harris, 2015), failure to address real challenges (Qureshi, 2015), and people not assuming the appropriate responsibility (Qureshi, 2015), to name a few.

There are, however, several success factors as outlined by Pade et al. (2009). These authors briefly discuss nineteen such factors which are listed below. The nineteen factors are discussed in more depth below:

1. *Simple and clear project objectives*

   Projects are complex in nature, however, Pade-Khene, Mallinson, and Sewry (2011) identify a number of key critical success factors, with a strong focus of approaching implementation in phases, making goals and objectives explicit from the very beginning. To enable project funding, clear objectives are necessary (Peter, 2015), however, some of the project objectives are not always linked to any of the desired development outcomes (Meyer & Marais, 2014), therefore a balance between setting objectives, but building in flexibility, might lead to improved success rates.

2. *Approaching the project in a holistic way*

   If one is to approach an ICT4D project holistically, one as to identify perceived benefits by looking at the project as a whole (Galloway & Mochrie, 2005), while Marais (2011) argues that projects should not only be market-led, but also allow for socially-led, given the context of the ICT4D initiative.

3. *Using ICT to enhance existing rural development activities*

   Rural development should not simply react to ICT trends (Salemink, Strijker, & Bosworth, 2017), but should include the two major aspects of inclusion and connectivity, as is shown in Figure 20 below, with people-based inclusion research and place-based connectivity research.

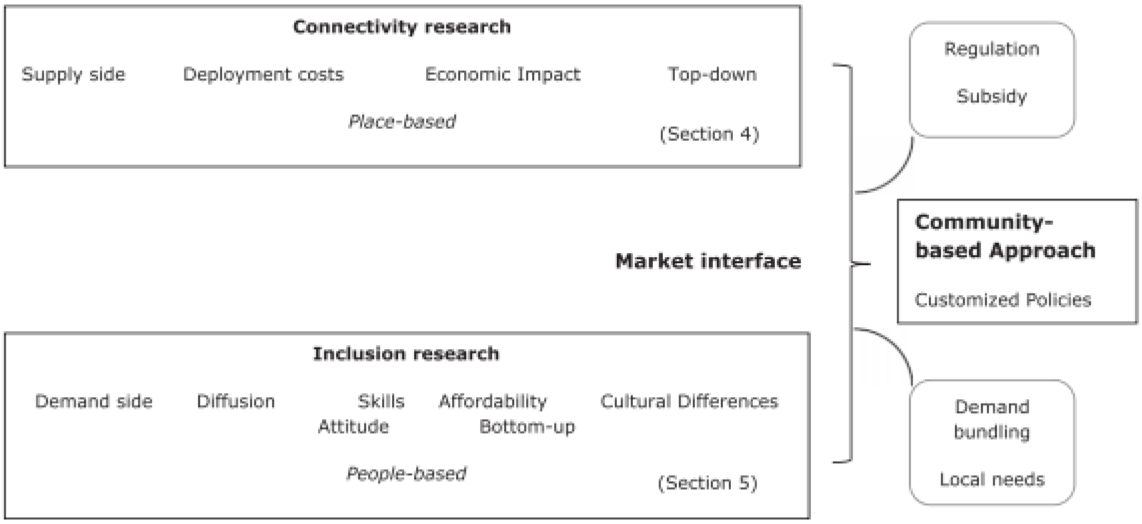


Figure 20. Combining connectivity and inclusion research to create a community-based approach (Adopted from Salemink et al. (2017))

There are initial steps needed to ensure that communities are not simply given access to the Internet, but rather:

> *"Laying infrastructure where it may not be economically viable and providing access for disadvantaged groups are initial steps towards enabling digital inclusion. However, the provision does not automatically lead to adoption."*
>
> *(Park, 2016)*

Bhatnagar and Schware (2000) feel that if ICT centres can fulfil multiple purposes, it will be more economically viable, given that the necessary training is provided. ICT in rural communities can be seen as a commodity, as supporting general development activities, a driver of the economy and solving development project problems (Sein & Harindranath, 2004). One should keep in mind that technology can assist in doing a lot of good in rural communities by empowering multiple stakeholders and beneficiaries.

4. *Cultivating an influential project champion*

A project champion ultimately sees a project through, making it much more successful. It is often seen as the one differentiating factor between a successful developmental project and a failure, as is true for the Kenyan M-Pesa example, where Michael Joseph, Susie Lonie and Nick Hughes played significant roles (Renken & Heeks, 2013). These individuals are known by name, due to the lasting impression that they made with such a big project.

5. *Incorporating socially excluded groups*

   New ICT4D initiatives should be endorsed by the society, the benefactors (Pitula, Dysart-Gale, & Radhakrishnan, 2010), with "social structures" and social contexts" key factors to keep in mind (Barrett, Sahay, & Walsham, 2001). If the intended benefactors are included in the process, made aware of the intended project outcomes and benefits, one has a much larger chance of success (Shin, 2009). One example of the disastrous outcome of not including the community, is where large numbers of mosquito nets were distributed in Kenya, but the main social problem was hunger. The project's objective was to lessen the cases of malaria, however, the result was that the communities used the nets to fish, but the mosquito nets were so finely weaved, that not only did the people manage to fish, they also, in the process, destroyed the eco-system (Bush et al., 2017).

6. *Awareness of specific ICT Policy influencing the project*

   Musiyandaka et al. (2013) state that the "absence of sound policy means that, projects will be focussed only on areas with infrastructure", whereas other factors such as information exchange, partnerships and enabling the community to become more empowered in the process of the ICT implementation, creates an appreciation for the new initiative, for example where e-commerce empowers communities to promote and sell their products to new markets (Musiyandaka et al., 2013).

7. *An understanding of the local political context*

   Political dictatorship is not uncommon in certain African countries, for example Zimbabwe. The political environment directly led to an economic meltdown, with unemployment at 80% in March 2009 (Perekwa, Prinsloo, & Van Deventer, 2016), in a process where president Robert Mugabe drove farmers off their farms, leading to hunger and social unrest (Norman, 2015). If one does not take the political context into account, one might become captive in a hostile environment, where people intending to be good Samaritans become victims themselves (Barker, 2015).

8. *Participation of community target groups in the project process*

   Some ICT4D projects fail because of one reason: there is no socio-economic benefit for the target community, but rather a western solution made to fit an indigenous issue, met with resistance and scepticism (Chipidza & Leidner, 2017). The benefits may be worthy of an ICT4D project where money is spent on improving lives of the poor and hungry, as are outlined in the first two SDGs, but the target communities are not involved or included, merely informed.

9. *Focusing on local needs*

   Hunger, poverty, lack of education, lack of infrastructure, lack of political stability, lack of basic human needs (Bartlett, Hart, Satterthwaite, de la Barra, & Missair, 2016; Hussain, Bhuiyan, & Bakar, 2014), these are issues that need to be addressed before handing out tablets to illiterate children (Chang, Tilahun, & Breazeal, 2014) without any sustainable internet providing solution. If one can use technology to improve local farming skills, create social networks where people can communicate and ask advice from peers, if one simply takes the time to listen to the people, the beneficiaries and address their basic needs first (Bradach & Grindle, 2014), one builds trust. Trust is vital to rural communities to create sustainable relationships and projects (Smith & Harper, 2015).

10. *Building on local information and knowledge systems*

    In many rural communities, the role of culture plays a very important role in how decisions are made (Nakagawa & Shaw, 2004), forming part of social capital, one of the forms of capital as outlined in the sustainable livelihoods framework (Carney & Britain, 2003). By combining information gathering from the local and traditional knowledge sources, one can then add onto it a modern technique of preserving the knowledge for future generations (Mathibela, Egan, Du Plessis, & Potgieter, 2015). Rural communities have survived for centuries without technology, that is something that everybody should value and respect, instead of dictating to them the importance of technology and change.

11. *Appropriate training and capacity building*

    Rather teach someone to fish, rather learn by doing, by building local skills to get buy-in from communities to embrace the project, to encourage the rest of the community to become stakeholders and take ownership of initiatives (Sahay & Mukherjee, 2017), than to follow a top-down approach in communities where indigenous structures are more respected and important than any new technology. Project sponsors should visit the areas they want to uplift and build capacity in and identify areas where the greatest impact can be made, not dictated by the sponsor, but rather by consulting community members (Greany & Allen, 2014).

12. *Facilitating local content development*

    Indigenous knowledge and the preservation of it is necessary, not only to create a better understanding of the culture and beliefs of the communities being studied, but also to be able to link ICT in their local context to a more global context (Johnson, Pejovic, Belding, & van Stam, 2012). South Africa has developed a system called the National Indigenous Knowledge Management System (NIKMAS) (Khalala, Botha, & Makitla, 2016), where Indigenous

Knowledge Recorders identified the primary holders of the knowledge, usually the elders in the communities, conducted interviews with them and then collate, verify and expand the knowledge into NIKMAS. Indigenous knowledge is preserved and stored centrally. This initiative is a good way of ensuring that with the introduction of new ICT systems, the role of indigenous knowledge is respected, taken into consideration and preserved for future generations.

13. *Motivation and incentive for ICT job placement in the community*

Community Health Workers are often being used to drive ICT initiatives in poorer countries (Strachan et al., 2015) for example in Mozambique, with mixed results, especially to retain those workers. Davies and Fumega (2014) discuss a number of ways of empowering the local communities by introducing ICTs:

1. The ability to analyse and solve problems better.
2. Improved self-esteem.
3. Social development.
4. The ability to play a bigger role in the economic realm.
5. The ability to find new employment.

The more involved the beneficiaries of a project are, the more they will take ownership of the initiative and become a role-player in the project, leading to local empowerment and job creation (Craig & Mayo, 1995).

14. *Focusing on self-sustainability*

Marais (2015) explains that practitioner-based themes of sustainable ICT4D initiatives rely on the design solution for the local context, proper governance and socio-economic and political sustainability, while Mabila, Van Biljon, and Herselman (2017) argue that one needs to incorporate economic, political, cultural, technological and institutional sustainability dimensions as critical success factors, with self-sustainability playing an important part.

15. *Encouraging local ownership*

As part of the cultural dimension of self-sustainability, Mabila et al. (2017) emphasises the role of local ownership by local participation, long-term public-private partnerships and programme management that includes both the communities and the managing stakeholders. The focus of ICT4D initiatives should focus on the user and the user's context, leading to an evolving local ownership (Sahay & Mukherjee, 2017), rather than simply bringing in technology and disappearing, without the necessary skills transfer and listening to the communities' needs and expectations.

16. Choosing the appropriate technology

There are various studies suggesting the usefulness of mobile technology in overcoming the digital divide, leading to sustainable and successful ICT4D initiatives as stated by Perekwa et al. (2016) and Loudon (2016), where one should not lose focus of the importance of the actual technology deployed to assist ICT4D interventions. One also has to keep future technologies in mind, allowing for the technology to grow, expand and scale as far as possible.

17. Building local partnerships

This point links with points 13, 14 and 15, where a project should enable job creation, should be able to become self-sustainable and should transfer skills and knowledge to the local communities, with the emphasis on public-private partnerships (Mabila et al., 2017).

18. Building on existing facilities

Danjuma, Onimode, and Onche (2015) are quoted as saying that “there is a technological divide-great gap in infrastructure” in the context of initialising an ICT4D project. The ideal would be to identify any existing infrastructure and to then enhance and upgrade it, rather than creating something unfamiliar. One example is to look at existing health facilities in communities if one is to promote ICT4D health intervention (Hoque & Ashraf, 2015). The communities are less resistant and curious to incorporate the new knowledge.

19. Ongoing monitoring and evaluation of the project

Measure the successes of your interventions by incorporating the monitoring and evaluation of ongoing ICT4D projects is important to move beyond failure (Uimonen, 2015). By tracking the successes and focusing on what is being done right, instead of looking back and realising resources were wasted, the stakeholders can get value for their money in terms of their ICT4D intervention (Hollow, 2015).

4.3.3. ICT4Ag projects

The first two SDGs as discussed in chapter one – no poverty and zero hunger – can be achieved faster and with greater success if one is to grow rural agriculture (Fan, Olofinbiyi, & Gemessa, 2015). Belcher, Boehm, and Fulton (2004) created a model called the Sustainable Agroecosystem Model (SAM) linking the economic and environmental models, starting with inputs and outputs opening new markets, to climate change and soil erosion that can be better managed once the financial means are there to plough back money into the rural farmer’s immediate environment. More attention is being placed on rural farming and sustainability to ensure sufficient food supply, although a lot more can be done in this regard. In Figure 21, a rough timeline is shown of how the emphasis of significant agricultural events shifted from developing the needed science in the 1950s, to policy needs, the role of ICTs, the Internet and system models between 1960 and 1990, to how to ensure agriculture can remain sustainable from the 1990s up to the emphasis of food security from 2010.

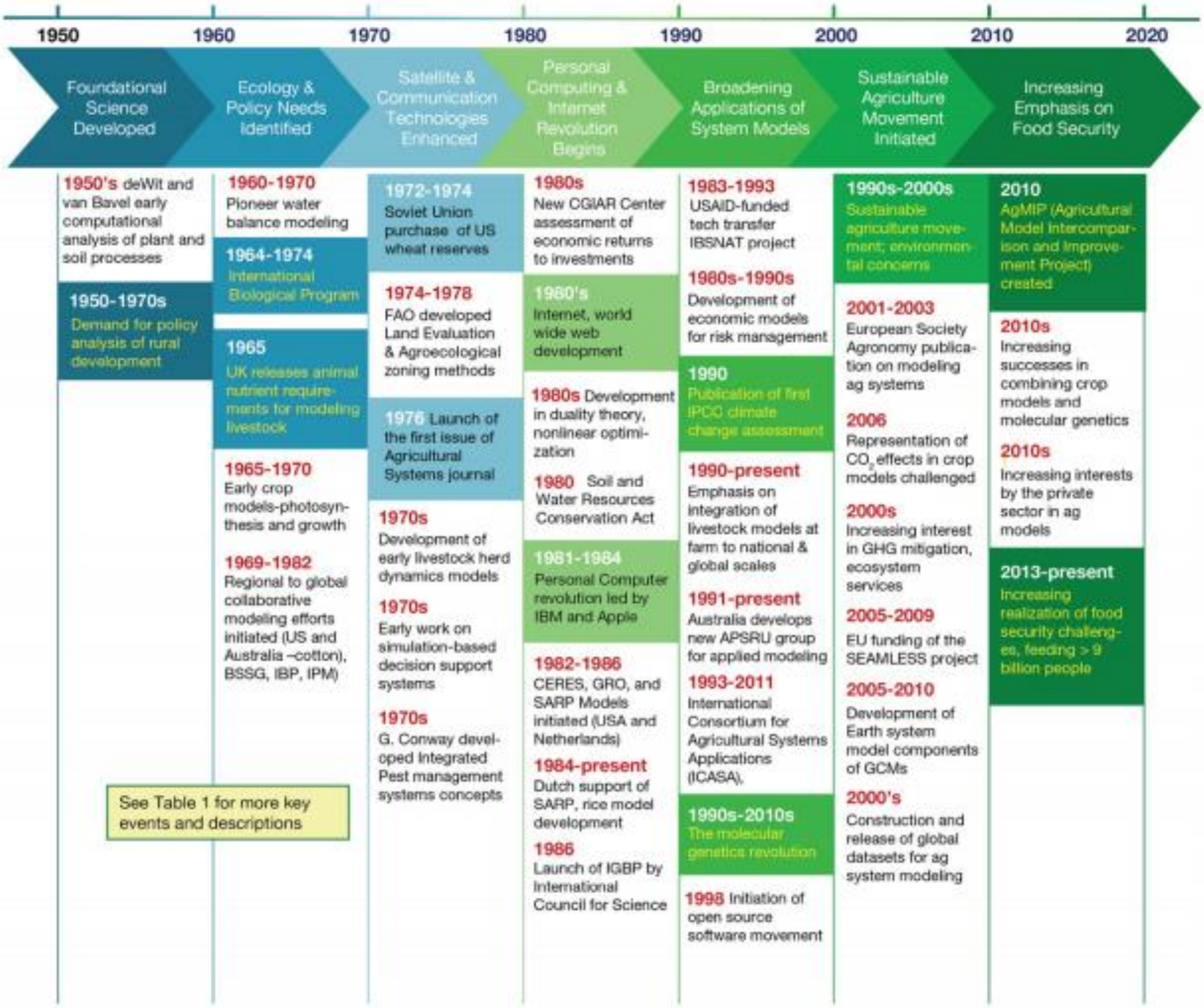


Figure 21. ICT4Ag change in focus timeline (Adopted from Belcher et al. (2004))

The local youths can be included in ICT4Ag success stories by means of simple mobile technology (Pye-Smith, 2014) as a means of providing resources and information available to them, with ICTs that can lead to behaviour changes and benefits to rural farmers. Bell (2015) says that one can change the behaviours towards ICT4Ag by raising awareness, getting the community interested and making sure that it is easy enough for them to want to try it, also stating that it should have realistic up-front costs, the project sponsors should be willing to be flexible and focus on getting small tasks completed in terms of the overall programme, while using competent people. Long-term sustainable successes should be approached for wide adoption from the inception of the project up to the end by making it applicable to the larger population of users (Gichamba, Wagacha, & Ochieng, 2017).

4.3.4. Concluding ICT success stories

ICT success stories are ample, but by staying up-to-date with the literature as was done in sections 4.3.1 to 4.3.3, one can see that not only are people learning from past mistakes, but are taking into account more factors that proved to be successful in the past. ICT successes in the broader context, the ICT4D context and the ICT4Ag contexts do share some success criteria, but what the researcher concludes is that one cannot overlook the importance of the local vs. the global contexts. This thesis will continue to delve into ICT4Ag sustainability, with the next section focusing on the role of sustainable livelihoods.

4.4. Sustainable livelihoods

In the sustainable livelihood approach, the main emphasis is on people, helping them to reach their potential, but also looking at other factors such as legislation and policies, different institutions and new trends (Carney & Britain, 2003). The sustainable livelihood (SL) considers, among others, the sustainability in a livelihood. A livelihood is defined simply as gaining a living (Chambers & Conway, 1992).

For the farmers, SL can assist in increasing their income and generate a regular stream of income (Tacastacas, 2011). The sustainable livelihood framework was first illustrated by the Institute for Development Studies (1996), but was adapted and later published by Adato and Meinzen-Dick (2002), who added the agricultural technologies component, as illustrated in Figure 22 below. The livelihood assets are H: human capital; N: natural capital; F: financial capital; P: physical capital; and S: social capital.

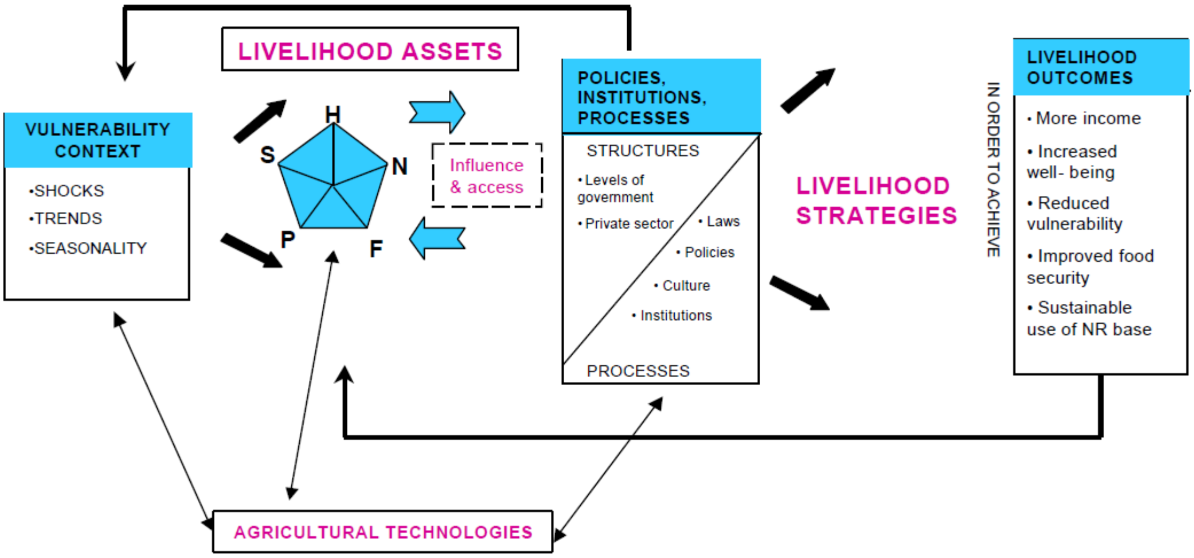


Figure 22. The sustainable livelihoods conceptual framework with agricultural technologies (Adopted from Adato & Meinzen-Dick (2002))

The livelihood component is of importance in this study, as it is posited that, for a development project ultimately to reach sustainability, a true impact must be seen by the people or communities whom the development project was intended for. If one is to dissect the sustainable livelihoods framework, the vulnerability context, policies, institutions and processes, and the livelihood outcomes all link to some extent to the framework proposed in the study. The method of gathering the data in this case differs. The primary traceability system users are used as key informants to enable the researcher to gather data on the beneficiaries. The impact that the traceability system has on the communal farmer – the beneficiary – is not measured on an individual farmer-level, making the different forms of capital as an input variable inapplicable. The livelihood outcomes, referred to in this context rather as livelihood impacts, are also derived using other components of frameworks that will be discussed in more detail in chapter 6. The SL Framework is certainly a framework that cannot be dismissed if one has the resources to measure livelihoods on an individual scale.

4.5. Conclusion

Chapter 4 deliberated the role of sustainability in the greater ICT context, but mainly focusing on the ICT4D goals, discussing how the role of sustainability and sustainable development grew over many decades. The chapter continues by discussing ICT successes, first broadly, then more focused on ICT4D and then focusing specifically on ICT4Ag successes. The sustainable livelihoods framework is also mentioned, noting that it remains one of the key frameworks in ensuring sustainability, both in ICT4D and ICT4Ag projects. This chapter concludes the literature review, with chapter 5 discussing the research methodology and design of the thesis.

5. Chapter 5: The research methodology and design

If we knew what it was we were doing, it would not be called research, would it? Albert Einstein

5.1. Introduction

In the previous chapter an overall discussion of the literature review was concluded with a discussion on sustainability and ICT success stories. In order to describe the impact on communal farmer accurately, data has to be gathered and analysed, using the appropriate research methods. Research is about answering the unanswered questions, creating something that does not exist (Goddard & Melville, 2004). There are many purposes of research, according to Oates (2005), including to add to the body of knowledge, to solve a problem, to find out what happens, to predict, to plan and control and to contribute to other people's well-being. The research method has to pave the way for the essence of the research to become evident. What are the building blocks of a methodology? According to Wynekoop and Russo (1997), a methodology is a "systematic approach … consisting of a set of guidelines, activities, techniques and tools, based on a particular philosophy". Goddard & Melville (2004) explain that a methodology enables one to solve the research problem systematically. A methodology further gives the reader the roadmap, explaining the significance of the research. One of the most difficult tasks of a thesis is to make sense of the data. The meaning of the data must be conveyed to the reader in a clear and concise manner, using appropriate methodology.

The rest of the chapter provides a detailed explanation of the building blocks of the research methodology. Figure 23 is a summary of the research design. It is an extension of the methodology, and it indicates how the research has been structured and shows the planning of the thesis as a whole.

Theoretical foundations

Food safety, traceability and legislation
- Food safety and pressures on agriculture
- Definition of traceability
- Certification and legislation

Livestock traceability systems
- In-depth discussions of requirements of a traceability system
- Entry to export markets

Sustainable ICT project discussion
- Sustainability
- Sustainable development
- Critical success factors
- Sustainable Livelihoods

Main research question

What framework can be designed to evaluate the introduction of ICT-linked livestock traceability on communal livestock farmers in Swaziland and Namibia?

Data collection methods

- In-depth case study research
- Interviews, both formal and informal, and broad discussions with key role-players
- Questionnaires completed by veterinary assistants in Swaziland and animal technicians in Namibia, the first point of contact with communal farmers

Data analysis

Multiple sources of evidence and a systematic combining of the evidence

Face-to-face interviews

Questionnaires

Visits to Swaziland and Namibia

Official documents:

- Audit reports on livestock systems
- Annual meat production reports
- UN, UNESCO and WHO reports
- The Namibian Meat Board
- Swaziland Meat Industries

Media articles

Websites

Formulation of a conceptual framework

Identification of themes

Additional questions generated

Refer back to literature

Additional data collection

Figure 23. The research design (Adopted and adapted from Bhat (2012))

5.2. A pragmatic approach

An epistemology is a theory of knowledge (Hansen, 2010); the context of this study is very much entrenched in the view of the researcher. The findings relate to the researcher's experiences when gathering the data, and the data is described. A framework is proposed as a way of explaining what was discovered, and to offer a way of explaining other related ICT4D projects. It is therefore not in essence a measure of truth, but rather a description of events witnessed and experienced. The emphasis is on practice, where low-level generalisations are formulated to describe certain relationships (Cartwright, 1983). An ontological approach was followed in determining what it is that should be studied, and what exists (Turk, 2006). In this case, the ontology is formulated by illustrating the relationship between sustainability, impact assessment and the D4D framework to formulate the proposed framework and to substantiate it with the evidence collected.

5.3. The research philosophy

To make a clear distinction between positivism and interpretivism, one has to distinguish between the questions asked, and the conclusions drawn from the questions (Lin, 1998). An interpretive philosophy has been used throughout the study. An interpretive study is more "subjective" (Burrell & Morgan, 1979), and is not aimed at generating facts or proving hypotheses, but at studying people in their normal, social settings (Oates, 2005) with multiple realities. The researcher is also seen as interacting often with the people and environment (Angen, 2000). The interpretive philosophy of this study relied on case studies and interview data, but the distributed questionnaires had a dual purpose: to gather data on how the key beneficiaries of the traceability systems leading to change in communal societies, and also to distinguish between how the primary users, the animal technicians and veterinary assistants' answers differ in terms of their age, number of years of experience and regions of operation – a quantitative analysis, but still falling under the interpretive philosophy. The quantitative analysis serves only to describe the experiences of the different primary users and their frame of reference.

Critical realism closely examines structures in order to constrain or dominate our activities (Houston, 2001). It requires "an explicit overall theory of truth", as stated by Bhaskar (2010), and needs to be fair to all parties and authentic, while empowering people to overcome sources of power and alienation (Oates, 2005). Critical realism is not applicable to the study, as it does not leave the audience with a single overall truth, but rather a subjective account of what has been seen, heard and experienced by the researcher.

5.4. The research approach

A deductive research approach can be explained by throwing two dice and calculating the probabilities of certain numbers being thrown at a specific time, thereby determining the frequencies (Johnson, 1932), whereas the inductive research approach looks at the consequences of gambling with dice and how it can affect society. The inductive approach further looks at the application of technologies and what we perceive to be true in terms of change or other social consequences (Barbieri et al., 2010). Deductive research explains rules, and inductive research generalises rules (Gollin, 1998). In order to derive a model or framework to explain the impact of traceability systems on communal farmers, as is the overall aim of the study, one has to generalise, and in future, apply and test the model or framework. An inductive research approach is used as a means of creating a more generic framework, rather than determining frequencies.

5.5. Conceptualising a new framework

When one builds a new conceptual framework, one has to ensure that the entire framework is at the heart of solving the problem of interest (Salerno, Hinman, & Boulware, 2004). The impact on the communal farmer remains a central theme, and the framework in part addresses the impact with implementing the "communications-for-development" impact assessment framework, as proposed by Heeks and Molla (2009). Other impact assessment frameworks are discussed in the following chapter, for example the livelihoods framework. The livelihoods framework looks at different forms of capital, such as social, human and financial capital, but because individual rural farmers, the beneficiaries of the system, could not be interviewed or a survey conducted to obtain individuals' data, it was not deemed as the best fit in this study, but to rather focus on another framework that does not need individual feedback to derive deductions regarding the different forms of capital. Another impact assessment framework that was considered, but later dismissed, was the cultural-institutional framework. The micro-level drill-down of the cultural aspects are important, but one has to overcome the one weakness of this framework, as stated by Heeks and Molla (2009):

> *"There are specific models and methods for investigating static, national-level, cause-oriented perspectives on culture, but little specific guidance to date in ICT4D research on the recommended dynamic, micro-level, impact-oriented perspective on institutions."*

The two countries and their cultures differ, with a dynamic relationship and one cannot generalise the cultural aspects in a framework, especially a framework with multiple layers. Sustainability is another central part of the framework. Giovannucci & Ponte (2005) explain in an article relating to the sustainability of the coffee industry:

"The concept of sustainability in agriculture usually refers to aspects variously referred to as economic viability for farmers, environmental conservation and social responsibility. Both existing and emerging standards seek to meet some or all of these needs. These are process standards that rather than just measuring the characteristics of a final product – typically assess the interconnected processes of production, agro-processing, and trade. In so doing, they attempt to cover the whole value chain from farmer to consumer."

The three pillars of sustainability: economic, environmental and social responsibility (Kahn, 1995) are addressed in the design of the sustainability component of the framework.

The four policy objectives of the agriculture-for-development agenda as created by Burch et al. (2007) form the third part of the conceptual framework, also discussed further in Chapter 6, where the macroeconomic fundamentals, governance and the socio-political context of both countries are explained as the first part of the framework. The five impacts, namely improved food sustainability, improved food safety, increased income, improved self-esteem and earning a market-related income are based on the four policy objectives and aligned to the hierarchy of Maslow's basic motivations (Maslow, 1943).

The three forms of input in the conceptual model, namely the C4D model as an impact assessment framework, the necessity of sustainable initiatives as three pillars and the four policy objectives of the agriculture-for-development framework as it links to Maslow's hierarchy of needs are combined into a single, new framework, placing the communal farmer in the centre, and taking into account various aspects relating to agriculture in general.

In the conceptual framework design, grounded theory is not used, merely because the researcher does not intend to use grounded theory as a means of explaining a phenomenon, but rather to build a framework first, then gather the data and apply it to the new framework. Much of the data gathering has close ties with grounded theory, for example the sources being used, including interviews, field observations and various other documents (Strauss & Corbin, 1994), and links to the two principles of grounded theory (Corbin & Strauss, 1990):

1. The effect of change, and to build change through the processes and methods used.
2. To investigate how actors respond to the new changes in their environments.

This research differs, however, in the sense that numerous incidents are not compared, and not used to identify patterns or categories (Glaser, 2002). The research is instead examined through a theoretical framework to derive conclusions and summaries from (Karanasios, 2014) and not by the ongoing interplay between collecting and analysing the data (Da Silva & Fernandez, 2013; Urquhart, Lehmann, & Myers, 2010).

5.6. The research strategy: In-depth case studies

Yin (1994) explains that case study research is "an empirical enquiry that investigates a contemporary phenomenon within its real-life context", and "it relies on multiple sources of evidence" as stated by Benbasat (1984), Bonoma (1985), Yin (1994), and Kaplan and Maxwell (2005). Yin (2013) believes that the multiple sources of evidence should come from relevant documents and archived documents, interviews, observations and physical artefacts.

A strong case study has been built around communal farmers in both Swaziland and Namibia, with four visits to Swaziland, and two visits to Namibia, starting in December 2012 and concluding in October 2015. During that time observations took place, interviews were conducted, documents were obtained and RFID chip ear-tags and pamphlets were gathered. The observations provided the researcher with the "inner experiences" of the communal farmers, their normal every-day activities, and enabled her to determine how "meanings are formed", to "discover, rather than test variables" Corbin and Strauss (2008). The observations were exploratory and descriptive.

Benbasat, Goldstein, and Mead (1987) list the following eleven different characteristics of case studies:

1. *The phenomenon examined is done so in a natural setting.* If the researcher takes people away from the known, their behaviour and attitudes might change. The purpose of any observation is to experience or witness an everyday activity.
2. *Data is collected from multiple sources.* Case studies develop richness when the data is captured and verified through more than one piece of evidence. It also makes the research credible, and allows the reader to derive conclusions from the research based on various sources.
3. *One or only a few entities, people, or groups of people are examined.* One has to be able to complete a research project or thesis in a given time span. Although only a small sample of communal farmers was reached, the results were verified by other forms of evidence, assisting one in making similar assumptions.
4. *The entities, people or groups of people are studied intensively.* The people have to be observed, asked to participate in interviews and informal discussions, and in this case, asked to complete questionnaires.
5. *Case studies aim to explore and to build knowledge.* By taking all the evidence into consideration, a proposed framework was created with all the facets of the framework explained by the different sources of evidence gathered. The new framework contributes to the body of knowledge, and can be tested in other scenarios.
6. *The researcher does not aim to control the situation.* In an observation the researcher remains impartial, and in an interview, the researcher refrains from asking leading questions.

7. *No independent or dependent variables are set in advance.* The researcher explores and describes, and does not set any expectations.
8. *The results depend heavily on the researcher.* In an interpretive study, and with case studies, the researcher is a subjective instrument.
9. *Changes in locations and data collection methods could take place for the researcher to develop new hypotheses.* Once a framework has been conceptualised, it leaves room for the researcher to add to or enhance the framework, or even build a new framework, based on new knowledge.
10. *The questions typically asked are "Why?" and "How?"* The researcher is interested in the impact of traceability on communal farmers, and can determine the impact only by asking the right questions.
11. *The researcher captures contemporary events.* The traceability systems in Swaziland and in Namibia's protected and restricted zones, are discussed as they are new areas, and lead to new areas of interest.

The case study research strategy was appropriate in this study, although one might argue that it could also form part of an ethnographic study.

Ethnography, however, is not suitable, as it implies that the researcher spends a significant number of hours in the field, acting as part of the community, and in their everyday lives, not just observing the people or groups of people (Oates, 2005). Action research, on the other hand, is also not preferred, as it seeks to find solutions to issues that are of pressing concern for the people or group of people involved (Reason & Bradbury, 2001). In this study the impact of the traceability system on the communal farmer remains key, with no solution offered. A framework has been built, but serves as a means of formalising the impact on the farmers, and can be applied and tested on other case studies.

The data for the case studies was gathered over a period of three years, with four visits to Swaziland and two visits to Namibia. During that time the necessary evidence was collected.

5.7. Data collection methods

The data collection process involves gathering all the necessary data to comply with case study research, such as interviews, observations, official documents, media articles and websites. Questionnaires were used as an additional method, and served to describe attitudes of people, and the practical use of the traceability systems.

5.7.1. Personal interviews

“Interviews provide a ‘deeper’ understanding of social phenomena than would be obtained from purely quantitative methods, such as questionnaires” (Gill, Stewart, Treasure, & Chadwick, 2008) and consist of structured, semi-structured and unstructured interviews. There are steps to be followed when conducting interviews, according to Boyce and Neale (2006). Firstly, the interviews are planned. The participants need to be identified, the questions set and all ethical research standards followed. Secondly, the instruments used are specified. The beginning and ending of the interview is planned, and the method of capturing the answers specified. Thirdly, the dates and times of interviews are arranged, and consent is received from interviewees. The interviews are then conducted. Fourthly, the interviews are transcribed. Fifthly, the results from the interviews are formally written into documents or reports, feedback obtained from the interviewees to ensure validity is revised and then finally published.

The interviewees for the study were selected from various backgrounds. The two main developers of SLITS and NamLITS were interviewed to gain knowledge specific to the traceability systems. The project managers and key stakeholders were interviewed together with state veterinarians, as well as the users of the traceability systems, the veterinary assistants in Swaziland and the animal technicians in Namibia.

Communal farmers were not interviewed, as they were in remote areas, often inaccessible, and the languages they speak were unfamiliar to the researcher.

All interviews were conducted by the researcher, and served as qualitative data. The level of complexity of the interviews differed significantly, with the experts in their fields providing detailed information, whereas the veterinary assistants and animal technicians simply explained their working conditions and experiences in the field. English is the second or third language of the veterinary assistants and animal technicians who come from rural backgrounds.

Participants in the interviews	Relevance to the study
Participant 1	One of the key decision-makers in the implementation of SLITS
Participant 2	One of the key decision-makers in the implementation of SLITS
Participant 3	A commercial farmer farming for the Swazi government, and also an owner of a number of cattle grazing on communal land
Participant 4	A Swazi veterinary assistant
Participant 5	A Swazi veterinary assistant
Participant 6	A Swazi veterinary assistant
Participant 7	A representative of the Meat Industries of Swaziland
Participant 8	The project manager of SLITS

Participant 9	A developer of NamLITS and SLITS
Participant 10	A developer of SLITS
Participant 11	A developer of NamLITS and commercial farmer in Namibia
Participant 12	A representative of the Namibian Meat Board
Participant 13	A representative of the Directorate of Veterinary Services in Namibia

Table 8. A summary of the participants who were interviewed as part of the data collection process

5.7.2. Observations

Observations were done in both Swaziland and Namibia. The observations were done independently from one another, and the researcher did not participate. The purpose of the visits was to observe rural communal farmers and to witness cattle branding and dehorning. The visits were not manipulative in nature, but rather “observation selective” (Schneirla, 1950), by not destroying the social system of the observation (Altmann, 1974). Johnson and Onwuegbuzie (2004) are of the opinion that observations can either be rich in content or cold, hard facts. They further state that both quantitative and qualitative methods can be used in observations to address the research questions. The veterinary assistants and the animal technicians were present at dipping events, and also in the communal day-to-day lives, and because they played a central role, they were the participants who completed the questionnaires. They were able to communicate in English. Both quantitative and qualitative methods, also referred to as a “mixed method” approach (Venkatesh, Brown, & Sullivan, 2016) were used in the analysis of the questionnaires, with the mixed method approach showing that “there is more insight to be gained from the combination of both qualitative and quantitative research than either form by itself. Their combined use provided an expanded understanding of research problems” (Creswell, 2013). The validity of using questionnaires is discussed in the next section.

5.7.3. Questionnaires

Questionnaires ask pre-defined questions in a very specific order (Oates, 2005), and do not provide the researcher with the opportunity to go back and ask something else, or ask for further explanations. The planning of questionnaires is very important, and they are carefully designed as a reliable source of studying the impact of the traceability systems on communal farmers. Part of the planning of the questionnaire involves taking into account the concluding conceptual framework that serves as a means to fill-in any missing gaps not addressed through the case studies. Dillman (1978) lists a few pitfalls that one can avoid when designing a questionnaire:

1. Ensure that the questions are clear and unambiguous.
2. Do not word questions in a negative manner.
3. Do not to have biases in the questions.

4. To ensure that the participant answers only one question at a time, the questions should not be "double-barrelled".
5. Ensure that questions are not too general or too specific.
6. Do not to presume anything when asking questions.
7. Ensure that all participants have the necessary background to be able to answer the questions.

Specialised statisticians assisted in designing the questionnaires, ensuring that all the above mentioned pitfalls were avoided.

The sequencing of the questions is important, as stated by Bhattacherjee (2012), suggesting that the questionnaire starts with easy questions that the participant can answer without feeling threatened. The questionnaires used in this study had four different sections, each with a specific function.

Sections of the questionnaires

Section A: Biographical information of the veterinary assistants in Swaziland and the animal technicians in Namibia.

In Section A the gender, age and working experiences of the participants were gathered. The data was then used to distinguish between the gender, age and experience, and used to compare the experiences given by the group of participants in the different categories.

Section B: Information on the dip tank / crush pen

Section B provides insight into the veterinary assistants and animal technicians' everyday surroundings and the farmers they regularly work with at dipping events or at crush pens. The veterinary assistants and animal technicians were asked to provide the names of the towns nearest to them, indicate how many farmers were catered for in the areas, the number of male and female farmers, the main type of farming, whether the farmers lived on communal or commercial farms and finally, how often the veterinary assistants and animal technicians saw the cattle in their regions.

Section C: Information relating to the traceability system and the communal farmer

In Section C the efficiency of the traceability systems were measured with the veterinary assistants and animal technicians, the regular users of the traceability systems. Questions included the number of cattle not ear-tagged at the time, the general health of animals and the effectiveness of the systems when managing disease outbreaks, and the prices received for cattle, and whether they were market-related after traceability was introduced. Cattle vaccination documentation and its effectiveness was also determined.

Section D: The interaction of the individual with the traceability system

The veterinary assistants and animal technicians were asked to state whether their overall attitudes were positive or negative towards the traceability systems, and to provide reasons, as well as provide any other relevant feedback.

The questionnaires were completed by a group of veterinary assistants in Swaziland; a combination of veterinary assistants from four different veterinary offices in rural areas; a group of animal technicians in Namibia, all from the NCAs. The group of animal technicians used were selected on the basis of a general meeting held in Omuthiya, where animal technicians from a number of regions in the NCAs met. The questionnaires were distributed as hard copies, and the data manually inserted into an Excel spreadsheet, where the answers to the questions were coded.

The answers were analysed using both quantitative and qualitative methods. To distinguish between quantitative and qualitative data analysis is two-fold: on the *data collection process* and the *way that the data is analysed (2013 Index of Economic Freedom, 2013b)*. Quantitative analysis uses closed-ended questions, and qualitative analysis open-ended questions (Creswell, 2013). As mentioned, the overall research philosophy in this study was interpretive. “Interpretive researchers attempt to understand the way others construe, conceptualise and understand events, concepts and categories” (Kaplan & Duchon, 1988), and one would expect quantitative research to fall under the positivist philosophy. In this case, however, the researcher did not answer a specific question or prove a hypothesis. Venkatesh, Brown, & Bala (2013) feel that as researchers, we often find ourselves in situations in which “existing theories and findings do not sufficiently explain or offer insight into a phenomenon of interest”. The use of statistical analysis in an interpretive study is merely an additional way of “telling the story” (Babones, 2006). The quantitative analysis in terms of the closed questions formed a large part of the questionnaire, and served to simplify the completion of the questionnaire. Participants could select from “Yes”, “No” or “Uncertain”. Closed-ended questions were followed-up in Sections B, C and D with open-ended questions, where the participants were asked to provide reasons for their answers. The way that the data was then analysed only described the different age groups, gender and work experience of respondents in Section A of the questionnaire in terms of cross tabulations and Chi-square tests with Sections B and C. The data was displayed in tables and graphs. Section D consisted of only open-ended questions. The main purpose of the questionnaires, apart from providing data about the veterinary assistants and animal technicians, was to enable the researcher to explain the proposed framework partially.

5.7.5. Official documents, media articles and websites

Traceability in Swaziland and the NCAs of Namibia is a contemporary theme. One can find scholarly literature about traceability and its application to other countries (Leitgeb, Funes-Monzote, Kummer, & Vogl, 2011; Loureiro & Umberger, 2007; Marumo & Monkhei, 2009; Roosen et al., 2003), and even literature referring to Namibia (Cabrera, Cochran, Dangelmayr, & D'Aguilar, 2010; Paskin, Pauw, Mack, & Maki-Hokkonen, 2004), excluding any mention of the NCAs. In order to build the case studies, news articles, policy documents, websites containing new facts and figures, and other official documents were used as additional reference material.

5.8. Ethical considerations

All participants in this study voluntarily contributed, taking into account ethical considerations that included informed consent, protection of privacy and safety in participation (Polonsky & Waller, 2014). Letters of consent were attached to all completed questionnaires, written in simple language, and included the following sections to ensure that all participants participated with informed consent:

1. The identity and affiliation of the researcher
2. The identity of the researcher's supervisor
3. The purpose of the research

The questionnaires were completed anonymously, with the participant merely signing the letter of consent. All interviews were voice-recorded and consent was given by all interviewees. The interviews were transcribed and used as reference material. The research instruments had been approved by the Ethics Committee of the Faculty of Economic and Management Sciences prior to the data collection process.

5.9. Conclusion

In this chapter the methodology used for the research is explained and reasons are provided for the choice of research philosophy, approach, strategy and data collection methods. The study is an interpretive study, inductive in nature, focusing mostly on in-depth case studies, supplemented by questionnaires, interviews, observations and current documents relevant to Swaziland and Namibia. Reasons are given why the three forms of input were used in the research. Reasons are also provided why certain methods, strategies and theories were not used, and in so doing the researcher hoped to answer some of the questions of the audience reading the thesis.

The next three chapters outline the intended conceptual framework, provide meaning to the data, interpret the data gathered in the case studies, interviews, observations and questionnaires, A data collection process remains meaningless until analysed, described and interpreted. Finally, the new conceptual framework is applied to the findings and conclusions.

6. Chapter 6: A discussion of frameworks proposed in creating an impact-for-sustainable-agriculture framework

You don't have to be a genius or even a college graduate to be successful. You just need a framework and a dream. Michael Dell

6.1. Introduction

A conceptual framework serves many purposes, as it paints a picture of who and what will be included in the study, the relationship between the concepts based on the case studies and experiences, and sorts the different constructs of the study into logical compartments, also referred to as intellectual "bins" (Miles & Huberman, 1994). In this thesis, a framework is developed as part of the findings, but before the data collection, ensuring that the relevant data is collected as a means of explaining and validating the framework, making the approach somewhat unconventional. The purpose of this chapter is to describe the different building blocks of the proposed framework in detail, as well as point out why they have been chosen, and are relevant in this case. The building blocks will then be combined and proposed as a new framework that can be applied in other agricultural development contexts. The first building block is the three pillars of sustainability.

6.2. The three pillars of sustainability as a building block for the new conceptual framework

Three main dimensions, also referred to as pillars, arose from sustainable development, and are still widely used today: sustainable development needs to focus on social, environmental and economic aspects. The three pillars of sustainability are first referenced as part of Agenda 21 and Kahn (1995) describes sustainable development as resting on three conceptual pillars: "social sustainability", "environmental sustainability" and "economic sustainability". Stephen (1996) briefly explains the role of the ecology or environment, and to live within its capacity, the role of the economy provides us with a means to maintain a standard of living and the role of society ensures that we set values people would want to live by. In figure 24, the pillars are shown with sustainable development as a triangle on top, symbolising the importance of the pillars to support the sustainable development initiative, forming the underlying building blocks of sustainable development.

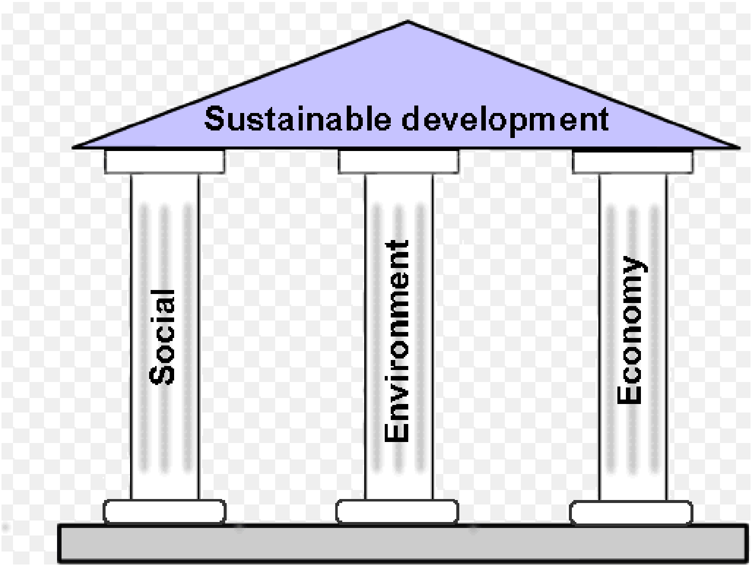


Figure 24. The three pillars of sustainability (Adopted from Lack (2012))

Humans and society

People are at the heart of any developmental project, and one needs to look not only at the individual, but also the broader social context. Specific values, ethics, cultural beliefs and traditions are some of the concepts that cannot be ignored when a project, aimed at being sustainable, is undertaken.

The community needs to buy-in, and see the worth of a project, to adopt it. Without the consultation of the community throughout the project, people will feel that the project was forced on them, and although useful and beneficial, the project will fail. Successful sustainable development projects involve communities.

The environment

The project environment encompasses more than just the immediate surroundings and physical environment. The political climate and the ability to adapt to change remain key in creating the right environment. Other environmental factors include the basic standard of living, human rights – including the rights of women and children – and level of education.

The economy

Money flows into any developmental project, and becomes sustainable when the country or countries involved are also willing to invest. A stable economic environment makes the project easier. The combination of the social, environmental and economic pillars leads to sustainability, as illustrated in Figure 25 below. All three factors are of equal importance, and need to be in relation to one another to reap the desired results.

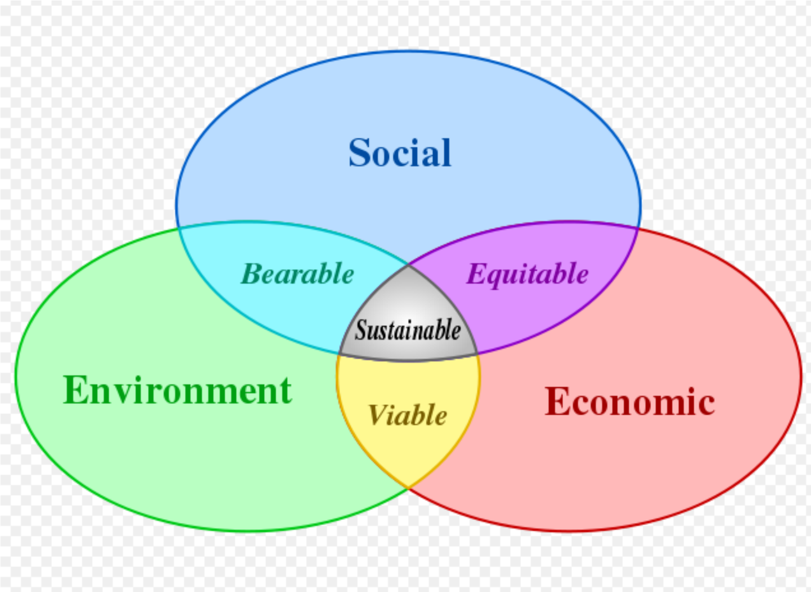


Figure 25. Sustainable Development (Adopted from Marien (2012))

In studies where different forms of capital are at the heart of the research, individuals are studied as explained by Putnam (2001), Ellison, Steinfield, and Lampe (2007), Colombo, Franzoni, and Rossi-Lamastra (2015) and Hewitt-Dundas and Burns (2016), to name a few. A different method of data gathering is used, because of the meaning of the different forms of capital. In the cases presented in this thesis, the benefactors could not be reached, reasons being that communal farmers do not speak English in most cases, and the farmers live in remote areas not easily accessible. The first point of access to the farmers are the veterinary assistants in Swaziland and the animal technicians in Namibia, key informants and primary systems users and play a part in the communal farmer's life, and summarised data was collected through them to apply to the case studies as a reliable alternative source of data. The pillars of sustainability form a solid foundation, together with other framework and are seen as providing an alternative to other ICT4D frameworks, for example the SL approach, because of the key role that the three layers play in the new framework, making sustainability a linear process, with increased sustainability more likely as one moves from the one layer to the next. In designing this new framework, the more simplistic pillars of sustainability are used instead as a building block, rather than focusing on a widely-used framework that does not allow for the limitations in the data gathering process of this particular study.

The nineteen ICT4D success factors listed in chapter 4 were reduced to thirteen factors under the specific headings of the three pillars of sustainability and applied to the success of the traceability systems of both Swaziland and Namibia, and were used as a set of pre-conditions applied to the proposed conceptual framework. The pre-conditions were divided into social, environmental and economic factors:

Social

1. Using ICT to enhance existing rural development activities
2. Cultivating an influential project champion
3. Incorporating socially excluded groups
4. Focusing on local needs
5. Building local partnerships

Economic

1. Simple and clear project objectives
2. Appropriate training
3. Choosing the appropriate technology
4. Building on existing facilities
5. Ongoing monitoring and evaluation of the project

Environmental

1. An understanding of the local political context
2. Focusing on self-sustainability
3. Encouraging local ownership

6.2.1. Ethics and sustainable development

People want to believe that their food is safe, as is the intention of traceability systems; however, on 25 February 2013 the world took notice when the University of Stellenbosch in South Africa published an article on donkey, water buffalo and goat found in their meat products (Van Vark et al., 2013).The same week Kenya was also involved in a scandal with donkey meat being passed off as beef, leading to the world asking if traceability is possible. Traces of horse meat were found in Ireland and England in January 2013, especially in the cheaper beef products like burger patties (O'Mahony, 2013), causing the world to mistrust traceability yet again. The central theme is that consumers were misled, thinking that they were buying and eating beef products, when they were actually also eating horse meat and water buffalo.

Two of the key thrusts of sustainable food for life are building consumer trust in the food chain and deriving food from sustainable and ethical production (Ohlsson, 2010). Without explaining the complex nature of ethics and ethical behaviour, without an ethical and honest approach to sustainability, as is deemed generally acceptable, the hard work will be lost. It is necessary for traceability systems to remain sustainable for the world to trust meat products, and the meat needs to be produced in an ethical manner to ensure sustainability.

6.2.2. The three pillars of sustainability as applied to similar cases

In order to justify the use of the pillars of sustainability as a framework to feed into the framework proposed, three different agricultural development cases are briefly discussed to warrant the validity of using the framework.

Case 1: Globalisation and Sustainable Development: Case Study on International Transport and Sustainable Development by Köhler (2014).

Least developed countries are very often excluded from sustainable development projects, but there is a strong drive to empower these countries, especially in the transport sector, as is seen in countries such as Brazil, India and China. Globalisation and better integration, in terms of political, economic and cultural aspects, is easier to achieve with technology. Köhler (2014) examines the role of sustainable development in terms of the three pillars of sustainable development as a means to explain the holistic growth of long-haul international transport. Different aspects of the transport industry and the level of sustainability achieved in terms of social, environmental and economic factors contributing to International transport are explained. These factors are discussed in terms of the international role, as well as of country-specific, industry-specific and individual-specific impacts, and the function each portrays in intercontinental transport. In this study, Köhler (2014) states that, in order to measure the impact of sustainable development fully, the pillars of sustainability play a central role. Köhler (2014) concludes by stating that "an important overall policy implication is that the current system of international organisations that deal with trade and with environmental sustainability need to be more closely aligned with the requirements for social and technological innovation for sustainability".

Case 2: Development of an Empirical Model of Sustainable Rice Farming: A Case Study from Three Rice-Growing Ecosystems in Bangladesh by Roy, Chan, and Rainis (2013).

Agriculture is facing immense challenges because of urbanisation, environmental hazards and growing food prices. This study focuses on the elements of social, environmental and ecological indicators, where the indicators are further divided into the applicable sub-sections. In the social pillar or indicator, the study highlights the importance of social and human capital, equity and good governance; in the economic pillar, land productivity, net farm return and on-farm employment all play important parts.

Finally, the environmental pillar clearly points out resource conservation practices and technologies, crop diversification, and the integrated management of nutrients, pests and diseases. The study concludes by recommending what interventions are necessary in terms of the pillars, and they include economic interventions, institutional capacity building, policy reform and cultural and ethical values. It posits that one will create a more favourable agricultural environment when implementing the necessary strategies, which in turn, will ensure that the transitions applied will remain sustainable.

Case 3: Pillar Talk: Local Sustainability Initiatives and Policies in the United States – Finding Evidence of the “Three E’s”: Economic Development, Environmental Protection, and Social Equity by Opp and Saunders (2013).

Local sustainability initiatives are examined through the lenses of the economic, environmental and social pillars in order to explain why certain factors ensure more sustainable project outcomes than others. The definitions of sustainability and sustainable development are discussed, paving the way for identifying sustainable cities in America, and how their successes can be measured. Some of the success stories have factors that need to be taken into account, and include the population size, the diversity of the stakeholders and beneficiaries, as well as ethnicity and race. Religion and political views also determine the outcome. Applying the pillars to the different cases provides a comprehensive picture of the applicable factors. The study concludes by explaining the value of identifying criteria or indexes, and welcomes further studies to use the identified patterns and apply them to other projects.

Although sustainability is only briefly discussed in terms of its input into the overall framework of this study, it is one key factor that will ensure future development success stories. One can focus on creating a sustainable livestock traceability system, and this, to some extent, will certainly be sufficient to warrant a study; however, the researcher wishes to add another dimension to ensuring sustainable livestock traceability systems, and that, by aiming one step higher, to ensure that the impact of the sustainable projects is felt by the actual stakeholders and beneficiaries of the projects. The next section introduces an impact assessment framework, and how it is seen as another dimension on top of sustainability.

6.3. The communications-for-development model as an impact assessment framework

A study was conducted by Heeks and Molla (2009) to combine the most-used impact assessment frameworks of ICT4D development projects in a compendium. The compendium lists in total eleven frameworks, and the communications-for-development (C4D) framework, the livelihoods framework and the cultural-institutional framework are considered as a means of explaining the impact of the project on communal farmers. The livelihoods framework is not suitable, due to its different forms of capital studied at individual level, as well as its poor linkages to information (Hoque & Sorwar, 2015); the cultural-institutional framework focuses very strongly on the roles of the different institutions, and how it affects the behaviours of the ICT4D users as a means of cause-and-effect in a given context (Heeks & Molla, 2009). The main focus in the study is not on the users of the traceability systems, but rather on the farmers, involved in a secondary role only, and not primarily a system user. The only remaining framework left to consider, is the C4D framework, as illustrated below in Figure 26:

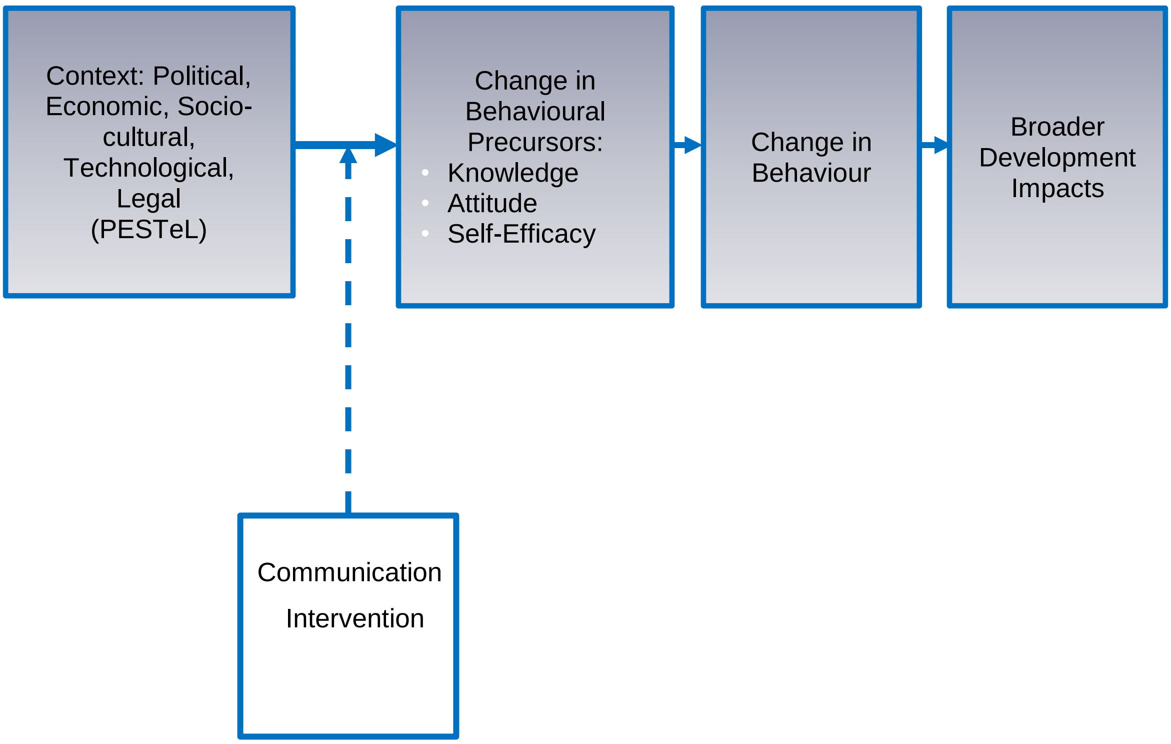


Figure 26. Communications-for-development framework (Adopted and adapted from Heeks and Molla (2009))

The C4D framework sketches a strong background picture by looking at the various political, economic, social, technological and legal (PESTeL) facets; all of these facets feed into the final framework, as both Swaziland and Namibia are greatly influenced by PESTeL, and are needed to provide context. They are used together with the pillars of sustainability to provide the context and first layer of the new, proposed framework.

The changes in behavioural precursors, leading to a change in behaviour, and leading to developmental impacts round off the two case studies and the subsequent framework very well. However, the communication intervention in this case is replaced by a technological change, causing a slight adaption of the framework in the traditional sense. The emphasis is not so much on how communication has led to change, but rather how the introduction of the traceability system – the technology – has led to changes.

It is not uncommon for researchers to adapt frameworks to their desired contexts, as is illustrated by Burton, Huq, Lim, Pilifosova, and Schipper (2002), Briner, Elkin, Huber, and Grêt-Regamey

(2012) and Shortall, Davidsdottir, and Axelsson (2015), to name a few. The role of an impact assessment framework is to answer six simple questions (Heeks & Molla, 2009):

1. Why the specific framework chosen?
2. Who is the intended audience?
3. What is being measured?
4. How will the different indicators be measured?
5. At what points of the study will the indicators be measured?
6. How will the indicators be used overall as a way of explaining the impact?

Figure 27 illustrates the relationships between the questions:

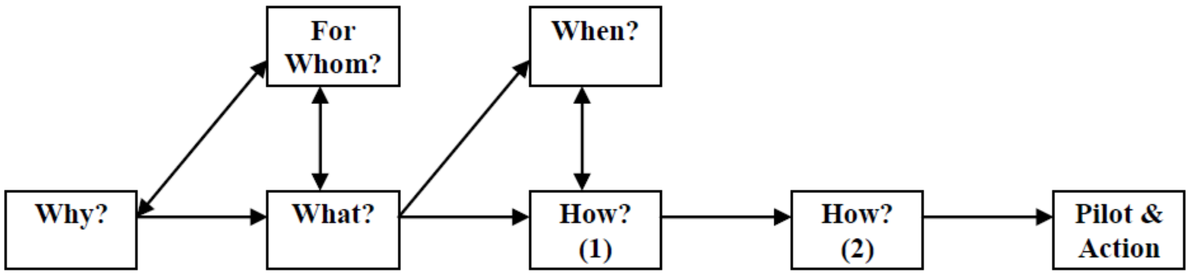


Figure 27. The planning of an ICT4D project impact assessment framework (Adopted from Heeks and Molla (2009))

To answer the above-mentioned six questions for the choice of the C4D as the framework of choice in this study, one has to start by asking the following:

1. Why was this framework chosen? Reasons include the following:
    - An impact assessment framework needs to form part of the proposed framework, as the overall measure of sustainability is seen only as the impact of the beneficiaries of the traceability systems, the communal farmers, are tangibly measured.
    - There is no other impact assessment framework suitable to explain the phenomenon.
    - The specific human behaviours are observed, and it is the changes that are of extreme importance.
2. Who is the intended audience? The audience is the future investors of ICT4D projects, specifically ICT for agriculture (ICT4Ag) investors, who want to ensure that their investments are ultimately going to lead to sustainable projects with broader developmental impacts.
3. What is being measured? The sustainability and illustrated impacts of ICT4D projects.
4. How will the different indicators be measured? The indicators will be measured in the form of a triangle of Maslow's hierarchy of needs, from the most basic impact to the impact best associated with the aspect of self-actualisation.

5. At what points of the study will the indicators be measured? At the stages of introducing the technology that leads to changes, and its subsequent impact.
6. How will the indicators be used overall as a way of explaining the impact? The overall indicators will form part of the new framework, called the impact-for-sustainable-agriculture framework.

6.3.1. The communications-for-development framework applied to similar cases

The communications-for-development (C4D) framework has been used widely in developmental studies, and the three cases below aim to illustrate its relevance to this study:

Case 1: The Role of Communication in Achieving the Millennium Development Goals: A Case Study of the National Development Planning Commission (NDPC) and the United Nations Development Programme (UNDP) In Ghana by Tetteh (2014).

Development, both national and global, is of great importance worldwide. In this study the author places the role of communication central in achieving development, and looks specifically at development aimed at achieving some, if not all eight of the Millennium Development Goals (MDGs) in an African context, focusing on Ghana as a case study. The study identifies certain issues, such as “a strategy in communications for development …, using communication to influence policies for development, participatory communication and development and identifying the news media as channels for communication in development” (Tetteh, 2014). Qualitative case studies, interviews and field observations have been used in reaching certain conclusions, including that the principles of participation need to apply when creating a country’s development agenda. The main challenges were bureaucracy, insufficient staffing, and political interference. Clear guidelines are needed when drawing up a plan assisting the development programmes. This study focuses on the role of communication throughout the process of development.

Case 2: ICT based e-government services for rural development: a study of union information and service center (UISC) in Bangladesh by Hoque and Sorwar (2015).

In this article the authors highlight the importance of access to information to enhance rural development. The settings for the study are three areas in Bangladesh, namely Murapara, Kalatia and Shimulia that are renowned for their poor regional administration. Data was collected in the form of discussions, semi-structured interviews and observations in order to capture the social context. Three frameworks, namely the livelihoods framework, the cultural-institutional framework and Sen’s framework were dismissed because of certain limitations. The study centres on the C4D framework, and sketches ten different contexts that directly influence changes in behavioural precursors, again leading to actual behavioural changes, and ultimately showing developmental impacts, as is seen in Table 8. Two contexts that show significant similarities between the study conducted in Bangladesh and in the contexts of Swaziland and Namibia are those of the lack of knowledge and the inequitable access to information. Union Information Service Centres (UISCs) are the external influence leading to changes. It is especially applicable to the study of the impact on communal farmers in Swaziland and Namibia, due to the similarities in approach and adoption of the C4D framework. The manner in which the study is approached in this example was applied in the analysis of the Swaziland and Namibian case studies, the only difference being that the intervention occurring was not communication, but the introduction of a new technology.

Context	Change in behavioural precursors	Change in behaviour	Broader developmental impact
1. Lack of knowledge	1. Acquisition of a new skill	1. More confidence about output	1. Developing an efficient and knowledgeable farmer.
2. Lack of awareness	2. Acquisition of a new skill	2. More confidence about the future	2. Developing an efficient and knowledgeable student.
3. Internet browsing	3. Acquisition of an online social skill	3. More confidence about the future	3. Human Resource Development
4. Lack of consciousness	4. Awareness of the alternative source	4. More confidence about their dream	4. Human Capital Formation
5. Computer training	5. Acquisition of a new skill	5. Higher self-belief	5. Raising per capita income and contributes to economic growth
6. Health service	6. Finding an alternative way of health services	6. Ensuring the human development by providing e-Health services	6. A gadget to upgrade Human Development Index (HDI)
7. Lack of information	7. Proper knowledge of law	7. Higher confidence and security	7. Empowerment of women
8. Disability and distance barrier	8. Proper knowledge of admission process	8. Application without physical contract	8. Empowerment of disabled persons
9. Inequitable access to information	9. Inequitable access to information	9. Less confident on UISC	9. Digital Gender Divide increase
10. Lack of quick services	10. Unavailability of services	10. On time services are not possible	10. Time consuming and expensive

Table 9. Implications of C4D model (Adopted and adapted from Hoque and Sorwar (2015))

Case 3: Adoption of information and communication technology for development: A case study of small and medium enterprises in Bangladesh by Hoque, Saif, AlBar, and Bao (2015).

Although the main author of this study is also the main author of Case 2 as discussed above, the two studies have different focuses, as well as data collection methods and analysis. The framework is still the C4D framework, and the contexts leading to behavioural precursors, behaviours and impacts are shown in a table similar to Case 2. The contexts or inputs are different, and focus on five areas, including lack of training, use of the Internet and website facilities. The ultimate goal is to lead to better developmental programmes to suit the needs of small and medium-sized businesses, and both qualitative and quantitative methods are used. The qualitative data was gathered through 50 interviews, and the quantitative data by testing five hypotheses. The conclusion reached is that businesses, especially smaller business, do not adopt technology as expected, with the key factors explained as being a lack of top management support, insufficient government support and financial support, and finally not enough awareness of the benefits of ICTs (Hoque et al., 2015).

6.4. The objectives of the agriculture-for-development framework

The World Development Report of 2008 focuses on agriculture, and Sub-Saharan Africa is lacking in agricultural development in various aspects such as failed agricultural opportunities, not creating economic growth and increased rural poverty (Sadoulet & De Janvry, 2009). Agriculture can lead to economic growth, and has done so in India, Chile and Vietnam in the recent past (Sadoulet & De Janvry, 2009), where 10% of public spending is routed to agricultural development, compared to between 3% to 4% in Sub-Saharan Africa. It is in this context that the World Development Report of 2008, specifically the emerging national agenda for agriculture, is of importance to provide an agriculture-for-development agenda in the form of a diamond (World Bank, 2007), stating the following four main objectives:

1. *To improve market access.*

If one is able to improve access to markets to small-scale, rural farmers, one opens up possibilities, new revenue and ultimately economic development.

2. *To enhance smallholder competitiveness.*

Rural farmers now compete on a bigger scale, becoming role-players who can then influence market prices.

3. *To improve livelihoods in subsistence agriculture.*

Once rural farmers compete on a larger scale, they earn an income, leading to better living conditions.

4. *To increase employment in agriculture.*

Better living conditions, with more money at rural farmers' disposal, lead to growing businesses, enabling more employment. This paves the way for less poverty at the centre of the diamond, as shown in Figure 28.

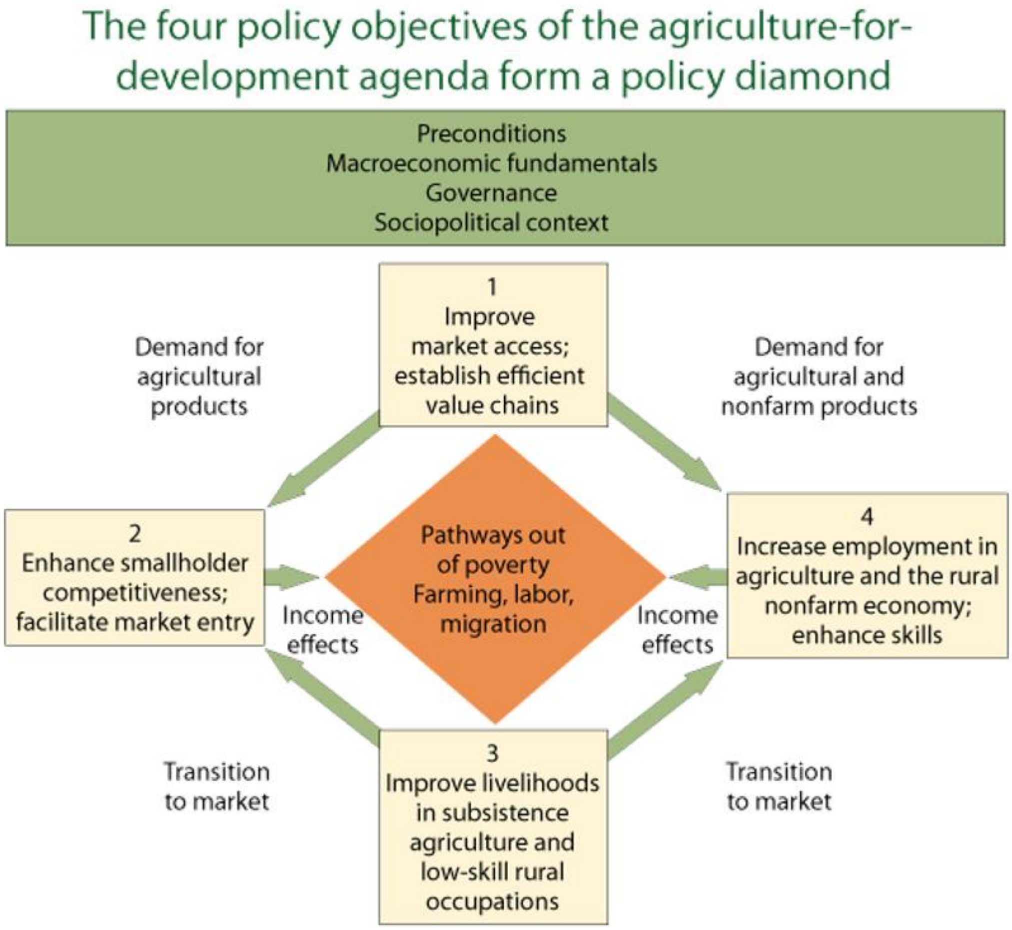


Figure 28. The four policy objectives of the agriculture-for-development agenda form a policy diamond (Adopted from the World Bank (2007))

The four policy objectives and their different effects, transitions and demands are applicable to a vast number of contexts, including urban development and countries in transition, as stated in Chapter 10 of the World Development Report (World Bank, 2007), but the simplified model, looking at the four main objectives, was applied to an agricultural context to narrow the focus in the context of this study. The four objectives are grouped in a specific order, from the most basic human need to the need for self-actualisation, and use Maslow's hierarchy of needs, discussed in the next section, to describe the specific order.

Another part of the framework, its preconditions, macroeconomic fundamentals, governance and socio-political context form part of the basis of the new proposed framework, the pre-conditions for sustainability. The pre-conditions look specifically at the social, environmental and economic aspects, as they are summarised in the pillars of sustainability.

6.4.1. The four objectives of the agriculture-for-development framework applied to similar cases

The agriculture-for-development framework is described by looking at review and background papers that are broader than only Chapter 10 of the report, but the entire report revolves around agriculture, and is therefore also applicable to Chapter 10 specifically.

Case 1: Global agricultural performance: past trends and future prospects: Background paper for the WDR by Wik et al. (2008).

It is with a sense of hopelessness that one has to report that Sub-Saharan Africa is not experiencing a sustainable increase in "per capita agricultural output" (Wik et al., 2008), but rather rising food shortages, an increase in poverty as well as hunger. With the spotlight on livestock, the demand for animal food, coupled with the impact of climate change and vulnerable natural resources, not only creates challenges, but also disempowers agriculture today. Livestock production consumes almost 40% of all agricultural land, creating a need to utilise the land for feed production rather than food production. In order to propagate agriculture, one needs firstly to make more useable land available, secondly increase crop intensity, thirdly have more output per input worker and fourthly, produce higher demand products. Challenges faced are population growth, declining agricultural production in various cases, food insecurity and higher energy prices, as well as water shortages and climate change. One has to wonder if, in the light of the development report, the future is indeed looking bright for the agricultural sector as a whole. The hope is that regions such as Sub-Saharan Africa can improve its agricultural output by creating sustainable initiatives, and provide the world with the much-needed hope for prosperity in future.

Case 2: (Re)imagining agrarian relations? The World Development Report 2008: Agriculture for Development by Akram-Lodhi (2008).

This article takes a closer look at the WDR, and examines structural changes that are taking place in the food sector by describing the agricultural landscape in terms of agriculture-based countries, transforming countries and urbanised countries. Each classification brings about its own opportunities and challenges, with agricultural countries employing 65% of its workforce in agricultural activities. It seems that the higher the agricultural employment, the greater the rural poverty in those countries, as is the case in many of the Sub-Saharan countries. Smallholder competitiveness needs to increase with better soil quality and fertilisation, water and environmental management, but also access to improved financial services and support through microfinancing. Akram-Lodhi (2008) feels strongly that farmers need to be empowered to "farm their way out of poverty". In transforming countries, there is typically high rural poverty and limited economic growth through agriculture, although agricultural employment is high. Smaller farming areas lead to stronger political pressures, often only enriching a small rural elite, compared to the larger, rural poor communities. Urbanised countries, employing roughly 18% of their entire workforce as agricultural workers, have a skewed relationship between opportunities and resources available to the urbanised communities compared to the rural areas, including access to libraries, health services and infrastructure, making urban employment more attractive to many. The article concludes by suggesting that the only way out of rural poverty is by improving entrepreneurial skills and "depeasantisation" by selling their labour power.

Case 3: Banking on agriculture: a review of the World Development Report 2008 by McMichael (2009).

Although subsistence farming is common worldwide, it does not necessarily lead to any form of development. Many rural farmers do not aim for any form of empowerment through development, and seem content to live off the land. Some countries like Indonesia are now categorised as urbanised, but are in fact only repositioning themselves in terms of their monetary figures and statistics. Private institutions drive development projects with their own agendas, feeding the rich. It is not the norm to empower rural farmers, and the drive does not necessarily lead to better living conditions, or any form of development, when in fact the whole drive is on the rural poor, making agricultural practices more appealing and sustainable. To improve agriculture, private institutions need to partner with the local communities, and create opportunities not only to feed the rich, but to create better living- and working conditions for the rural farming communities. In the two case studies presented in this study this consideration is exactly what has led to the project success: the correct partnering of people, and empowerment through access to markets, and a strong drive by the project stakeholders to ensure sustainability.

6.5. Maslow's hierarchy of needs

In 1943 Abraham Harold Maslow wrote a paper on the theory of human motivation. In this renowned work he looks at human needs, and classifies them in a specific order. He also wrote a paper prior to the theory of human motivation, where he reached certain conclusions, the one being central in formulating the framework in this study: Human need number 7: "Human needs arrange themselves in hierarchies of pre-potency. That is to say, the appearance of one need usually rests on the prior satisfaction of another, more pre-potent need. Man is a perpetually wanting animal. Also no need or drive can be treated as if it were isolated or discrete; every drive is related to the state of satisfaction or dissatisfaction of other drives" (Maslow, 1943). Since 1943 Maslow has been cited by various authors such as Simons, Irwin, and Drinnien (1987), Maslow (1987), Huitt (2004), McLeod (2007), Griffin (2015), to name but a few, with the authors arranging

Maslow's human motivational needs as a hierarchy, often referred to as "Maslow's hierarchy of needs". Figure 29 depicts this hierarchy:

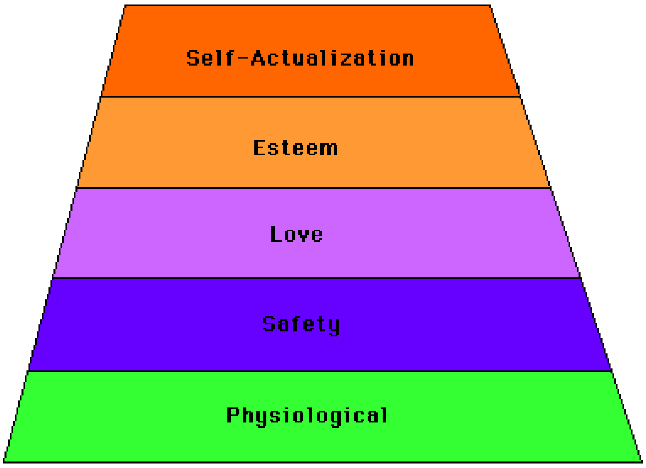


Figure 29. Maslow's hierarchy of needs (Adopted from Huitt (2004))

Maslow's basic needs are:

1. Physiological needs for example oxygen, food and water.
2. Safety needs in order to feel secure and safe in disorganised times.
3. Need for love, affection and belonging
4. Needs for esteem to be treated with respect and dignity, to feel self-confident.
5. Needs for self-actualisation to become the person one is meant to be.

(Simons et al., 1987).

For communal farmers to ensure the sustainability of livestock traceability systems, they need to feel the impact in order to improve their livelihoods, and to do so, their livelihoods need to improve in a hierarchy, similar to Maslow's hierarchy of needs:

1. Physiological – improved food sustainability, because traceability reduces animal disease, so there are more animals to be slaughtered for local consumption, or sold to pay for food and housing.
2. Safety – absence of disease in the human population is also linked to improved food safety, which is a primary goal of traceability.
3. Love, affection and belonging – increased income from selling cattle at a higher price and having more cattle to sell, will result in benefits for the family of the smallholder and the rural community, which will promote community development.
4. Esteem – it results in improved self-esteem for the once-excluded communal farmer who will receive a more market-related price for his/her cattle, allowing for a better standard of living.
5. Self-actualisation – when people are earning a market-related income which reflects a higher standard of living, they are able to achieve self-actualisation.

The framework proposed in this study therefore depicts the impacts in a specific order, implying that the impacts on the communal farmers need to be achieved in a specific order:

Figure 30. The hierarchy in which the impact on the communal farmers need to be achieved

6.6. Towards an impact-for-sustainable-agriculture framework

Through the use of the different frameworks as discussed previously in this chapter, a new conceptual framework has been constructed and presents sustainable agriculture, and its impact on communal farmers, ultimately to propose a way of increasing agricultural development, especially in the light of all the evidence in the World Development Report of 2008. The need for this framework is illustrated, with reference to literature, and to all the facets needed to describe sustainability and impact simultaneously, while keeping in mind that the data collection is done through indirect role players, not the communal farmers themselves.

The different inputs in this proposed framework have all been legitimised through their applicability in current research and trends. To summarise the overall framework briefly, as seen in Figure 31, the framework places the PESTeL context components at the foundation of sustainability, linking with the C4D framework, together with the three pillars of sustainability to form the information and pre-knowledge needed to build the framework. The PESTeL components and the pillars of sustainability should be seen as mandatory, leading to the initial building blocks of the overall framework. The second layer or building block, is that of the introduction of new technology to bring about certain behavioural changes, with the ultimate goal of highlighting developmental impacts. Finally, the third component or layer is the various impacts on the communal farmer, depicted in the order of Maslow's Hierarchy of Needs. Considering the three layers, in that specific order, then lead to more sustainable agricultural initiatives, as illustrated by the arrow of sustainability pointing upwards.

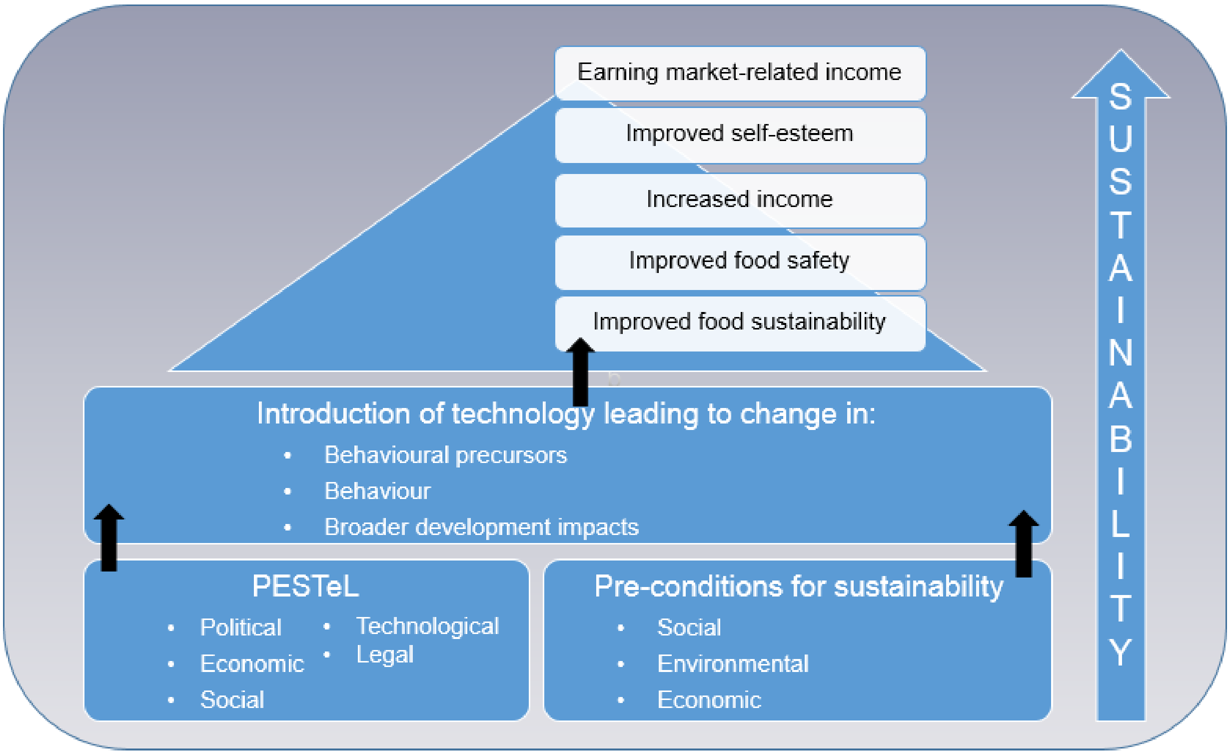


Figure 31. The Impact-for-sustainable-agriculture framework

6.7. The ICT4D value chain: touch-points with proposed framework

Heeks (2010) created the ICT4D value chain, a chain that depicts readiness, availability, uptake and impact of ICT4D projects. It is seen as a way of explaining input-process-output as a sequence in the value chain. Transformation happens with the contribution that any technology makes to development, and happens in small steps. This framework has been considered, with definite sections of value, but it takes a slightly broader ICT4D context into consideration, whereas the framework in this study aims to address an ICT4Ag framework, with a more specific context. Some of the precursors of the ICT4D Value Chain are replaced in the new framework by outlining the "Readiness" in terms of PESTeL and pillars of sustainability, as the context of the traceability system implementation is interweaved with the specific countries in the study. The pillars of sustainability build on the arrow that indicates the upward trend of the more one moves from the bottom layer to the top layer, the more sustainable the initiatives. In the proposed framework of the study, the arrow of sustainability inherently implies that as one moves further along the layers of the framework, one is more likely to reach a stage where developmental sustainability will have a greater chance of being achieved.

The impact of the ICT4D value chain is not measured on the beneficiaries of the project, but rather more broadly, focusing on developmental impacts as public goals. The changes that a new technology brings are seen as being adopted, and the changes that occur with the new technology are not measured in terms of behavioural changes of the beneficiaries themselves, but rather on the overall project. This framework has a sound foundation, and is worthy of mention, but is not seen as a means of summarising the findings of this study in particular. The ICT4D value chain is shown in Figure 32.

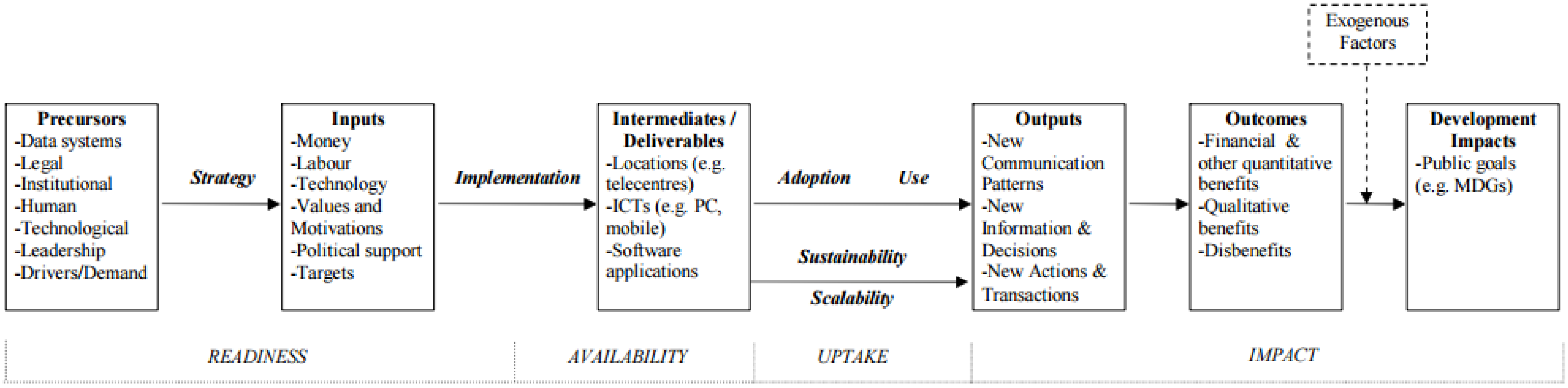


Figure 32. The ICT4D Value Chain (Adopted from Heeks, 2010))

6.8. Conclusion

Chapter 6 concludes the design of the new framework and all the building blocks for the proposed framework, explained theoretically and made applicable to similar research through different cases. The rationale for the framework is discussed, and the reason for all the components are clarified, with the overall framework graphically illustrated. The three building blocks, the pillars of sustainability, the C4D framework and the four objectives of the agriculture-for-development framework are put forward as a means of input, and placed in a specific order. Chapters 7 and 8 take all the evidence collected, place it in the new framework as a way of proving its validity, and explaining its relevance to this particular study.

7. Chapter 7: Discussion of evidence collected from Swaziland and its traceability system

I've always enjoyed traveling and having experience with different cultures and different people. But it's also a wonderful thing to be able to benefit and enable research, not only in our country but around the world. Laurel Clark

7.1. Introduction

In this chapter Swaziland is described through various lenses. Firstly, the focus is on the political, economic, social, technological and legal (PESTeL) background of Swaziland, followed by the pillars of sustainability, namely the environment, the economy and the social aspects, described through specific pre-conditions for development, with these aspects forming the basis of the first layer of the proposed framework. Secondly, SLITS is discussed as a technological change in behaviour that occurred, with the detailed case study, interviews and questionnaires providing evidence, building onto the framework as the second layer, highlighting the broader developmental impacts. Thirdly, the different impacts on the communal farmer are described. The impacts are discussed in the form of the Maslow hierarchy of needs, and start with the impact of SLITS on farmers' livelihoods, then employment, market access, and finally competitiveness, building on the developmental impacts of the second layer. The chapter concludes by summarising the evidence collected in terms of the sustainability of SLITS, and providing the framework proposed as a means of supporting evidence for the validity of the proposed framework.

7.2. Background on Swaziland

The first layer of the framework sets the scene for the evidence gathered in the second layer of the framework, and then the third. The layers follow one another, forming an entire picture of the different building blocks required to ensure that agricultural projects are sustainable, and in this case, the focus is on Swaziland, and how SLITS, the new technology, impacts Swazi communal farmers, and creates a sustainable success story. The first layer is shown in figure 33.

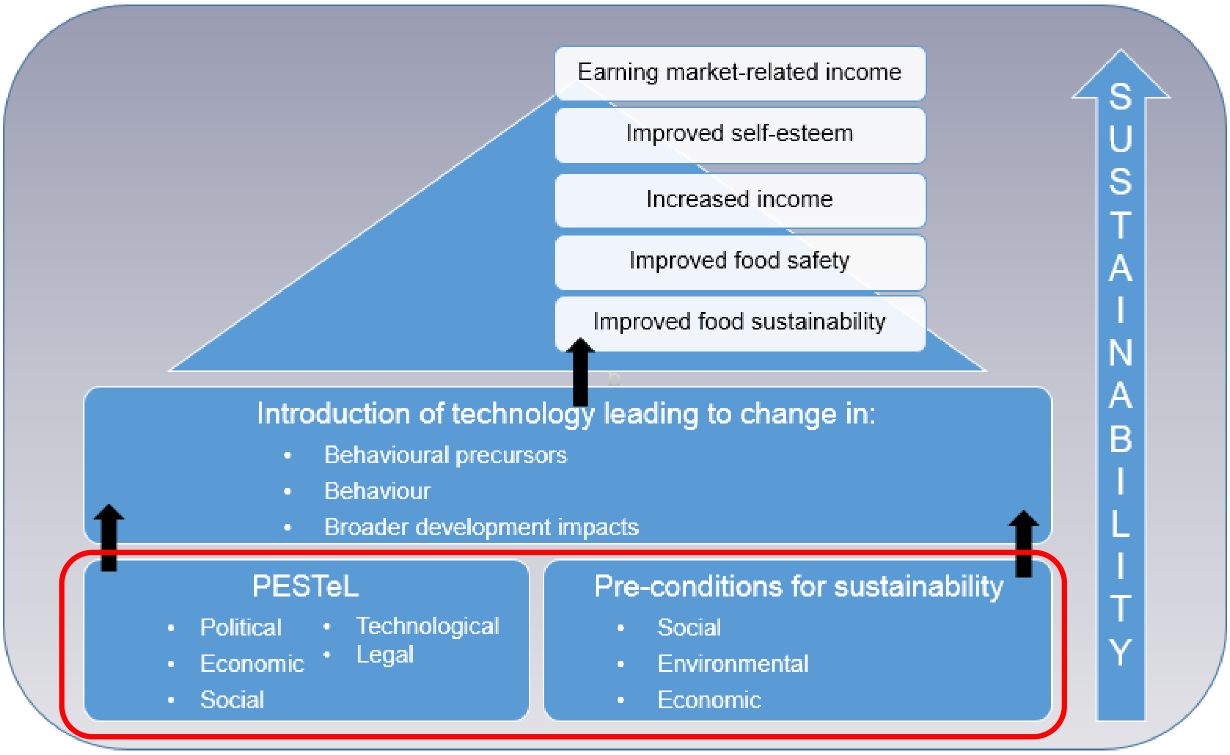


Figure 33. Applying the first layer of the proposed framework to SLITS

7.2.1. PESTeL conditions

Political conditions

In figure 34, the geographical location of Swaziland is highlighted.

Figure 34. Geographic location of Swaziland (Adopted and adapted from Maps-Africa (2012))

Swaziland, the smallest country in Southern Africa, is landlocked and borders South Africa and Mozambique, spanning 17 360 km² (World Trade Organisation, 2015), and is mostly mountainous. The population size is estimated at 1 323 010 (Worldomotors, 2017). Swaziland was named after King Mswati II who became king in 1839 (Herbert, 2007); the royal name is Dlamini.

The current king, King Mswati III, born in 1968, has reigned since 25 April 1986 (Central Bank of Swaziland, 2010), and is highly respected. Swaziland has a dual system of land tenure – Swazi National Land (SNL) and Title Deed Land (TDL), with the SNL being held in trust by the king, (Central Bank of Swaziland, 2016), housing approximately 84% of the poor in rural areas (The International Fund for Agricultural Development, 2013). Mr Barnabas S. Dlamini has been the prime minister since 2008, having been re-elected in 2013 and "the national constitution as amended in 2006 shifted judicial power from the monarch and vested it exclusively in the judiciary" (United States Central Intelligence Agency, 2016b), although the king is still the chief of state, having enormous political influence. The central government is a "constitutional monarchy" (Commonwealth Local Government Forum, 2015), with four administrative regions: Manzini, Hhohho, Shiseweni and Lubombo, each with a political head as appointed by the king. Parallel to government is the traditional system with the king and his traditional advisors and 55 sub-regional districts with traditional chiefs (Encyclopedia of the Nations, 2016).

Economic conditions

Swaziland has a small economy; it represents roughly 1% of South Africa's Gross Domestic Product (GDP) at $4.1 billion, and the currency used is Emalangeni (SZL), linked to the stronger South African Rand (Vandome, Vines, & Weimer, 2013). Its primary economic sectors are agriculture and forestry, focusing on maize, cotton, citrus, sugarcane and livestock, and mining, focusing on coal and iron ore. Secondary sectors focus on manufacturing, electricity and water supply and construction, while the tertiary sector consists of wholesale and retail, financial intermediation, transport and storage, information and communication, government services and real estate (Central Bank of Swaziland, 2016). In May 2012 the International Monetary Fund (IMF) "withdrew its advisory team from the country, highlighting the government's failure to gain control of its fiscal position and to implement policy prescriptions drawn up by the IMF" (Vandome et al., 2013). Swaziland is not a major role-player in the Southern African Development Community (SADC).

The ten economic freedoms are illustrated in the following four figures, Figures 35 to 38, highlighting the rank of Swaziland in the rest of the world:

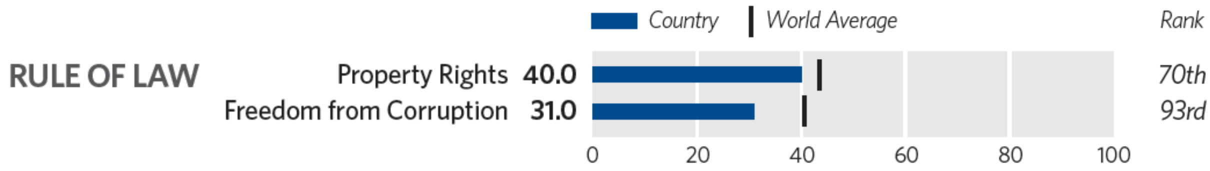


Figure 35. The economic freedom of law in Swaziland (Adopted from 2013 Index of Economic Freedom (2013b))

The public generally mistrust government, due to widespread corruption. The courts do not favour the business environment, leading to a high number of out-of-court settlements (2013 Index of Economic Freedom, 2013b).

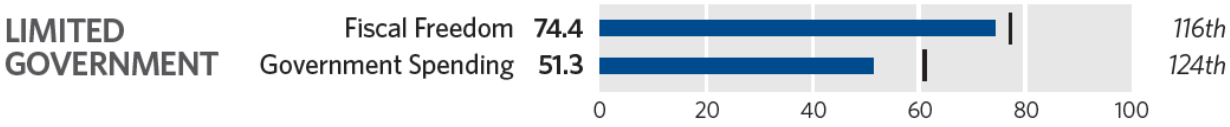


Figure 36. The economic freedom of government in Swaziland (Adopted from 2013 Index of Economic Freedom (2013b))

Figure 36 illustrates that government spending is very high, leading to less fiscal confidence. The tax rate of 33% for individual tax and 30% for corporate tax is not very high; however, public debt is increasing, and it is difficult to raise cash, resulting in cutting expenses.

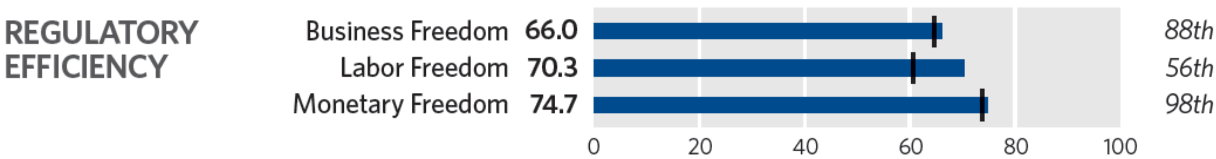


Figure 37. The economic freedom of the regulatory system in Swaziland (Adopted from 2013 Index of Economic Freedom (2013b))

Swaziland's informal sector is stronger than its formal sector, and there are substantial hoops to jump through in order to register a formal business entity. Growth in business ventures is slow, discouraging prospective investors.

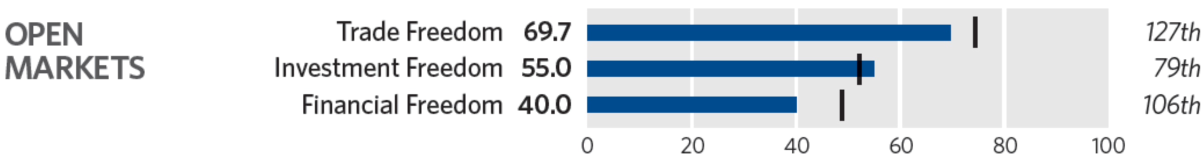


Figure 38. The economic freedom of markets in Swaziland (Adopted from 2013 Index of Economic Freedom (2013b))

In Figure 38 one can clearly see that financial freedom is not being achieved, with the majority of the population not having access to any form of credit. The country needs sustainable, long-term investment, but the poor economic climate, together with corruption and weak political structures, makes it unattractive.

Social conditions

The Swazis speak mainly English, its official language, and siSwati, its Southern native language. According to the website C*ountries and their Cultures* (2016b), there is a clear distinction between rural and urban citizens, where the knowledge of English marks status and education. Because the king is such a prominent figure in Swaziland, a Swazi is ranked according to his/her relationship with King Mswati III, the highest clan being Nkosi Dlamini, followed by clans that have provided queen mothers. Swazis value their sons more highly than their daughters, and has a traditional patriarchal system. Children are seen as essential in a marriage, but only men can inherit. TDL ownership remains a challenge for women, as only traditional household males are given land by chiefs (Dlamini-Ndwandwe, 2011). Men are also the only ones allowed to herd cattle, although cattle ownership is common among women. The most prominent religion is Christianity, but the Swazis' strongly believe that a person's spirit has a very distinct purpose, and one common ritual is for a widow to shave her head while in mourning. Swazis are generally friendly and greet everybody (Countries and their Cultures, 2016b). In 2015, there were 220 000 people living with HIV, an adult prevalence of 28.8% (Avert.org, 2016), the highest in the world, with one of the lowest life expectancies (49 years) in the world. The Swazis are proud of their traditions and cultures, and Figure 39 shows a photograph of a Swazi dance performed in their traditional dress.

Figure 39. A traditional Swazi dance

Technological conditions

Swaziland has a mobile phone penetration of 75.2% of the population, compared to the 3.2% of fixed-line telephones, with MTN the main provider and 30.4% of the population having access to the Internet (United States Central Intelligence Agency, 2016b); also a state-owned television station, but with satellite connections available from South Africa. The mostly rural population is not technologically advanced, except for mobile phone usage, where 90% of the country has mobile network coverage.

Legal conditions

The capital is Mbabane; Swaziland gained independence from Britain on 6 September 1986 (United States Central Intelligence Agency, 2016b). The constitution recognised both formal and informal laws, with formal laws referring to "Roman-Dutch common law", and the informal "Swazi customary law", pre-dating to the colonial era (Dlamini-Ndwandwe, 2011). Swaziland is a democracy and human rights are protected by the constitution (Vandome et al., 2013). Figure 40 illustrates the location of the country's capital: Mbabane.

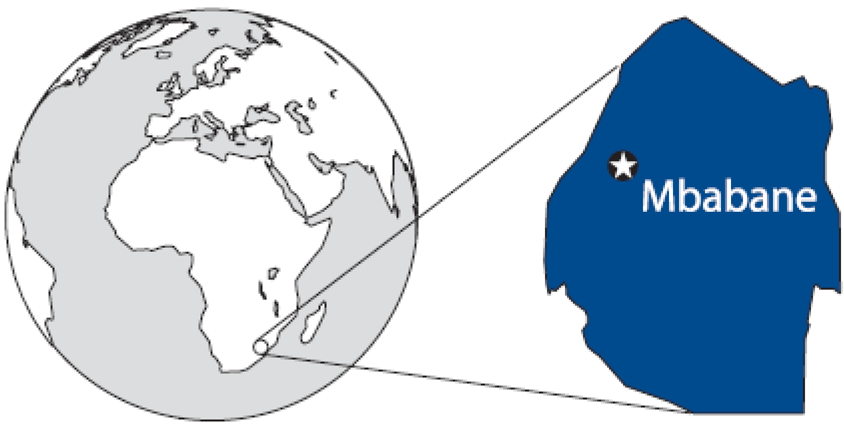


Figure 40. The administrative capital of Swaziland is Mbabane (Adopted from 2013 Index of Economic Freedom (2013b))

7.2.2. Pre-conditions

It is not adequate merely to list the PESTeL factors feeding into the framework, but one should have a deeper understanding of the pillars of sustainability as pre-conditions – or as setting the scene – for the case study and the introduction of the new technology. The three pillars are discussed as necessary conditions, based on thirteen success factors identified in Chapter 4. They are briefly discussed in terms of their relevance to the Swaziland case study.

Social

1. Using ICT to enhance existing rural development activities

The inclusion of the communal farmer in the livestock traceability system has created a sense of worth for all stakeholders in the project. Communal farmers are now also able to sell livestock at higher profit, and gain economic freedom, at least to some extent. SLITS needs to create an environment where the country's citizens feel as if the system belongs to all and benefits all. The individual ear-tagging of animals, together with capturing all the details of the animal and owner immediately creates a sense of inclusivity in the project.

2. Cultivating an influential project champion

It is true in the case of SLITS that certain key individuals became involved in the project, some on a basic level, for example the enthusiastic veterinary assistants, but it is the project manager of SLITS who played, and is still playing a pivotal role in the success of SLITS.

3. Incorporating socially excluded groups

Communal farmers, the group that is traditionally lagging in terms of skills and education, are the poorest people in Swaziland, and SLITS aims at empowering them. The project is at the heart of development, and it does not enrich the wealthy, but gives the communal farmer, with a relatively small herd of cattle, the opportunity to make a better living.

4. Focusing on local needs

Agriculture, a primary economic sector in Swaziland, leads to exporting of meat and meat products, contributing to growth in the economic sector. Communal farmers typically sell their livestock to local markets for a small profit, but with traceability they can sell their animals to feedlots or to the Swazi Meat Industries (SMI) where they receive higher prices. The needs of communal farmers are addressed through creating prospects of earning more money and gaining economic freedom.

5. Building local partnerships

SLITS is rolled-out throughout Swaziland, and is the required standard for all farmers to ensure safe meat by adhering to strict traceability legislation. The government and relevant departments have to work with local communal farmers, and by doing so, reach all stakeholders.

The Swazi livestock are dipped frequently, and at the dipping events the veterinary assistants build relationships with the farmers who bring their cattle. Communal farmers also receive their plastic ear-tags free of charge as an incentive to be involved in the project.

Economic

1. Simple and clear project objectives

At the inception phase of SLITS, clear goals had already been set, linked to benefits expected from SLITS, giving the project direction. The benefits are to:

- improve access to markets of livestock and livestock products;
- assist in the recovery and identification of stolen and strayed animals;
- assist in the reduction of stock theft and cross border cattle rustling;
- assist in disputes over animal ownership among farmers;
- assist in rapid containment of animal diseases in the case of outbreaks;
- assist in production management;
- improve efficiency of Government controlled movement permits (The Government of the Kingdom of Swaziland, 2012).

2. Appropriate training

The veterinary assistants are spread throughout Swaziland, and training was provided to a number of veterinary assistants, who could then teach others once they returned from their training. The training presented was a formal 5-day interactive workshop where the veterinary assistants received hands-on training on SLITS, received information on what is now being done differently, and given skills to train others in the use of the system, together with a training manual and slides. The training was identified as a way of managing the change that is taking place by creating enthusiasm and buy-in from the veterinary assistants. During the training the developers of SLITS discussed and addressed concerns, answered additional questions and streamlined functionality for ease of use.

3. Choosing the appropriate technology

The manual system needed to be upgraded, and the technology chosen to computerise the database is Progress OpenEdge, a stable and reliable application able to process a large number of transactions. The Progress OpenEdge platform is well-known to the developers of SLITS, and has proven to work well in similar applications where it has been used, for example the Namibian livestock traceability system, a sister application of SLITS, with some of the developers involved in both application designs and maintenance.

4. Building on existing facilities

The network of veterinary assistants deployed throughout Swaziland overseeing the dipping events is well-positioned to capture the events, and then to transfer the information to the computerised application. The same offices are used, the same employees capture the information, and the project manager is able to manage the project from the regional office in

Manzini, where a number of veterinary assistants meet regularly to touch base. In essence, the existing infrastructure, manpower and familiar faces of the communal farmers at the dipping events now just take on an added role.

5. Ongoing monitoring and evaluation of the project

SLITS is implemented throughout Swaziland, and the project benefits and goals are measured against the actual output. The evaluation of the project has been done with the veterinary assistants completing questionnaires to determine the impact it has on their daily working activities, and to determine their attitude towards its use and functionality. The questionnaires go a step further by asking the veterinary assistants to give an indication of how communal farmers experience the ease of interacting with SLITS, looking at aspects like the simplification of obtaining movement permits. The information is then analysed and discussed as part of the case study findings.

Environmental

1. An understanding of the local political context

The political landscape has been discussed under PESTeL; however, it remains relevant to note that the political context can be either conducive to the project, or work against its goals, leading to a negative environment in which to roll-out a new technology. Swaziland is in a very unique political state, with the king and government playing a part in how the country is operated and how decisions are made. For SLITS to be able to make a meaningful impact, it has to be supported by both the king and government.

2. Focusing on self-sustainability

SLITS received funding to from the European Union to develop and maintain a computerised database. The funding is not sufficient to purchase computer hardware and supply Internet access to all the regional veterinary offices. Swaziland has to make use of all the existing infrastructure, and needs the input of project champions to maintain project momentum. One positive aspect is the attitude of communal farmers towards the project, and the drive of the veterinary assistants to create streamlined processes. The funding will stop, but the project has been adopted throughout Swaziland, and SLITS is no longer merely taking baby steps, but proving to make a positive contribution to efficient livestock traceability and agriculture as a whole.

3. Encouraging local ownership

Local ownership links closely with self-sustainability, where the Swazis need to feel proud of what they achieve with SLITS; they see the value in monetary terms and want to keep it running smoothly.

The role-players from the European Union, the king and government, the project manager, the veterinary assistants, commercial farmers right through to the communal farmers, need to see the project's value and want to keep it working well, feeling important to the project success. The local people of Swaziland have been and still are the main drivers of the initiative.

7.3. Introducing the new technology leading to change and the findings from the data gathered as a result of the change

The second layer of the framework is discussed based on the information gathered through the case study and events witnessed, the interviews conducted and the analysis of the completed questionnaires. All the information grouped together leads one to reach certain conclusions, and the conclusions are summarised in Table 11, starting with the different contexts being identified, followed by the behavioural precursors, leading to certain behavioural changes, ultimately providing one with clear developmental impacts of the project, concluding the case study and second layer of the framework.

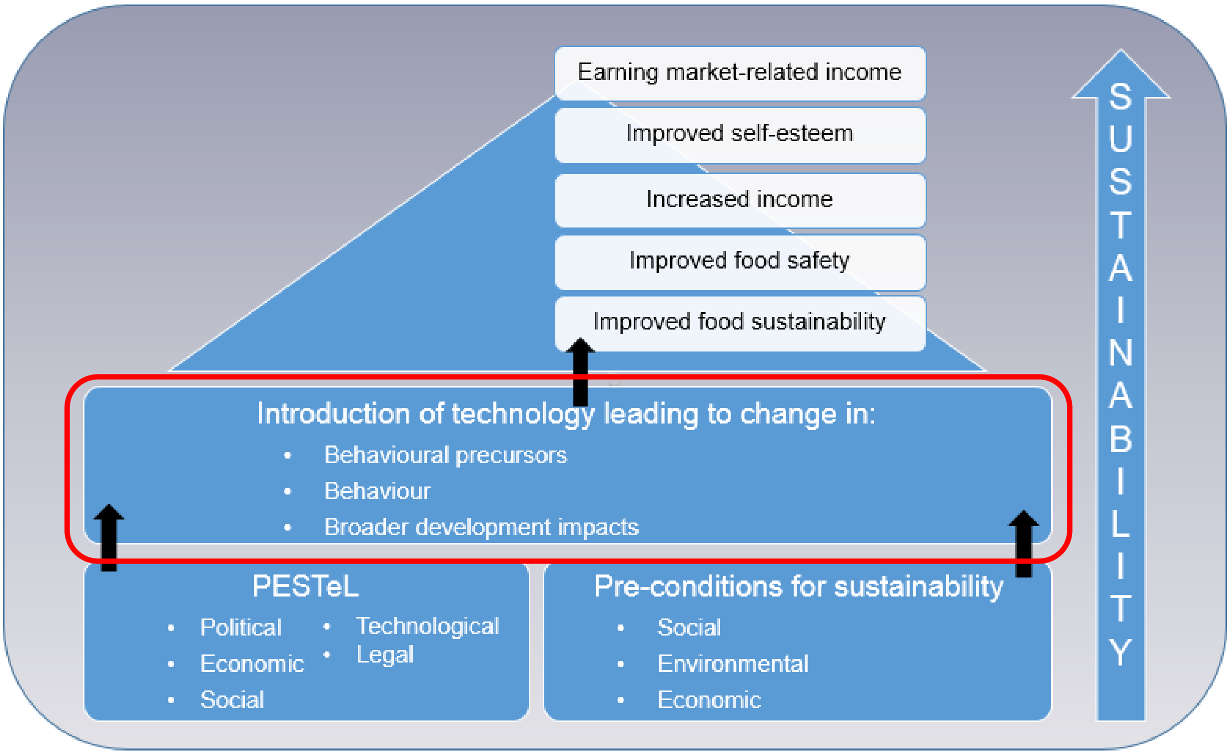


Figure 41. Applying the second layer of the framework to SLITS

7.3.1. The context-rich case study: SLITS

A broad analysis of Swaziland and SLITS is necessary to appreciate the scope of the project fully. Swaziland is a small, poor country in Southern Africa, where one of its key commodities is livestock and livestock sales, and it is in the light of the importance of the livestock industry that the case study is discussed. In figure 42 below, one can see the importance of key commodity markets for rural households.

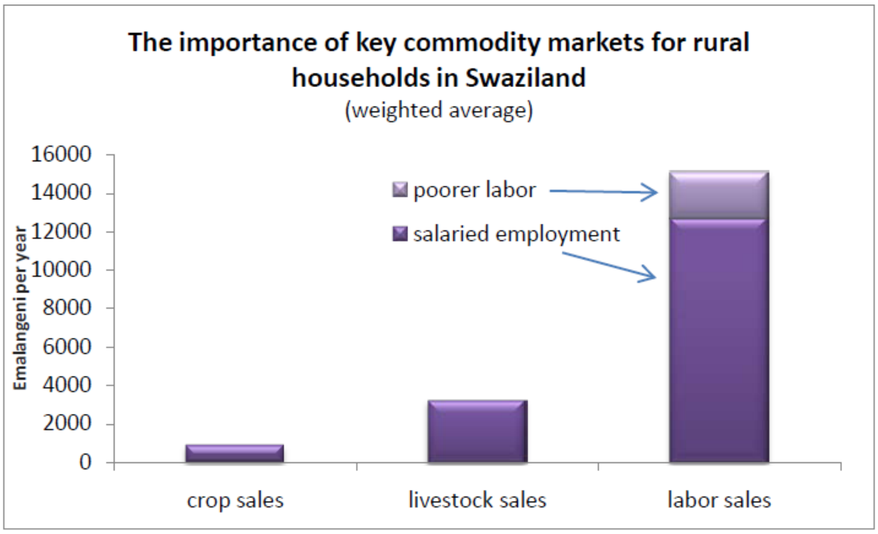


Figure 42. The importance of key commodity markets for rural households in Swaziland (Adopted from Boudreau (2010))

The journey of SLITS started in August 2012, when it was still in the development phase, and there was no clear picture of the impact of the new technology. By December 2012 SLITS had been rolled-out in its pilot phase, with initial training in the form of train-the-trainer given to a small group of veterinary assistants, who in turn shared their new knowledge with other veterinary assistants at the regional offices. The first visit to Swaziland took place from 12 to 14 December 2012, and included experiencing a livestock dipping event in Nkonkwane, a small rural area close to Manzini. Three subsequent visits took place up to September 2015. It was soon evident that SLITS was not only gaining momentum, but proving to remain sustainable.

SLITS is a system that enables users to identify and trace every individual animal in Swaziland. The Veterinary Offices identified a need to computerise their databases to ensure the registration, movement, animal health and branding of cattle as stipulated on the “The Government of the Kingdom of Swaziland” website. As part of the identification of the cattle within the SLITS system, all communal farmers’ animals have been ear-tagged, a project that started in March 2012. It is now much easier for the kraal (native village community) owners and government to keep a record of all animals. Communal farmers’ animals graze freely in the SNL areas and there are no fences to keep animals apart. The animals have ear-tags, one big yellow tag in the left ear and a smaller yellow round tag in the right ear.

The ear-tag has the Swaziland shield, the dip tank number as well as the number of the animal, where the number is assigned to a specific kraal owner. If change of ownership occurs, the data is transferred to the new owner. Another identification method used is the branding of cattle. The

Swazi shield is placed on the front left leg and the dip tank number on the left hind leg. Figure 43 is an example of how a Swazi ear tag looks like.

Figure 43. An example of a Swazi ear-tag

Veterinary assistants of the Veterinary Services oversee all dipping events and capture the detail of the event on SLITS. This simplifies the movement permits of the animals, and controls the outbreak of any disease. In summer cattle are dipped every 14 days in the drier areas, and once a week in the wetter Lowveld. In winter dipping occurs from 14 up to 28 days. The cattle know exactly when it is dipping time and kraal owners with their herds walk along the side of the road to the dip tank from dawn. Everything is done orderly at the dip tank, where the veterinary assistant, armed with a register of all the kraal owners and tagged animals, counts the cattle and checks for any signs of illness or scarring. The cattle are then chased through a narrow tunnel where they are plunge-dipped. They jump into the deep dip tank, designed in such a way that their hooves do not hit the bottom of the tank, both to prevent injury and to ensure that their ears are dipped too. They then swim for about twenty metres, climb out of the dip tank and head back home. Figures 44 and 45 are photos taken at the dipping event.

Figure 44. Cattle being dipped in a rural dip tank

Figure 45. Cattle leaving the dip tank.

If an animal from a dip tank is brought to a new dip tank, a special movement permit needs to be completed to ensure that the animal is disease-free and to establish if the new dip tank has capacity for the extra animal. It is quite a difficult process. If an animal is not brought to the dip tank, a reason for the animal's absence is recorded; it either strayed, died or got slaughtered, or is sick or hurt. If the animal is injured, the veterinary assistant goes to the specific kraal for an inspection, and if there are any traces of tick-borne diseases or foot-and-mouth disease, the entire dip tank and all its kraals are quarantined.

Figures obtained from SMI show a growing trend in beef exports until 2013, with a decline in 2014, believed to be directly linked to the implementation of SLITS, as can be seen in figure 46, with the highest export numbers to date achieved in 2016.

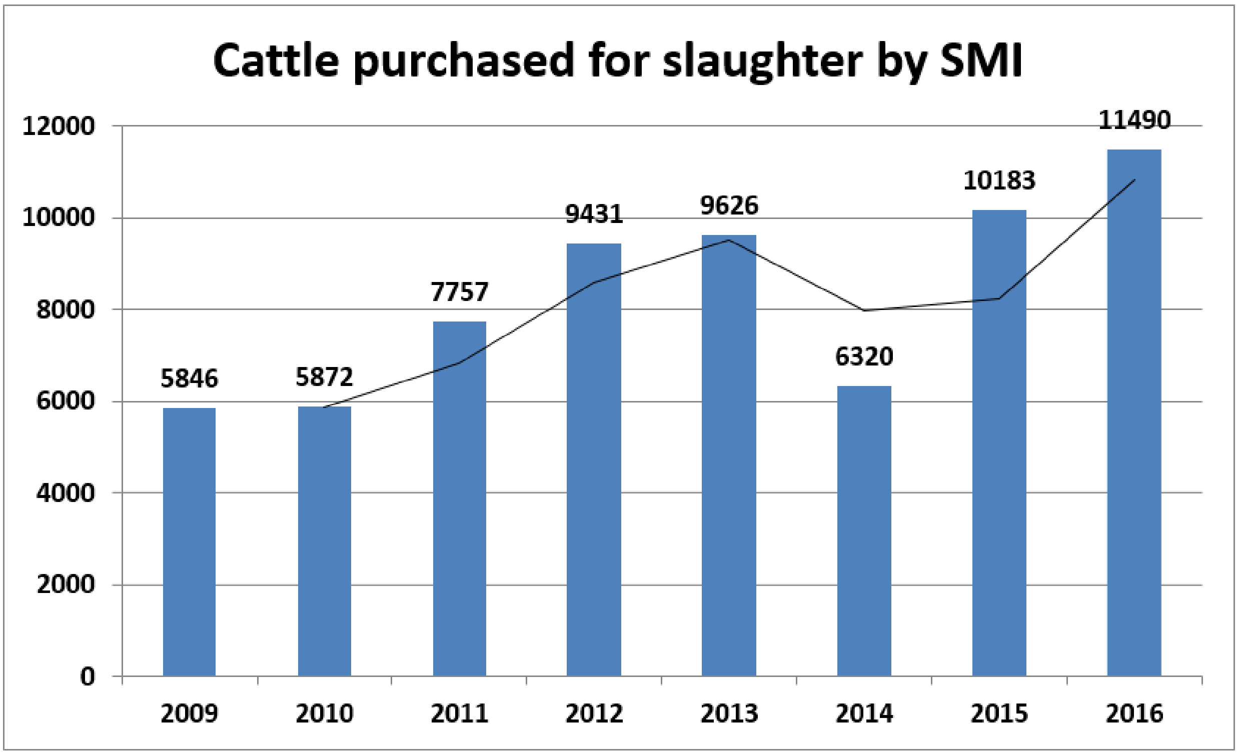


Figure 46. Cattle purchased for slaughter between 2009 and 2016

The actual number of animals purchased for 2014 was 6320, much lower than the three preceding years. The reason is that not all animals' details were captured on SLITS in the beginning of 2014, therefore the animals could not be sold to the SMI. Almost all Swazi livestock have been captured on SLITS following the problems in the beginning of 2014, and the numbers have increased again from 2015. The high mortality rate of 2015 is because of the persisting drought, as is illustrated in Figure 47.

Item	2011	2012	2013	2014*	2015#
Total Population	616,459	633,954	627,486	620,032	594,240
Total Slaughers	44,811	46,218	56,582	50,041	61,258
Deaths	27,417	37,341	35,096	38,899	57,796
Mortality Rate	4.5	5.9	5.6	6.3	9.7

Figure 47. Swaziland livestock cattle production (Adopted from the Central Bank of Swaziland (2016))

Swaziland reportedly has been free from foot-and-mouth disease since 2001 (Vosloo et al., 2002) and no incidences of BSE have been reported (Yam, 2003), without having to go to such lengths to opening-up world markets.

7.3.2. A discussion of evidence gathered from interviews

For data collection a number of interviews were conducted over a period of four years. The interview questions show the progression of SLITS, from being introduced to the farmers up to full implementation. This section highlights some of the questions, the main contributions made by the participants and the implications of the responses for SLITS.

The first interview was conducted at the beginning of the project, before it became mandatory to use SLITS. Key project members and sponsors were interviewed.

Interview 1

What do you expect from SLITS now that the new technology is being introduced in Swaziland?

> "It is not like we just want to pursue technology for the sake of technology or to please ourselves with something."
>
> "A vision where we believe that one day the livestock owners will be your 20 year-olds or 30 year-olds."
>
> \- Participant 1

The new electronic database enables users to move away from a paper-based system, where the animal and the owner's details are centrally stored. Service delivery has improved, with a more efficient and effective system, able to assist in disease control. If there is a sick animal, or an animal that has a condition, one can now go back to the system and ask for the history of the particular animal and then relate that history or that particular disease, or for the origin of the animal, any other treatment that was given to that animal and area of exposure.

In terms of ownership, cattle are no longer identifiable only by specific markings on the body, such as white with black spots. Every animal is now given a unique number, enabling the owner to trace it if it should stray, and to determine which specific cow gave birth to that animal. The system does not, however, provide the paternity.

SLITS also ensures better service delivery. One no longer has to go to the main offices to arrange change of ownership before going to the dip tank; it can now be done directly at the dip tank, simplifying the process significantly for the farmer. The expectation is to attract younger people to the farming industry by incorporating technology and improving rural livelihoods.

What are the differences between the traceability systems used by commercial and communal farmers?

Commercial farmers used their own system in the past, where a farmer would have a brand mark and apply that mark to all his/her animals. The branding was not standardised, making it difficult to audit. If a stray animal needed to be identified, a photograph of the brand was taken, and then compared to the brands in the register kept at the offices of the veterinary assistants. Only the owner of the animal was identified, not the individual animal. This system has now changed, and it has become mandatory that every animal, whether it belongs to a commercial or communal farmer, is uniquely branded by a number, and the number is linked to the electronic database, with a full record of the animal. The animal is typically branded on the left hind leg. Figure 48 is an example of such a brand.

Figure 48. An example of an animal branded with a unique number

What technology is typically being used at the dipping events?

"The problem is when you move from the paper system to the computerised system you have a risk of actually making it more ineffective and inefficient."

"The paper system is never down."

- Participant 1

Everything at the dipping event is recorded manually, and only later transferred to the SLITS database. The veterinary assistants count the number of animals brought by every farmer, and compare it to the number of animals owned by the farmer as is documented in the animal register. If it differs, reasons are provided and also recorded; for example, if the animal is absent due to injury, disease or death. The veterinary assistants receive training on SLITS, and are able to use the system correctly, and they understand the technology to utilise its full capabilities.

What is the main purpose of SLITS?

> "The system is not necessarily for export only."
>
> \- Participant 1

With the introduction of SLITS people are made aware of the use of information technology, and how it can benefit veterinary assistants. The data collected at the dipping events is captured at every office, even remote ones with more people capturing the data, streamlining the process.

SLITS makes identification of animals accurate and current, assisting in diminishing animal theft and rustling, controlling and containing disease outbreaks, and simplifying the issuing of movement permits. It assists the Swazi police in cases where animal ownership needs to be proved, specifically in cases where an animal is involved in an accident. The animals are not kept in camps that are fenced, but graze freely, even on the side of main roads, sometimes leading to accidents where animals are involved. The information that is readily available to the police force is an unintended but valuable benefit. SLITS also enables not only commercial farmers, but also communal farmers to export meat, as all animals now meet traceability requirements.

When will SLITS be rolled-out throughout Swaziland?

> "The answer to that question is difficult, it is like asking about marriage. When do you think the marriage will start working properly?"
>
> \- Participant 2

Everybody involved is committed to the system. The software was rolled-out towards the end of 2012, and the external funding continued until March 2013, but apart from some teething problems, everything was implemented and running according to plan. Some of the connectivity issues, including a lack of broadband services and slow network connectivity still have to be resolved, with the veterinary assistants identifying any problem areas once they have worked on SLITS regularly over a period of time. The economic implementation of the project remains unclear at this stage, with the full impact only available after full implementation countrywide in 2014, when it became mandatory.

How and when did the process of creating SLITS start?

> "It has been a topic that was discussed extensively."
>
> \- Participant 1

When one looks at cattle crossing the border from Mozambique, as well as at border control, there are cases where diseases like foot-and-mouth disease could be transmitted, and it poses a danger to the Swazi herd. Legislation has made it mandatory to distinguish an animal by its country of origin, and the Swazi shield on the ear-tag identifies that animal originates from Swaziland. The ear-tags are clearly marked and visible, a prerequisite of SLITS. In order to obtain access to the EU market, traceability is emphasised and required, and drives the project.

Explain the process of ear-tagging in terms of when it started, how often it is done and how much it costs.

Participant 1 explained that the tagging of the communal farmers' cattle started in 2010, with goats and sheep not yet forming part of the project. When a calf is six months old, the ear-tags are applied by the veterinary assistant. Ear-tagging is done on an ongoing basis at the dipping event, and continues taking place regularly, until the entire Swazi herd has been ear-tagged.

The tagging of new-born calves from thereon takes place only during certain times of the year. Ear-tags are provided free of charge to communal farmers, but commercial farmers have to buy the tags, costing about 12 Emalangeni each in Swazi currency, translating to less than one United States Dollar (USD)

What were some of the risks encountered with implementing SLITS?

> "There is always a question of continuity."
>
> \- Participant 2

SLITS was written by contractors, posing management and maintenance risks, and needs to be updated as technology advances. If the electronic database should have problems, the information gathered at the dipping events is still available, and animals have uniquely numbered ear-tags. Another risk is resistance from commercial farmers, but nothing mentionable predicting that it will have a big impact has been mentioned

Where do you mainly export your beef products to?

Participant 2 says that Swaziland exports beef mainly to Norway, Switzerland and other EU countries, but will open other markets, including the United States of America and Japan, therefore SLITS will benefit the entire country.

The second interview was with one of Swaziland's commercial farmers to determine the farmers' experiences with and feelings regarding SLITS. Commercial farmers farm on government-owned land, but also own their own cattle, grazing freely on communal land. The interview took place on 11 July 2013.

Interview 2

Do you use SLITS? In what capacity?

"The whole idea of SLITS is to have all your cattle numbered."

"We start calving in October. So it is actually our second year in SLITS. ... We tag them, we dehorn them and then record them."

- Participant 3

Cattle need to be uniquely identifiable in a cost-effective manner, and certain age groups of cattle are ear-tagged. Commercial farmers were initially not forced to use SLITS, but could take part in SLITS until it became mandatory in 2014. The cows on the specific farm had a very high pregnancy rate of about 85% in 2012, although an expected loss of 12% was calculated because of diseases or injuries. The 957 calves born in 2011 were fewer than expected, averaging at 68%, especially because of the drought, but these calves had all been tagged. The farm orders 1 000 ear-tags every year. They used only the ear-tag system, and had not fully changed to the SLITS system at that point.

When are new-born calves registered on SLITS?

Participant 3 explains that cattle are recorded three days after birth, but it can take up to six months. When an animal is recorded, it is ear-tagged to obtain the unique number in the SLITS database, and the animal is dehorned. At that stage of the implementation only the calves were ear-tagged.

From what age are the animals sent to the abattoirs for slaughter?

"All the cows go back into the ranch to be grown up as replacements for old cows in the system, but all the bulls, except for 10%, will go to the feedlot."

- Participant 3

Calves are typically born in October, November and December. The breeding season lasts only three months, and at this time the bulls are taken away from the cows, and after the calves have been born, the new-born calves stay with the cows for six to eight months. Then the weaning starts.

At the feedlot, the animals are fattened, and go either to the Swazi Meat Industries, or to local abattoirs to be slaughtered and sold at butcheries in Swaziland. The commercial farmers also supply meat to the indigenous Swazis.

How do you dip the animals?

> “Remember we have got a large game population which carry tics, so we have to dip.”
>
> \- Participant 3

On commercial farms most cattle are spray-dipped, compared to the plunge-dipping at communal dip tanks. Spray-dipping is done at different areas on the farm. In winter dipping takes place as needed, and the cattle are watched to ensure regular dipping events do take place. In summer dipping is done every week. During dipping specific substances are mixed with the water to prevent tick-borne diseases. A typical example of what is used at the dipping event is Taktic, shown in figure 49.

Figure 49. Taktic, a substance commonly mixed with the water at the dipping event

What diseases do you struggle with in Swaziland?

Participant 3 says that Swaziland struggles mainly with heartwater, and heartwater is transmitted by a tick, although there are different tick species. When the calves are born and stay with their mothers, they still have maternal immunity, but around the age of three months, they become vulnerable to tick-borne diseases, and in some cases, the calves die from heartwater. Another disease, redwater, is transmitted by the blue tick. Other causes of calve deaths are predators – there are hyenas in the area – and of course humans. Some local butcheries struggle to find sufficient meat for the communities, and steal from the farms.

Foot-and-mouth disease is always a threat, as Swaziland borders on South Africa. The last outbreak was in 2001, but it hit Swaziland only in areas that were close to the border. Buffalo carry foot-and-mouth disease, so Swaziland has to ensure that it has a buffer around its borders to prevent exposure. Cattle are inoculated and vaccinated against the disease. During vaccination, cattle are kept in quarantine, and the meat cannot be sold to overseas markets. If an outbreak of the disease is to hit a specific farm, the farm, as well as all bordering farms in a radius of fifty kilometres is immediately quarantined.

> "The whole ranch and neighbours, I think they talk about a radius of fifty kilometres."
>
> \- Participant 3

South Africa is not as strict with its veterinary regulations as Swaziland, and the country's regulations around foot-and-mouth disease are worrisome to the Swazis. Veterinary Services have to ensure that the international boundary fence is intact, and that no animal can enter the country, but the fence is not always secure. Foot-and-mouth disease is highly contagious, and easily spreads from game to livestock.

How often is data from the dipping event captured on SLITS?

On the specific farm, participant 3 explains, which has been in operation for more than 50 years, farmers still use their own system to capture the details of the animals. A government official that is stationed on the farm monitors the processes and record them, and then sends the information through to the main offices on Fridays.

Communal farmers' ear-tags contain the Swazi shield, the dip tank number and a unique identifying number. Some animals can have the same number as a branding number, as the numbers range from 001 to 3 000. The brand number does not correspond to the ear-tag number of SLITS. Swaziland also applies the dollar sign ($) as part of the branding as a unique farm identifier, and numbers the animals according to age groups to ensure traceability.

What are your feelings about SLITS?

> "Remember, the biggest number of cattle are not here, they are there on the communal areas and the Government is doing it for free."
>
> - Participant 3

Commercial farmers are not against SLITS. The only concern from the title deed farmers is the cost of the ear-tags. To pay 12 Emalangeni per ear-tag can be very expensive, considering that their current system is cheaper and implemented by all commercial farmers. But SLITS is a better method, and they plan to use SLITS in future. They are hoping to start using SLITS soon.

The focus is mainly on the tagging of the calves. Commercial farmers collect the cattle and they then go to a central area, calling it a central cone, where cattle are watered and fed. Before they dip the calves, a roll call is conducted, because there are always cattle missing and it is important to know exactly which ones are absent. It is important to know how long they have been missing, and it takes one some time to determine what is going on. One would find that out of 200 cows one could record 195 only, with five being missing.

It is vital to the marking process that all animals are accounted for. If five calves are missing today, farmers have to go look for them tomorrow, and if they are still missing, the problem needs to be addressed and resolved. If the cattle are dipped again the following week, and the five animals are still unaccounted for, it raises suspicion. There are predators, like hyenas, which often eat the ear-tags, creating problems for the farmers and veterinary assistants who need to trace every animal.

Do you sell cattle for export?

Commercial farmers sell their cattle to the SMI, and they then export whatever meat they have available. Legislation prohibits the SMI to export any meat or meat-products without full traceability of each animal.

> "But to them that traceability is the key thing".
>
> - Participant 3

Do you keep cattle at home? Your own cattle?

Employees on the commercial farm own a small number of cattle. It is important for a Swazi to own cattle, as they have a system in place, called lobola. If a young man wants to marry, he has to provide his bride-to-be's family with a certain number of cattle.

> "If you are a Swazi man and you don't have cattle, you are not regarded as a man in the community, you have to have a few cattle so that your sons can be able to fall in love with neighbours. To endorse that relationship".
>
> - Participant 3

Does the government attempt to educate communal farmers on the optimal time to sell their cattle?

The government is trying to change the mind-set of the Swazi farmer. Although farmers know the best time to sell an animal is before it is 24 months old, they do not want to part with their animals. Young animals perform better at the feedlots, and the meat is tender and sweet, compared to the meat of an old ox that has been ploughing fields.

> "But, our neighbours here, their mind-set have been changed".
>
> - Participant 3

A large number of cattle sent to the feed lot by the farm is bought from local communal farmers. The advantage is that they bring their animals themselves, the commercial farmers weigh the animals, and calculate the price, which the farmers then receive in cash, without having to wait two weeks to be paid by the Swazi Meat Industries.

> "Now we also do buy the older cows which we slaughter and provide some cheap meat to the cane cutters. A lot of people are working in the sugarcane areas where we sell meat to."
>
> - Participant 3

Do you perhaps see that in future that there might be a shift in culture where you would rather see your cattle as money in the bank than keeping them for lobola?

> "I don't see the culture changing. A Swazi will always prefer cattle for lobola.'
>
> \- Participant 3

A Swazi wants to own cattle. If he has money, he will buy more cattle. There is no Swazi that was born in a town. A Swazi coming from a rural area will move to a town only to be educated. He will take his wife there, and his children will be born there, but they do not belong there, their roots are still in the rural area. On a weekend they take the children back to the rural areas.

The third interview took place at one of the veterinary assistants' offices, where they shared some of their experiences of working with SLITS. The interview took place on 12 July 2013.

Interview 3

How do you, as Swazi veterinary assistants, experience SLITS?

Swaziland struggles with cattle rustling, and one of the benefits of SLITS is that it makes it possible to identify the owner, not only in Swaziland, but in neighbouring South Africa and Mozambique. The police find the system very useful in this regard.

> "We punch in the ear-tag number, the dip tank and the ID number for the livestock, then we get all the details pertaining to the animal or animals."
>
> \- Participant 4

Do you educate communal farmers on the best times to sell their cattle?

Communal farmers tend to want to hold onto their younger animals, participant 4 explains, and prefer to sell the older animals to the Swazi Meat Industries for slaughter. The meat is then less tender, and the farmers are not paid much for the older animals. The veterinary assistants have advised the farmers to sell the younger animals, but there is still work to be done in educating the farmers. It takes time to bring about a culture change.

How often do communal farmers sell their animals?

Participant 4 explains the lobola system as a system that is still widely practised in Swaziland, where a prospective husband will give some form of payment to the prospective bride's family, and this is usually done in the form of cattle, also known as lobola. Communal farmers typically sell animals just before Christmas to provide for the festive season and the start of a new school year for the children, and in April before Easter. The best time to sell is actually in October, as the newly born calves are then at an optimal age to be sent to the feedlots.

When, typically, do they sell livestock? What months?

> "Swazi's tend to keep their animals for their entire lifetime."
>
> \- Participant 6

Except for certain individuals who sell for profit, the cattle are sold mainly to support families during times of family event, for example cattle are slaughtered when there is a funeral, and other times when they need money for school fees and clothing. The most common months are December and April.

In terms of grazing areas, are the areas badly over-grazed?

The communal grazing areas are in a poor condition, says participant 6, with over-grazing being a major problem. It is difficult to prevent over-grazing, as all animals walk freely, and there is no way of keeping certain animals in certain areas.

Is SLITS beneficial to the veterinary assistants?

> "We lack resources. We are sharing one computer in four offices."
>
> \- Participant 5

SLITS simplifies data capturing, and ensures accuracy. While the manual system is still being used concurrently with SLITS, the work load is in fact double, as everything is captured twice, but once the manual system has been phased out, it will become faster and easier. There are, however, major obstacles with the necessary infrastructure and IT equipment, where large numbers of veterinary assistants use the same computer, causing backlogs on Fridays when the data needs to be captured at the regional offices. More hardware and a faster internet connection are required to make the use of SLITS less frustrating. The funding provided by the European Union for the development of SLITS did not include a budget for buying the IT equipment, and the current equipment is old. The manual capturing of data in the register at the dip tank is also not ideal, as it can lead to mistakes in the transferring of the data. A better system, including RFID readers and more robust equipment at the dip tanks will optimise the process. Figure 50 are photographs taken at a regional veterinary office, showing the use of SLITS as well as the outdated IT equipment.

Figure 50. Photographs taken at a regional veterinary office to illustrate their use of SLITS on their computers on a typical Friday

Do you benefit from using SLITS?

Participant 5 explains that the veterinary assistants are of the opinion that SLITS is not difficult to use. The benefits outweigh the initial teething problems, and make it easier to access the relevant information per animal. It does help to retrieve the electronic information at any given time and it makes the process much easier when dealing with animal movements, owners, the tagging of the animals and managing dip tank areas.

Did you receive any official training before using SLITS? Please elaborate.

Each regional office sent a delegate to attend the training in October and November 2012, says participant 6, and from there the veterinary assistants learn from one another. The SLITS system is intuitive and has the same look and feel as any Windows-based application. A number of screenshots from the application are illustrated in Figures 51, 52, 53 and 54.

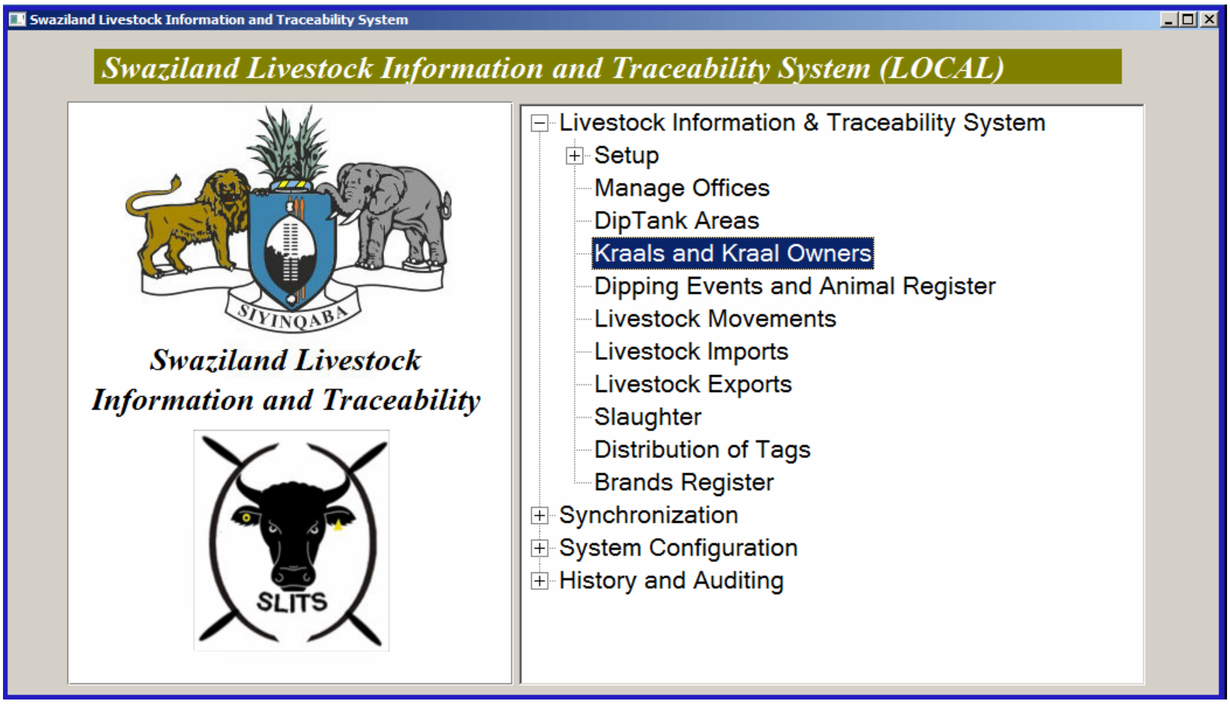


Figure 51. The main menu of SLITS

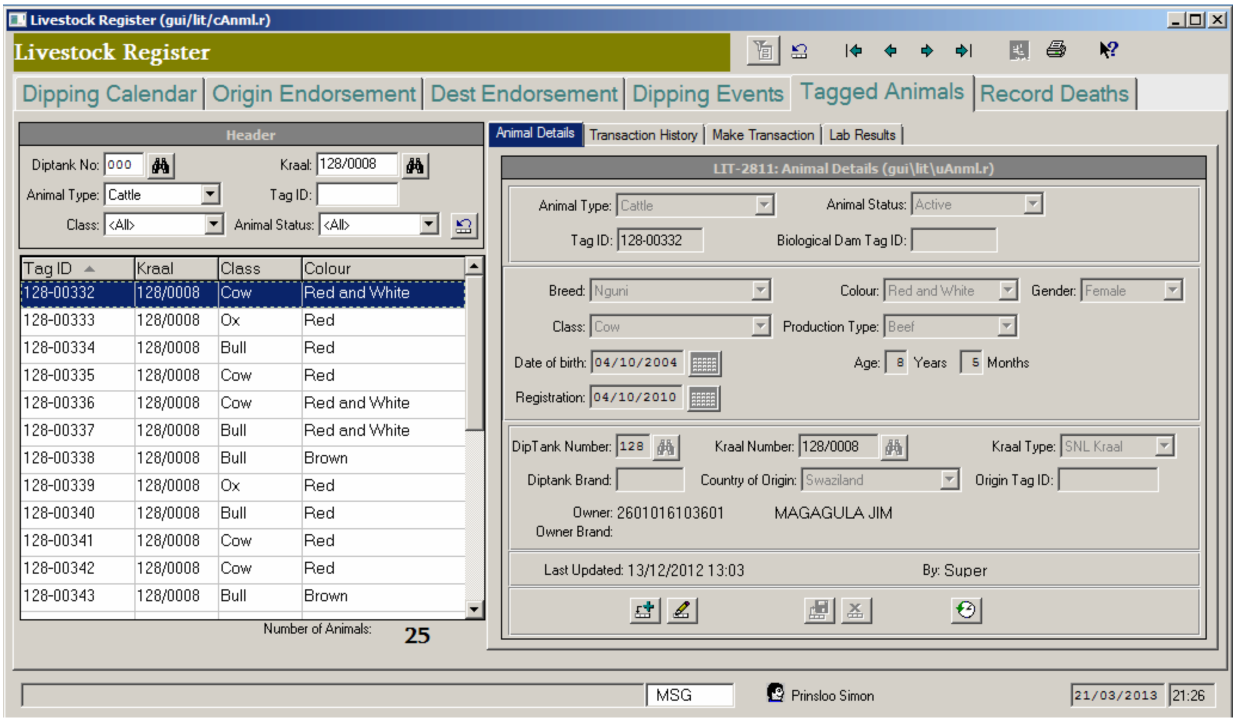


Figure 52. Animal details in the SLITS livestock register

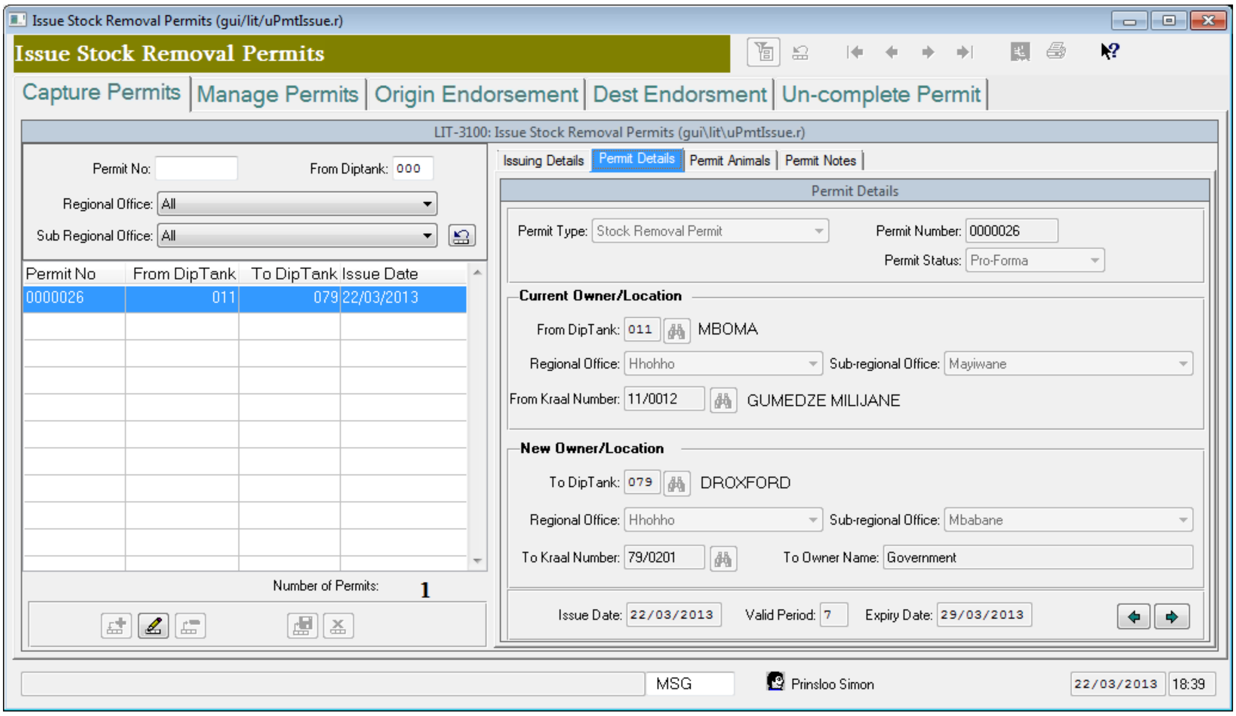


Figure 53. Origin and destination details of the stock removal permit

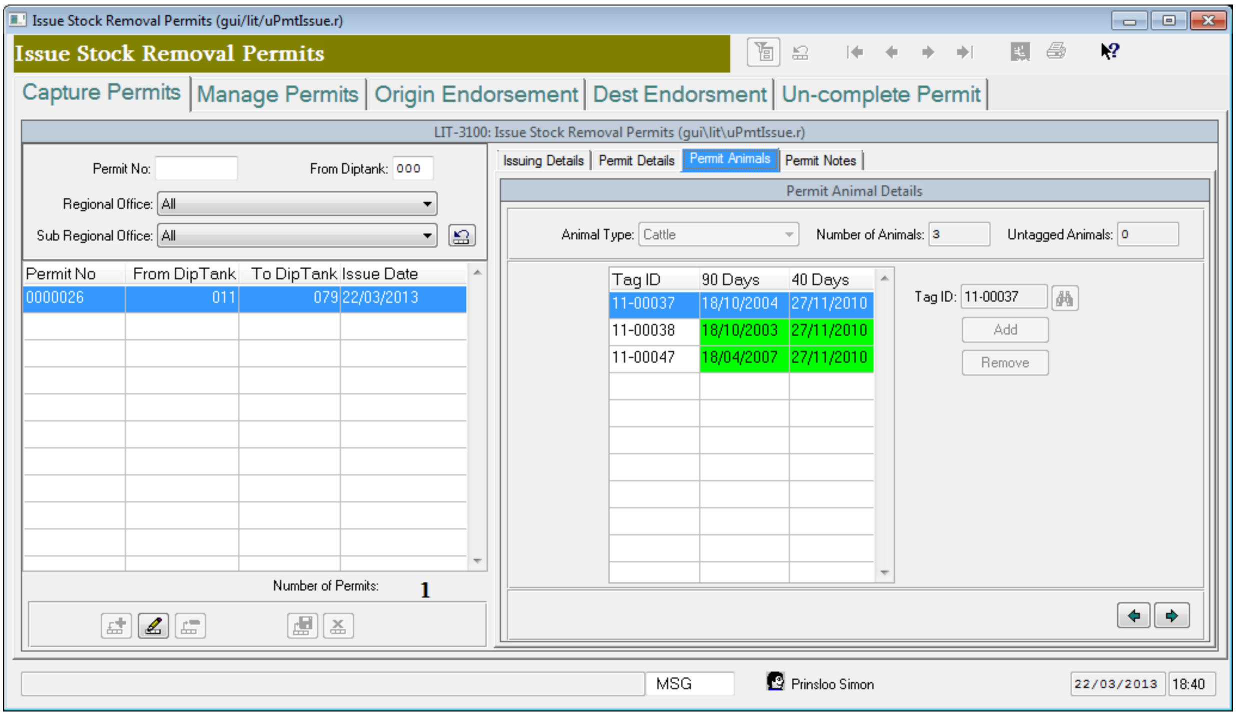


Figure 54. The list of animals on the stock removal permit

Interview 4 and 5 contained the same questions, but were asked to two different role-players, one being the project manager of SLITS, and the other working at the Swazi Meat Industries. They were asked to answer questions relating to SLITS once it became fully operational. Both interviews took place on 7 August 2014.

Interview 4 and 5

I believe SLITS became compulsory for all farmers to use at the beginning of 2014 and now the number of cattle bought for slaughter has decreased significantly compared to last year. Why do you think this is the case?

The implementation stage was a little problematic for the Swazi farmers. There were problems with obtaining the correct permits, getting all the animals tagged, and getting the animals on the electronic register to enable them to be sent to the export abattoir. Animals are often sent to feedlots, but without the necessary permits; the farmers then have to feed the animals themselves. The decrease in animals sent to feedlots results in fewer animals ready for export.

> "I think it is because of the implementation stage, it is a matter of getting through the implementation."
>
> - Participant 7

What were some of the major obstacles experienced?

> "I know the feedlot industry has been suffering from high beef prices but their numbers started falling down about a year ago. So that effect is in last year's figures as well as in this year's figures."
>
> - Participant 7

Participant 7 elaborated on the fact that SMI buy the animals from feedlots and farmers, without a specific set price, but at a higher price than what the farmers are paid at the local abattoirs. SMI buy the meat when it becomes available, generally in large quantities in January and April, due to high availability, but when communal farmers want to sell their older animals, the SMI will not buy the animals to export their meat. Traceability is key, and from the beginning of 2014 the SMI could not buy any animal unless it had been captured on SLITS, and this resulted in fewer animals than in previous years becoming available for the export market.

> "Because an animal which was registered at a dip tank you find that at the time when we migrated to the new system it has moved two, three, ten dip tanks down the line. So trying to reconcile what is physically on the ground and what is in the system seemed to be a bit of a struggle."
>
> - Participant 8

Participant 8, being in the project office, faced completely different obstacles, and encountered issues of how to capture animal movements effectively, work around insufficient infrastructure, how to keep everyone involved motivated and manage slow network technologies. The issues were based on the daily operations of SLITS.

What other factors played a role in the numbers being significantly lower compared to 2013?

> "The major impact on the low numbers is the implementation of SLITS which we think is just something we are going to experience this year but not in the future."
>
> - Participant 7

SMI are not too concerned about the drop in the number of animals slaughtered in 2014 compared to previous years. The effect will unfortunately also be felt in the drop of number of animals sent to feedlots, resulting in less meat available for export. The problem is not a long-term one, and measures have been put in place to ensure that SLITS is rolled-out widely enough to ear-tag all new-born calves, and to send the animals to the SMI and feedlots in future.

Participant 8 had queries, mainly regarding getting all the animals on the SLITS database, and listed issues such as slow broadband, lack of funds to ensure that all the veterinary assistants were trained and lack of the necessary hardware infrastructure. She was not concerned that the problem was a long-term one, but rather about how to ensure accurate transfer of information of cattle from the dip tanks to the SLITS database, and about enabling all communal farmers to be able to register their cattle. The teething problems experienced were addressed and she believed that the problem would not persist.

How many animals that were bought for slaughter came from communal farmers compared to those from commercial farmers?

> "I would say 75 percent of our animals were born on communal farms."
>
> - Participant 7

Only participant 7 was able to respond to this question, and elaborated on why it is so difficult to answer. Commercial farmers often buy cattle from communal farmers, then send them to feedlots that then record the animals as commercially-owned, selling them to the SMI. He felt that the figures of communal farmers' animals compared to commercial farmers are inaccurate, but that the majority of meat exported came from animals who originated from communal farmers.

Swaziland has a binding trade agreement to deliver 500 tons of beef to Norway, with less formal arrangements with other European countries, and no restrictions to export to South Africa. All meat is deboned before it is labelled and exported to Europe.

> "Certainly the European market is a big incentive for the whole industry because there is market for the poorer thinner animals too. Because the European market is so big it takes meat for every purpose. So if you got an animal who is old and not as fat as you want, there will be a market somewhere, which we can sell to. So it offers something extra to the farmer here, not that we want to support them to produce a low grade, we want to encourage them to produce a higher grade."
>
> - Participant 7

What happens if a farmer's animals have not yet been captured on the database? How do you assist the farmer?

Participant 7 states that SMI encourage all farmers to get registered on SLITS as early as possible, and assist in arrangements to help remote communal farmers in reaching the veterinary offices where the veterinary assistants can capture all their details.

Participant 8 feel that for the project office it is tricky when a farmer does not yet have a pin, or does not know his/her pin. The pin is required to register animals under the farmer's name or to remove animals that should no longer be in the farmer's possession. In the past the veterinary assistant could manually create a pin, and capture the details of the animals, but it can create a backlog if it needs to be done electronically. It is a source of frustration for the farmers. The veterinary assistants help as much as possible in this regard.

Why do you think SLITS is used optimally / not used optimally?

Participant 7 pointed out that in other countries the burden of maintaining all the information is moved to the people using the traceability system, compared to how it is currently centralised in Swaziland, and he associates it with an Internet banking profile where the bank does the checks and balances, but the customer manages his/her own finances.

> "It is a task and it is a big responsibility for the Ministry, so I think in the long term I would hope that it can change around so like we are slaughtering cattle, we capture those slaughters on the database rather than us giving the information to someone like a veterinary assistant, who is busy anyway, who then has to do the capturing themselves."
>
> - Participant 7

Participant 8 supports the use of SLITS as farmers are motivated to use the system to its full potential. They believe they simply do not have a choice but to make it work. The system is recognised for all its benefits, and the Swaziland parliament is committed to assisting SLITS to move forward and implementing it successfully countrywide.

> "Our overall attitude is actually very positive so far."
>
> - Participant 8

What do you think can be improved in terms of the SLITS usage?

Participant 8 is of the opinion that the biggest area of improvement is giving the correct access to information to the correct farmer. If the farmer's animals need to be added to the SLITS database, it takes more time than before, leading to frustration. To issue a movement permit can take ten minutes to process on SLITS, but one minute to write by hand. As the system reaches maturity, the areas of concern will have been addressed and improved where possible. The future of SLITS also lies in creating a mobile interface where all information at the dip tanks is directly entered, without having to re-capture the manual entries to the database.

> "It is for the best if we take it to mobile technology to make things easier."
>
> - Participant 8

In your opinion, will SLITS, in the long run, promote the livestock traceability in such a way that it will be easy for all farmers to be able to export their meat?

SLITS is a good system, according to participant 7, ensuring that cattle theft is contained, along with a list of other benefits, such as better disease control, and the built-in controls of SLITS. He raises the concern that the system is very advanced for the country it is being used in.

> "It is just quite a developed system for a developing country and it is just a challenge to get the grips of it."
>
> - Participant 7

Once all the animals have been ear-tagged, participant 8 feels that the system will work fully and effectively.

> "Yes, I think if we can implement it fully."
>
> - Participant 8

Is there anything else that you would like to add to ensure that I have the necessary information regarding the use of SLITS?

> "The only things is because it is very challenging the fact that everything has to be computerised, the fact that the technology is involved, but there is a certain logic there that if we can get over this pain now."
>
> - Participant 7

Participant 8 added that the project is now being incorporated in a much larger e-government project, and that the necessary infrastructure will follow to capture the information only electronically. Officials are talking to overseas investors about the potential added functionality, although it will still take a number of years to realise.

7.3.3. Summarising the results from the interviews

The five interviews form part of the behavioural precursors and changes in behaviours as seen by role-players in the implementation of SLITS. The interviews express views from several different people involved in the process, from the initial comments of government officials, to a communal farmer managing a commercial farm, to how the veterinary assistants feel about the use and benefits of the system, finally discussing issues that the Meat Industries of Swaziland faced when traceability became mandatory and a drop in export numbers were felt, but with the project manager of SLITS, a member of government, who remains positive and continues to drive traceability to better the lives of the Swazi people. The interviews are subjective, with people talking very much about how they feel, what they experience and what changes they can tangibly see as SLITS was rolled-out country-wide. The Swazis took full ownership of the system and are proud to be an international exporter of meat products.

7.3.4. An analysis of the results obtained from the questionnaires

During October 2015 questionnaires were distributed to veterinary assistants from various rural offices where they gather on Fridays to capture the dip tank information. The aim was to receive 50 completed questionnaires; however, only 47 were received. Of the 47 received, two had to be disregarded as they were incomplete, the sample sizes shown in table 10.

	Target	**Actual/Returned**	**Variance**
Sample Size	**50**	**47**	**3**
Questionnaires distributed by the SLITS project team	25	23	2
Questionnaires distributed by the researcher	25	24	1

Table 10. Summary of the sample size of the SLITS questionnaire

The sample size is regarded as sufficient, as seven different regions in Swaziland are represented. The questions were explained to the participants, as well as guidelines on how to complete the questionnaires. No participant was influenced when answering a question. The participants received no incentive to complete the questionnaire, but agreed to do so on a voluntary basis. The questionnaire was split into four sections:

Section A: Biographical information of the veterinary assistant

Section B: Information on dip tank area

Section C: Information on SLITS

Section D: The veterinary assistants' interactions with SLITS

The questionnaire was designed not only to gather data on the veterinary assistants and their interaction with SLITS, but also to gain a better understanding of the role of SLITS on communal farmers. The questionnaire was written in simple English to cater for second or third language English speakers, and it took no more than fifteen minutes to complete it. It was four pages long, and the first page provided information on the study, as well as asked the participants' signatures for consent. The questionnaire is available in Appendix 3.

Results from the analysis

- Section A: Biographical information of the veterinary assistants

The first section of the questionnaire set out to find out more about the veterinary assistants who completed the questionnaires. Figure 55 gives the percentages of the veterinary assistants completing the questionnaire. Of the 45 participants, 33 were male and 12 female. It is very often the perception that only males are veterinary assistants, but they are the majority, as females find employment more difficult because of the Swazi culture, where the males are seen as superior in the more traditional sense.

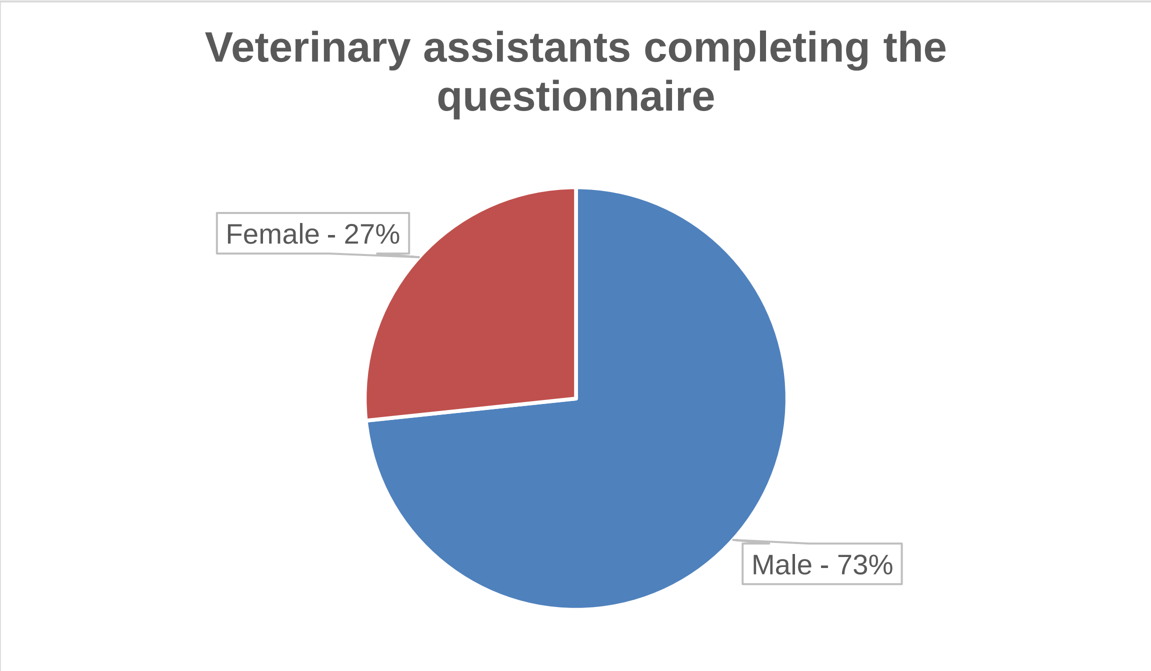


Figure 55. Veterinary assistants completing the questionnaire

The veterinary assistants were also asked to provide their age, and the ages were then grouped into four categories: 35 years and younger, from 36 years old to 45 years, 46 years and older, and finally everyone that did not disclose his/her age. More than 40% of the overall participants were between 36 and 45, and more than 30% were 35 and younger. The percentages per age group is relevant to show as the participants were asked to give their opinion on certain topics, and the age groups were then representative of the outcomes, with every age group totalling 100%. The main aim was to determine if there were very different opinions on certain topics per age group. Figure 56 shows the different age groups.

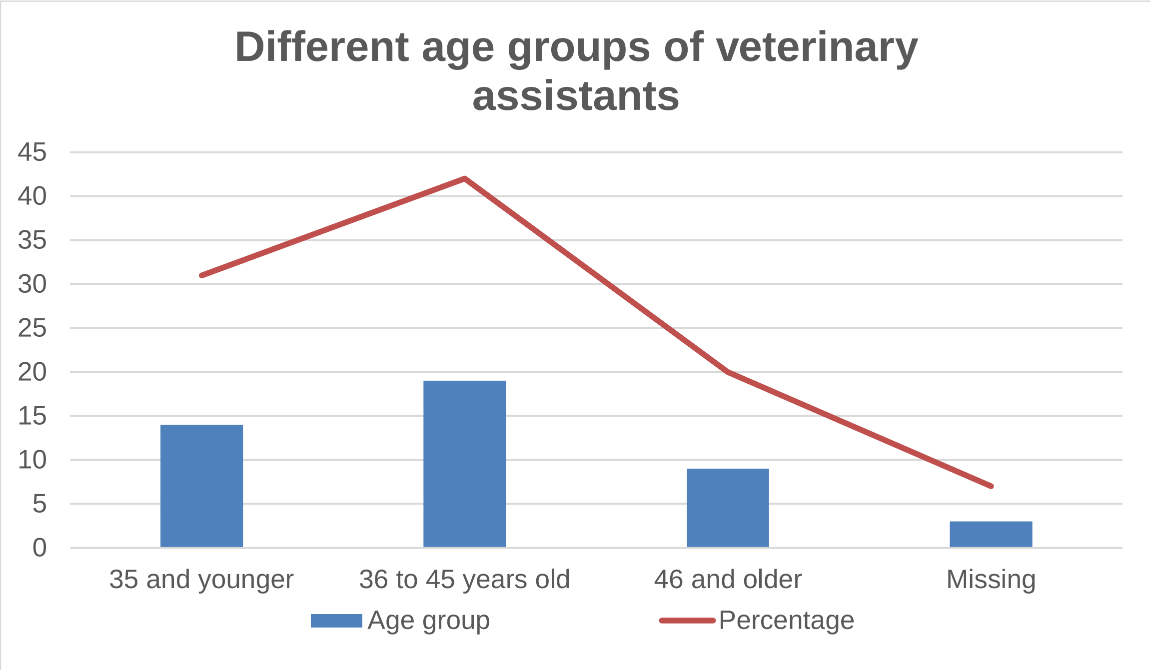


Figure 56. Different age groups of veterinary assistants

The veterinary assistants were asked to state the number of years that they had been in their current position, and again they were grouped into four categories: working for 5 years or less as a veterinary assistant, working for 6 up to 10 years, working from 11 up to 15 years and more than 15 years. Forty per cent worked as a veterinary assistant in the 6 to 10 year range, 24% less than 5 years, and 20% more than 15 years. Only 16% worked as a veterinary assistant between 11 and 15 years. The period worked as a veterinary assistant was used to determine if there were certain areas where age groups played a role in how the questions were answered, and is shown in figure 57.

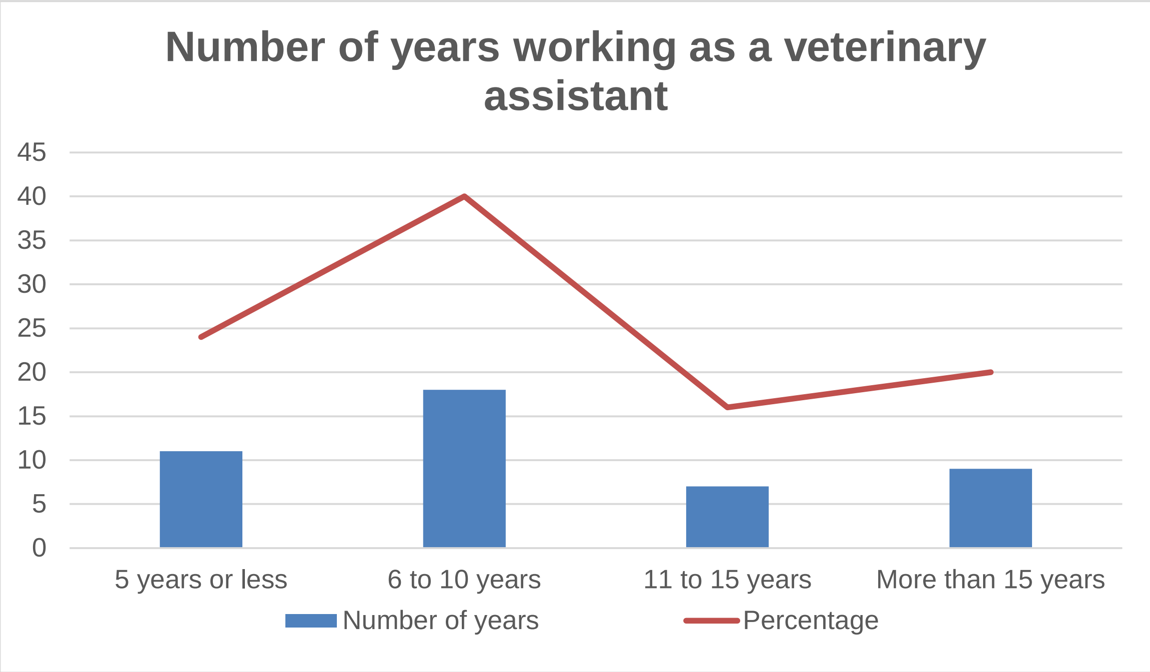


Figure 57. Number of years working as a veterinary assistant

- Section B: Information on dip tank area

The veterinary assistants who participated in the study came from seven different regions: Siteki, Malkerns, Luve, Big-Bend, Mankayane, Manzini and Siphofaneni. The majority of the veterinary assistants, 15 in total, were situated in and around Manzini, seen in figure 58.

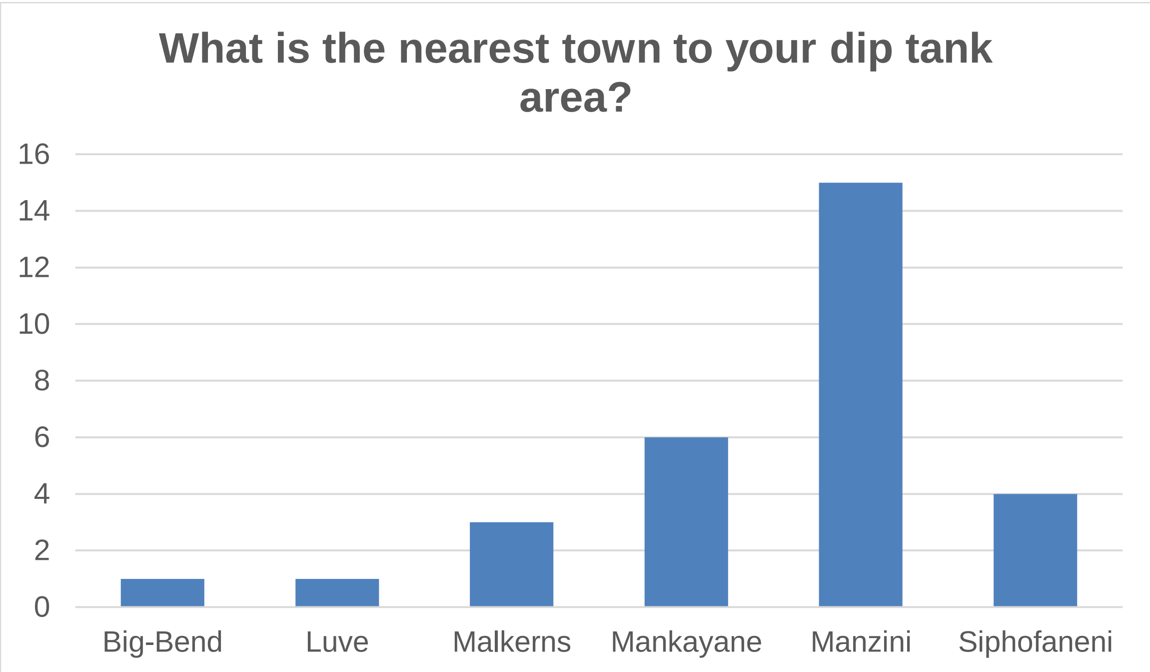


Figure 58. The nearest town to the veterinary assistants' dip tank area

The veterinary assistants were then asked to give an indication of the number of farmers in their dip tank areas that were male or female. One can easily come to the wrong conclusion when witnessing a dipping event, where there are only males present, and one thinks it is solely male farmers; however, it was found that 28% of the total number of farmers were female. The females simply did not attend the dipping events, and instead sent a male relative to the dip tank, as is the Swazi custom, shown in figure 59.

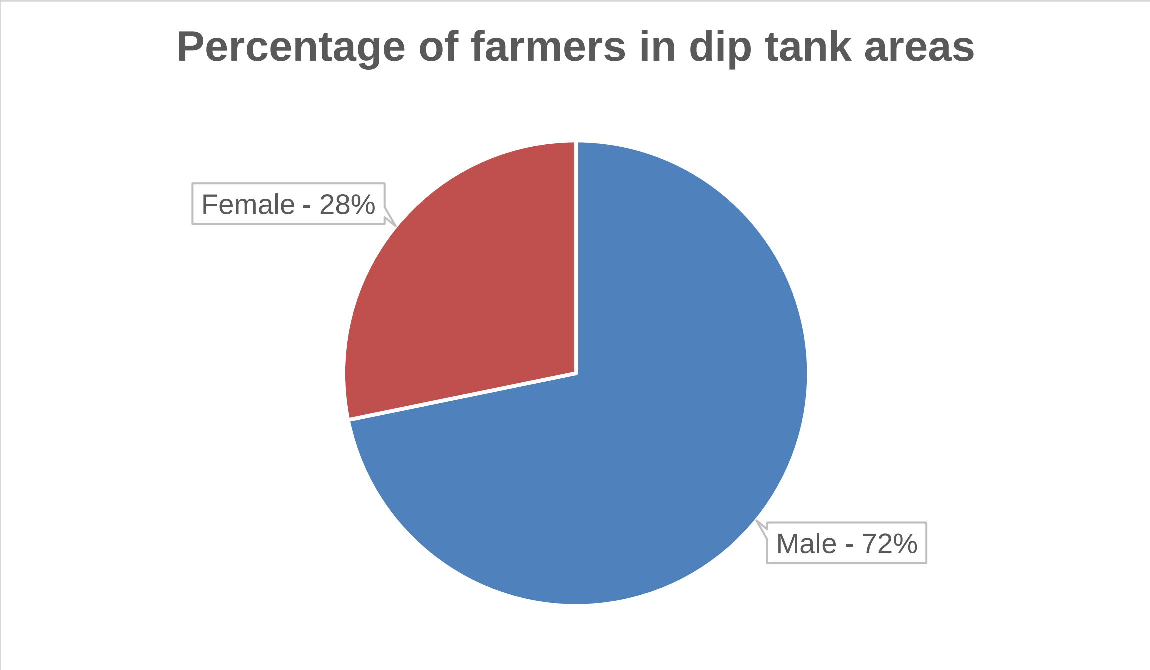


Figure 59. The average number of farmers in dip tank areas

Figure 60 is a distribution of the number of male and female farmers per dipping region, and shows that the male / female ratio is very similar in all the dip tank areas. Manzini, the best represented in the graph, with 15 responses from the veterinary assistants, is not much different from the other regions. The mean, or average, is 50% in all cases, clearly indicating that male farmers dominate the ownership of cattle in every region. The mode indicates the highest percentages, and is in all cases again indicative of male dominance. The standard deviation shows the difference in male / female ownership per region, with the smallest difference in Siphofaneni at 10%, and the highest in Malkerns and Siteki.

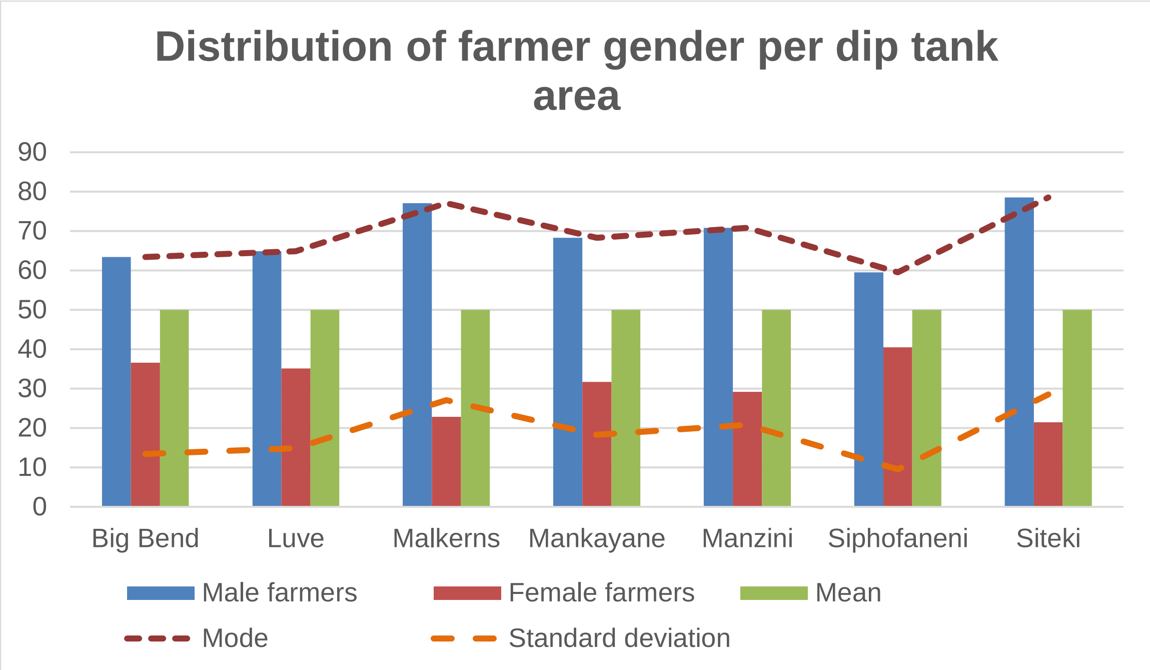


Figure 60. Distribution of farmer gender per dip tank area

The veterinary assistants were further asked to distinguish between the different types of farming practised by the farmers in their dip tank areas. This question made it easy to illustrate the importance of keeping livestock, and also to show that the farmers can indeed benefit from a traceability system. A total of 70% of all farmers grow crops and keep livestock, as can be expected from mainly subsistence farming. Twenty-eight per cent of the farmers kept only livestock, and 2% specialised in growing crops, shown in figure 61.

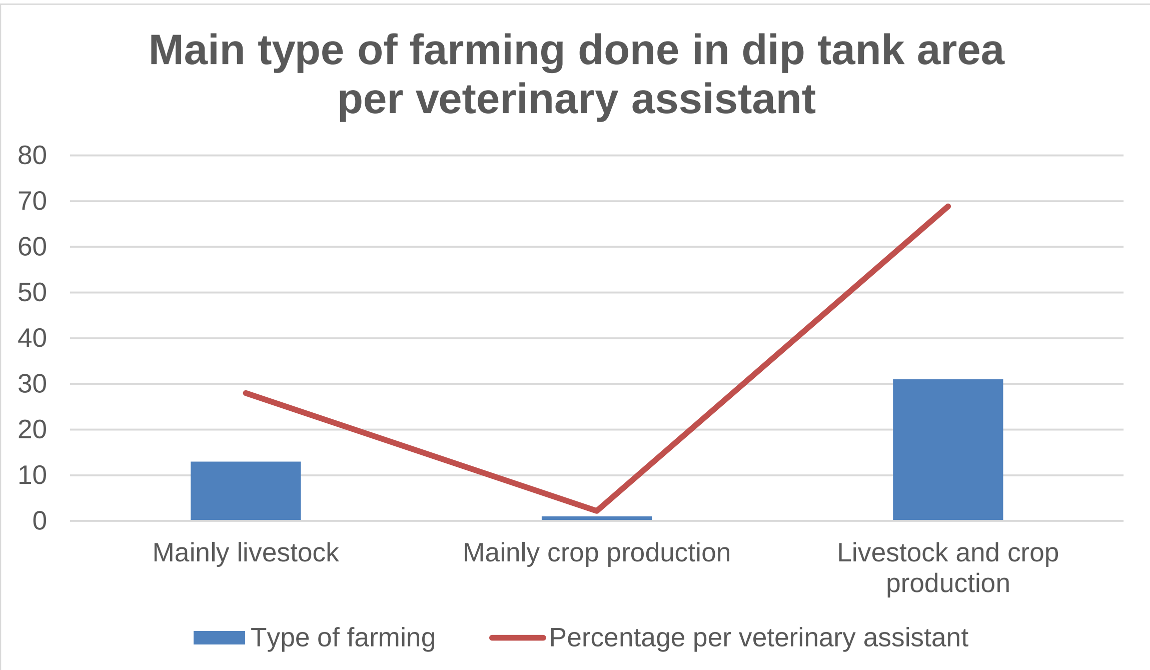


Figure 61. Main type of farming done in dip tank area per veterinary assistant

To determine whether the farmers that were reached during dipping events were mostly communal farmers, making the case that it is communal farmers that are set to gain the most from the implementation of SLITS, the veterinary assistants classified their dip tank areas according to the number of communal vs commercial farmers. Only 12% of the total farming community were commercial farmers, with the majority living on the SNL land, land that was under the control of King Mswati III, shown in figure 62.

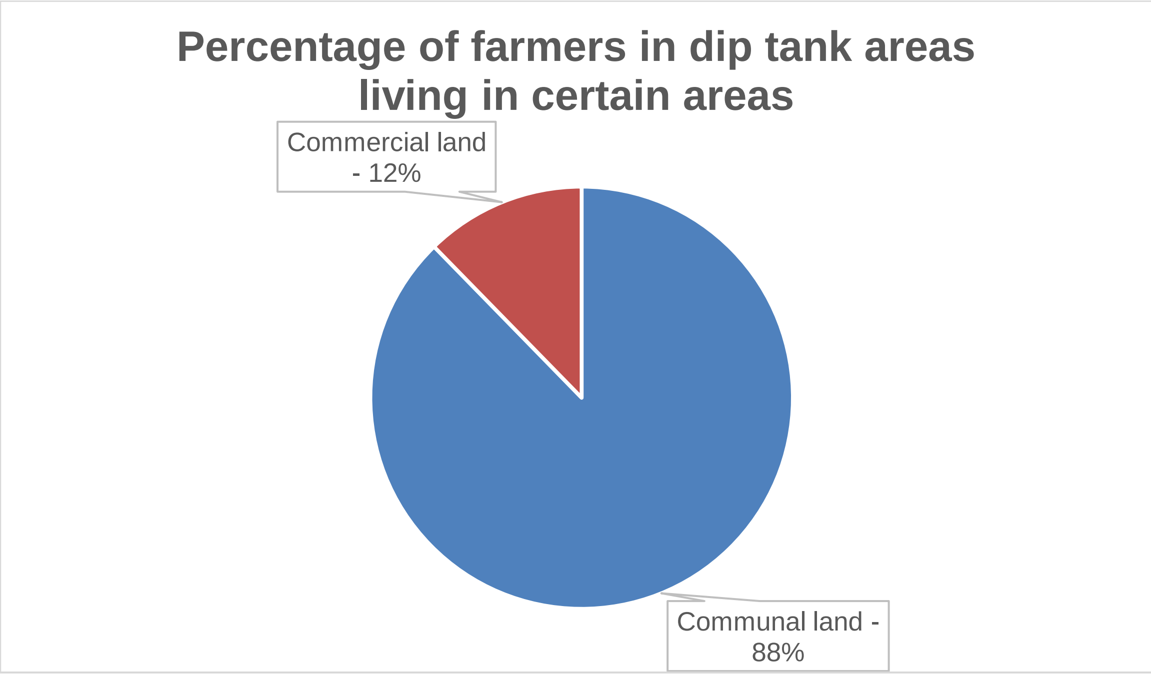


Figure 62. Percentage of farmers in dip tank areas living in certain areas

Swaziland is typically a wet country, and the main source of disease is ticks. In order to control the outbreak of tick-borne diseases effectively, cattle are dipped often, once a week in summer, once every two weeks in winter. In 5% of the cases the cattle are seen by the veterinary assistants more than once a week, and this is the exception to the rule. Summer is the longest season of the year, with the cold winter temperatures lasting between 3 and 5 months per annum, and more than 50% of all the veterinary assistants indicated that they visited the dip tanks areas once a week. The veterinary assistants could be used in this study as key informants, as they know every person coming to the dip tank weekly, ask about the family and are trusted in their communities where they capture the dipping information. Figure 63 illustrates the number of times the veterinary assistants visit dip tank areas.

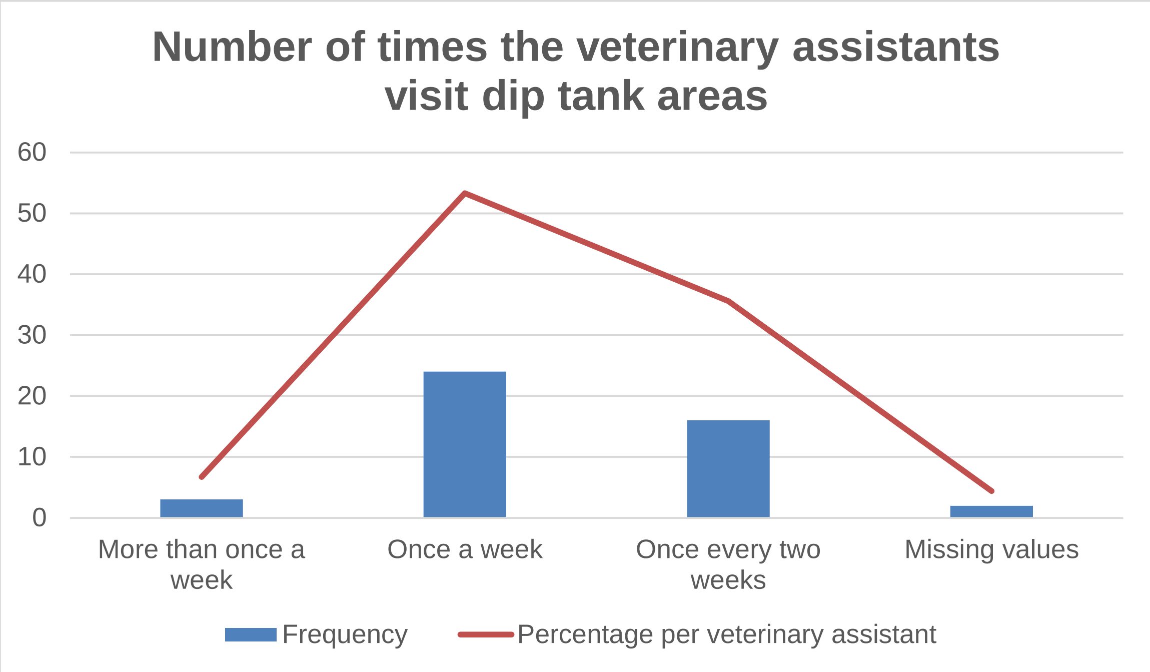


Figure 63. Number of times the veterinary assistants visit dip tank areas

- Section C: Information on SLITS

Section C takes a closer look at specific criteria to measure whether SLITS does have an impact on the lives of communal farmers, as is reflected by the veterinary assistants' perceptions acting as key informants. The veterinary assistants were asked a number of questions, and their responses were classified into three main categories: gender; age groups, and years working as a veterinary assistant. This enabled one to distinguish clearly whether there were differences of opinion between the different classification groups. The first question was aimed at determining whether all cattle are ear-tagged, because without an ear-tag an animal is not yet on the SLITS database. It was surprising to see that only 11% of all the dip tank areas had a 100% ear-tag percentage. The other 89% showed that although most animals were ear-tagged, not all of them were tagged, leaving one to ask the question: what percentage of animals had not yet been ear-tagged? Of the 45 questionnaires completed, only 39 indicated a percentage of animals not 100% ear-tagged in their dip tank areas. The overall average of untagged animals was is 9.15%, with the median, or mid-point at 3%, and in some instances the minimum percentage at 1%. One veterinary assistant indicated that 85% of the cattle in that dip tank area had not yet been ear-tagged, see figure 64.

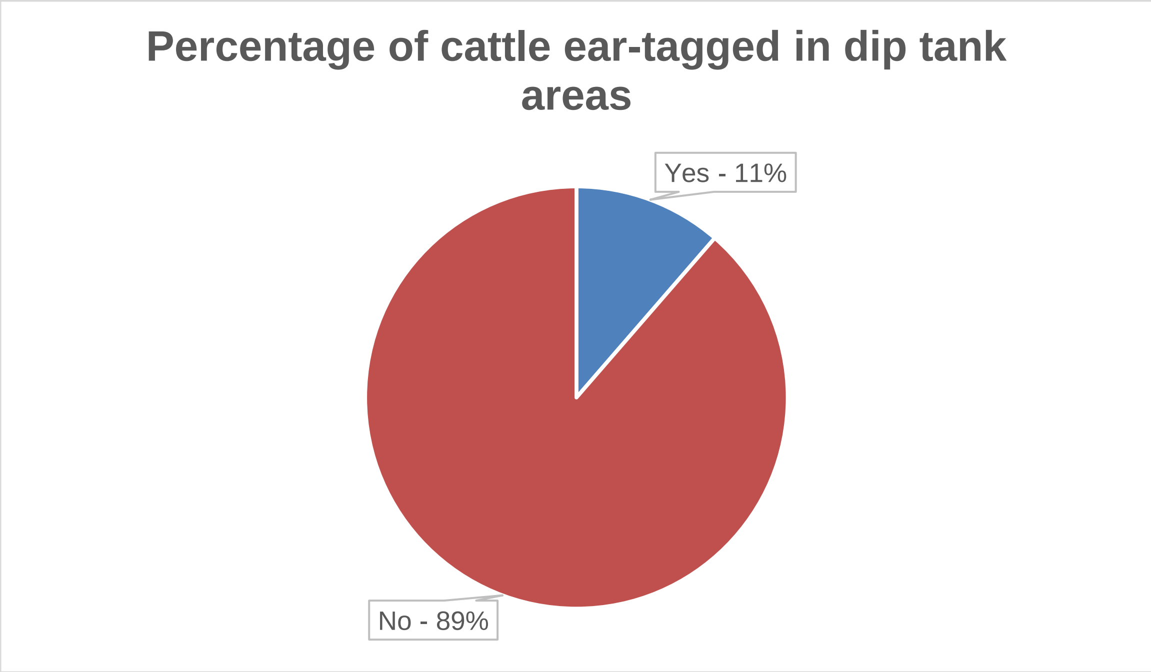


Figure 64. Percentage of cattle ear-tagged in dip tank areas

The veterinary assistants answered a series of questions relating to their experiences with SLITS, and their responses were then compared in terms of gender, age group and experience as a veterinary assistant and illustrated as graphs derived from cross-tabulations calculated with SPSS.

The actual output from SPSS is shown in Appendix 5, but to illustrate how the data was interpreted, the first example gives a breakdown of the output, while the rest of the calculations are illustrated as graphs, which is easier to interpret. The following three statements were answered by either choosing “Yes”, “No” or “Uncertain”. The traditional Likert scale was not used as it was a concern of the researcher that the veterinary assistants would find it more difficult to complete:

1. The general health of the communal farmer's herd has improved since SLITS was introduced, and it is shown as a percentage, ensuring that all the different criteria carry an equal weight, and is not shown as a number total, which will lead to a skewed result.
2. The incidence of highly contagious diseases, such as tick-borne diseases, has declined since SLITS was introduced, again shown as a percentage.
3. Since SLITS was introduced, communal farmers receive a more commercial market-related price for cattle sold, also as a percentage.

The first three graphs show the responses in terms of gender. In figure 65, 75% of all females expressed the opinion that the overall health of the communal farmer’s herd had improved, compared to the males at 59.4%, with 28.1% of males disagreeing. The percentage of uncertain responses was 16.7% for females and 12.5% for males. From this graph one can derive that more than 63.6% in total felt that the overall health had indeed improved.

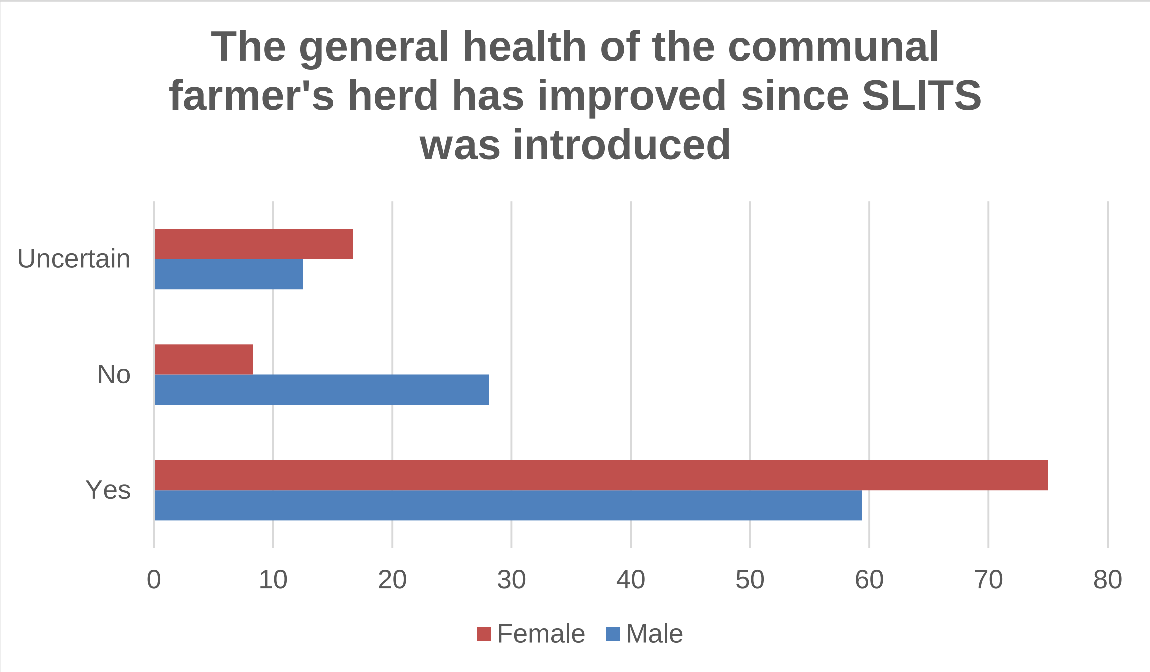


Figure 65. The general health of communal farmer's herd had improved since SLITS was introduced

Gender * Cattle_Health_Improved Crosstabulation

			Cattle_Health_Improved 1	2	3	Total
Gender	1	Count	19	9	4	32
		Expected Count	20.4	7.3	4.4	32.0
		% within Gender	59.4%	28.1%	12.5%	100.0%
		% within Cattle_Health_Improved	67.9%	90.0%	66.7%	72.7%
		% of Total	43.2%	20.5%	9.1%	72.7%
		Standardized Residual	-.3	.6	-.2	
	2	Count	9	1	2	12
		Expected Count	7.6	2.7	1.6	12.0
		% within Gender	75.0%	8.3%	16.7%	100.0%
		% within Cattle_Health_Improved	32.1%	10.0%	33.3%	27.3%
		% of Total	20.5%	2.3%	4.5%	27.3%
		Standardized Residual	.5	-1.0	.3	
Total		Count	28	10	6	44
		Expected Count	28.0	10.0	6.0	44.0
		% within Gender	63.6%	22.7%	13.6%	100.0%
		% within Cattle_Health_Improved	100.0%	100.0%	100.0%	100.0%
		% of Total	63.6%	22.7%	13.6%	100.0%

Figure 66. Cross-tabulation of gender and general health of animals output in SPSS

In figure 66, the Males are expressed as Gender 1 and Females as Gender 2. The general health of the communal farmer's herd has improved since SLITS was introduced is expressed as “yes” represented by 1, “No” represented by 2 and “Uncertain” represented by 3.

The same cross-tabulation calculations were done throughout the study and visually represented as graphs.

It is important to note that the Chi-square test that was conducted are measured against the following two hypotheses:

- H_0: There does not exist an association between gender and the improvement of the general health of the communal farmer’s herd
- H_1: There is a significant association.

One would examine the result of the Pearson Chi-Square test value p, and the significance should be less than 0.05.

In this instance, the following results were obtained in SPSS as shown in figure 67:

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	1.950[a]	2	.377	.427		
Likelihood Ratio	2.259	2	.323	.385		
Fisher's Exact Test	1.944			.427		
Linear-by-Linear Association	.214[b]	1	.643	.819	.420	.169
N of Valid Cases	44					

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is 1.64.

b. The standardized statistic is -.463.

Figure 67. Chi-square test done in SPSS

From the above results, one has to reject the H_1: There is a significant association, as the result of 0.377 is much higher than the 0.05 expected value for significance. Therefore by comparing gender to the improvement of the general health of the communal farmer's herd, the results show that there is no association and in effect, gender is not a good measure or indicator to derive any statistical data in terms of the general health of the farmer's herd. In all of the following graphs illustrating cross-tabulation, it will only be mentioned if the H_1 is accepted or rejected with the resulting value.

In Figure 68, 54.5% of all the male veterinary assistants felt that the incidence of tick-borne diseases had not declined, compared to 33.3% of females who disagreed, saying that it did decline. Twenty-five per cent of the females were uncertain. The reasons for the discrepancies in the answers received can be because of a lack of testing the effectiveness of SLITS, as since it was rolled-out in 2014, it has not yet had to deal with a specific outbreak of a disease that could halt all exports. The Person Chi-square value of 0.318 is higher than 0.05 and the results are not significant to draw statistical conclusions from.

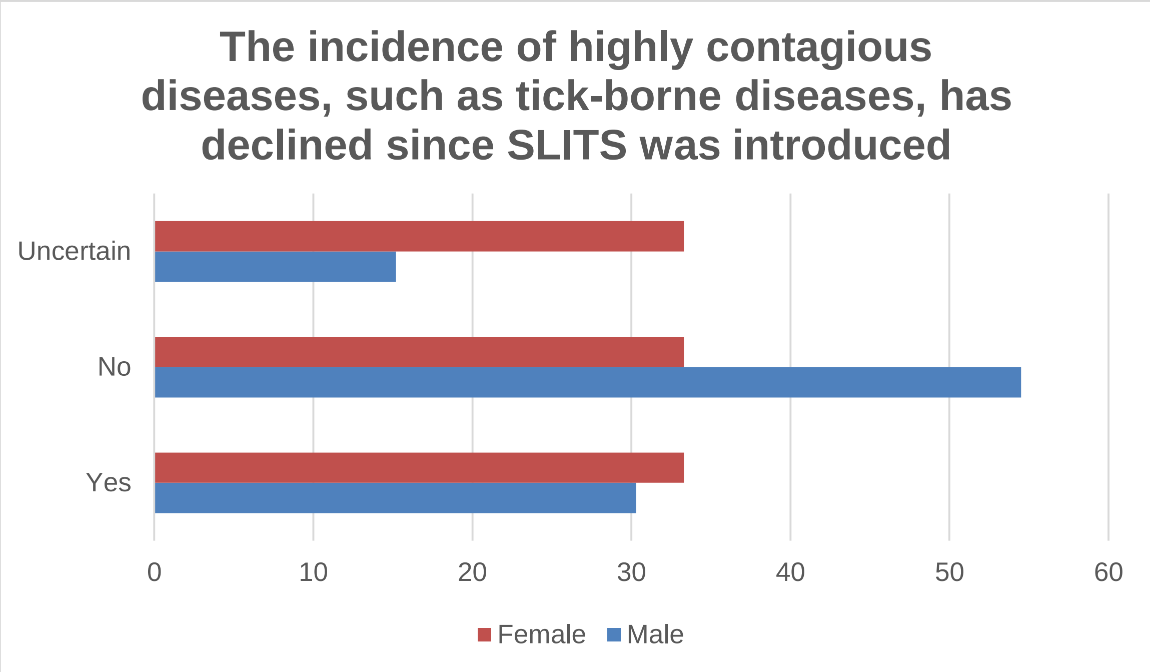


Figure 68. The incidence of highly contagious diseases, such as tick-borne diseases, had declined since SLITS was introduced

In figure 69, both males and females – 46,9% of males and 41,7% of females – felt that communal farmers were able to receive a more market-related price for cattle sold; however, there were still strong indications that it might not be the case if one looks at the percentage of “No” and “Uncertain” responses from the females, totalling 58.3%. In 2014, less cattle were sold and exported because of SLITS becoming a requirement in order to do so and in 2015, there was a severe drought, leading to malnourished animals in the communal areas. If the physical condition of the animal is poor, the farmer will not make a lot of money when selling it. However, there has been a turn-around, as is seen in Figure 46, where 2016 was a very good year for exports to the international markets. The Person Chi-square value of 0.409 is higher than 0.05 and leads to an insignificant association between gender and the decline in the incidence of highly contagious diseases.

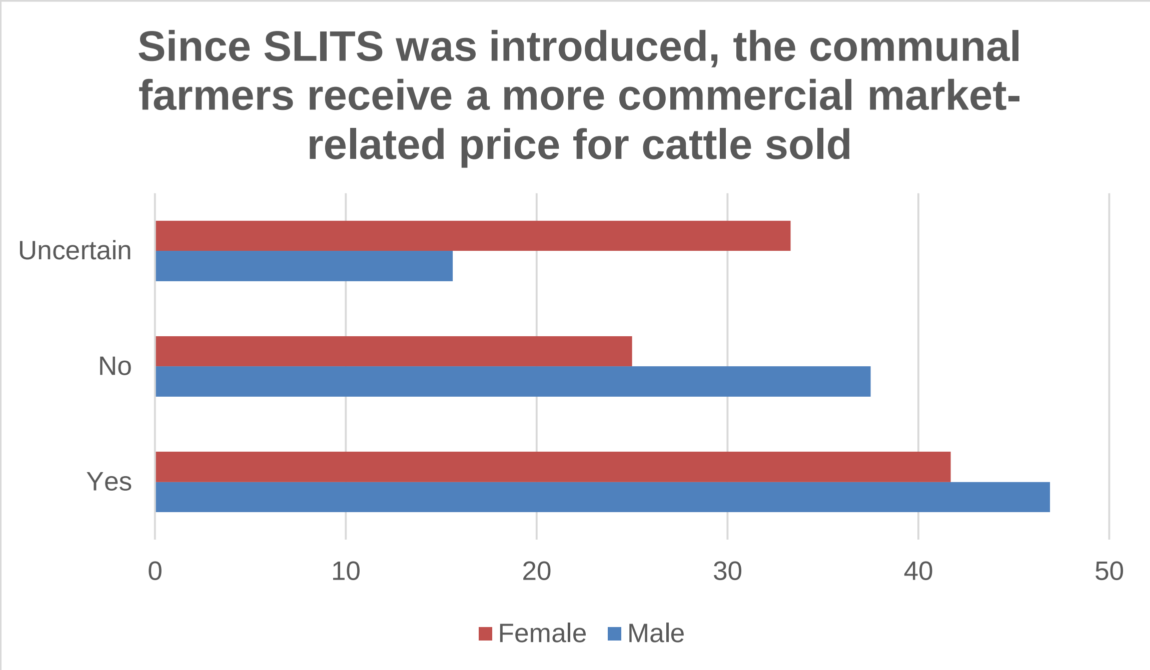


Figure 69. Since SLITS was introduced, the communal farmers had received a more commercial market-related price for cattle sold

The next three graphs show how the responses of the veterinary assistants differed if one sorted them according to their different age groups. In figure 70, the 36 to 45 year group was very positive that the general health had improved, with the youngest age group not being so enthusiastic and one respondent did not disclosure his/her age, however, the resulting value of the Pearson Chi-square test of 0.24 leads to the rejection of the H_1 and shows no significant association between age groups and the improvement of the general health of the communal farmers' herd.

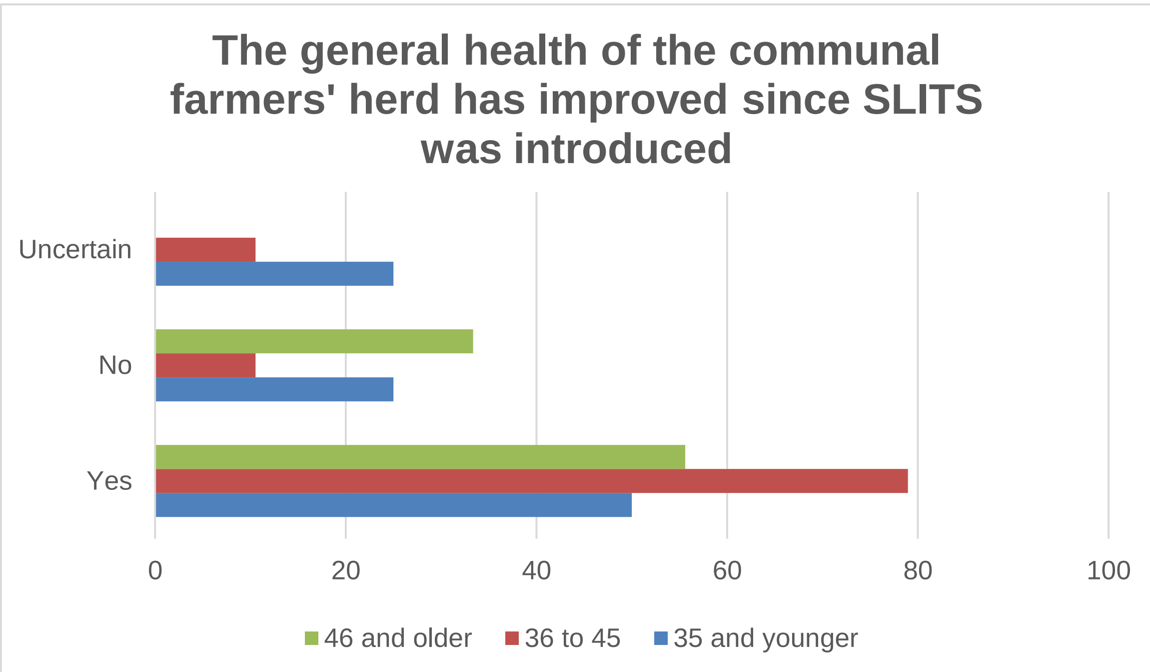


Figure 70. The general health of the communal farmers' herd had improved since SLITS was introduced

The age group 35 at 58.8%, and younger felt strongly that highly contagious diseases were still not in decline with the age group 36 to 45 at 47% years expressing the exact opposite.

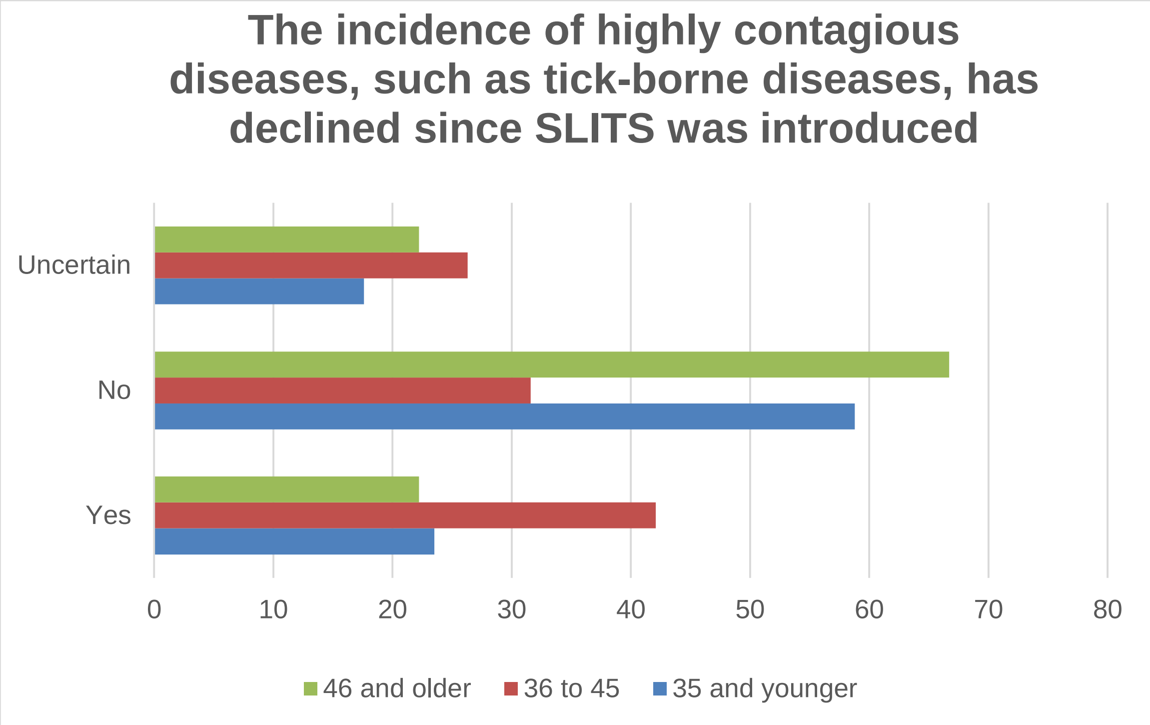


Figure 71. The incidence of highly contagious diseases, such as tick-borne diseases, had declined since SLITS was introduced

The different responses in age groups paint a different picture, as seen in figure 72, compared to gender differences. The 46 years and older group at 44.4% were of the opinion that communal farmers were still not receiving better income from cattle sales; however, the age group 36 to 45 years felt that it was the case, at an overall 55.6%. In both figures 71 and 72, the H_1 are rejected with p-values of 0.394 and 0.704 respectively.

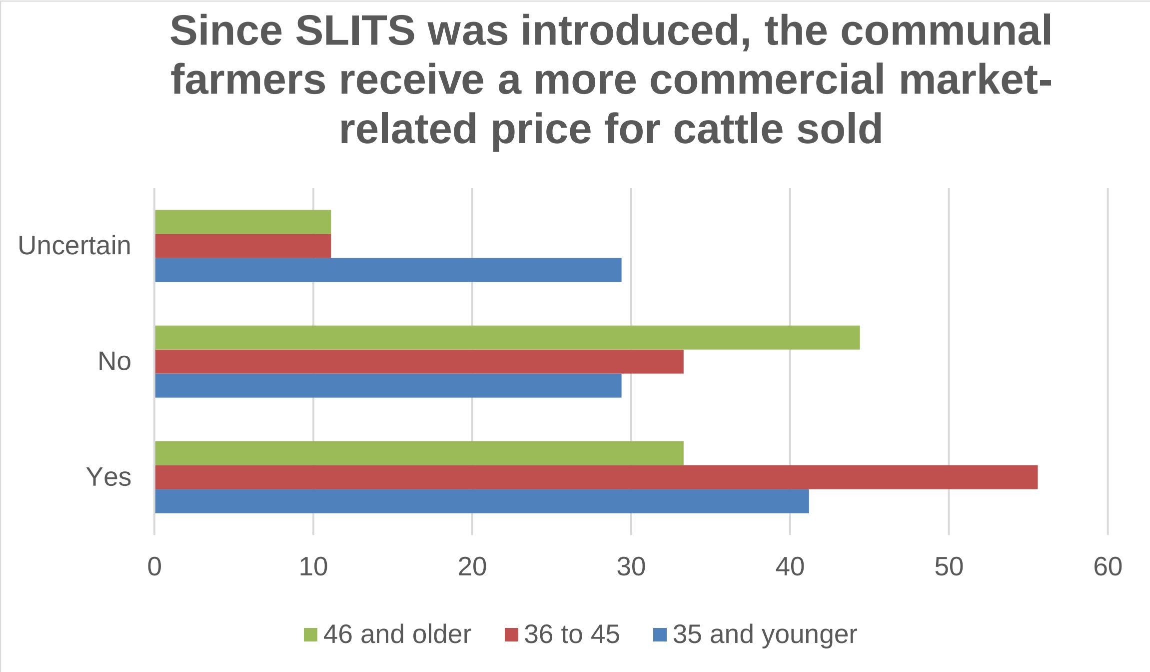


Figure 72. Since SLITS was introduced, the communal farmers had received a more commercial market-related price for cattle sold

The same three questions were answered again, but this time from the perspective of the experienced veterinary assistant. All age groups felt that the health of the cattle had improved, but the veterinary assistants with five years or less experience only felt confident of the fact with a percentage of 50% being a "Yes", compared to 75%, 58.3% and 70% of the other age groups. The difference in opinion in this graph, compared to the two previous similar graphs, is evident.

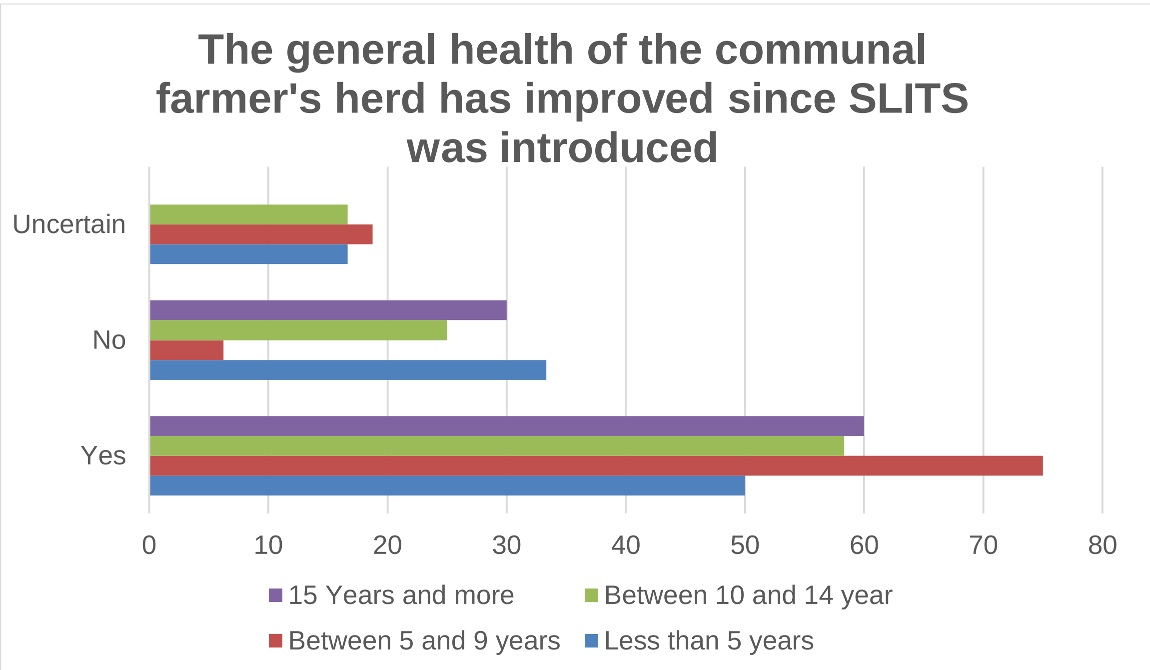


Figure 73. The general health of the communal farmer's herd had improved since SLITS was introduced

In Figure 74 two of the four age groups indicated that tick-borne diseases were not in decline, but the age group between 5 and 9 years seemed uncertain, with the percentage of "Yes" and "No" responses equal at 35.3%.

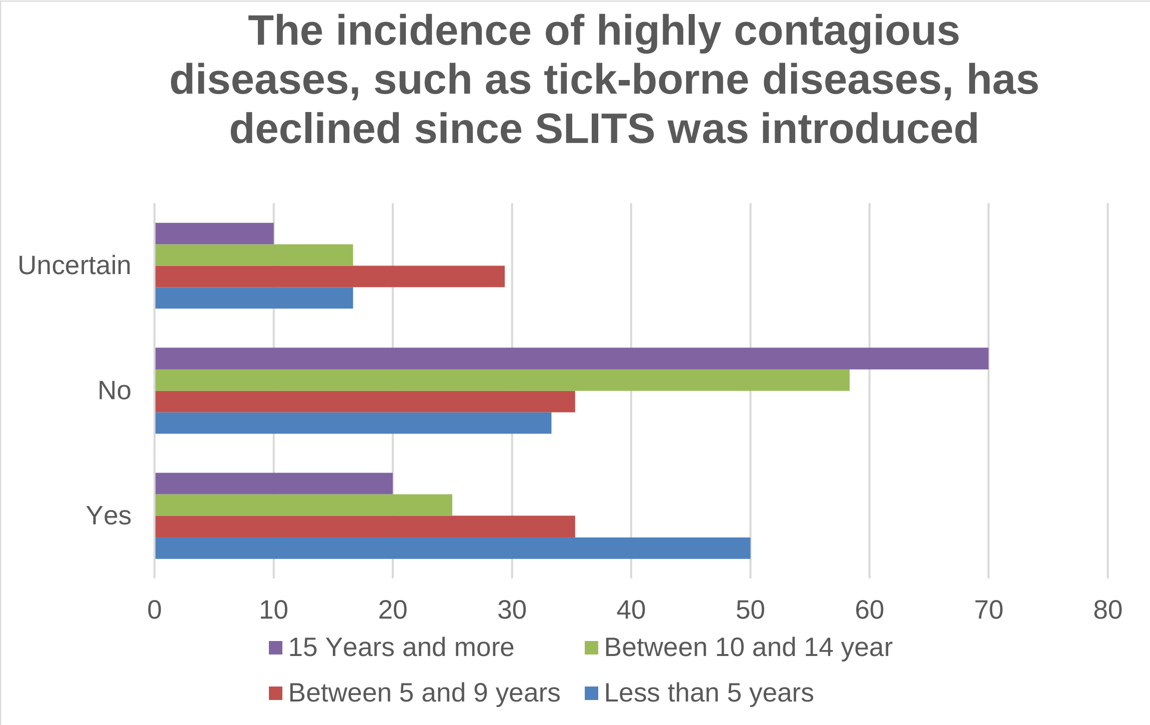


Figure 74. The incidence of highly contagious diseases, such as tick-borne diseases, had declined since SLITS was introduced

In Figure 75 the veterinary assistants with the most experience at 50% indicated that the farmers were not getting better prices for their cattle with the least experienced at 80% expressing very strongly that they were getting paid more. This is most probably due to the stage of data collection, when one has to keep Figure 46 in mind. It does seem that the veterinary assistants with the most experience were more pessimistic than their less experienced colleagues.

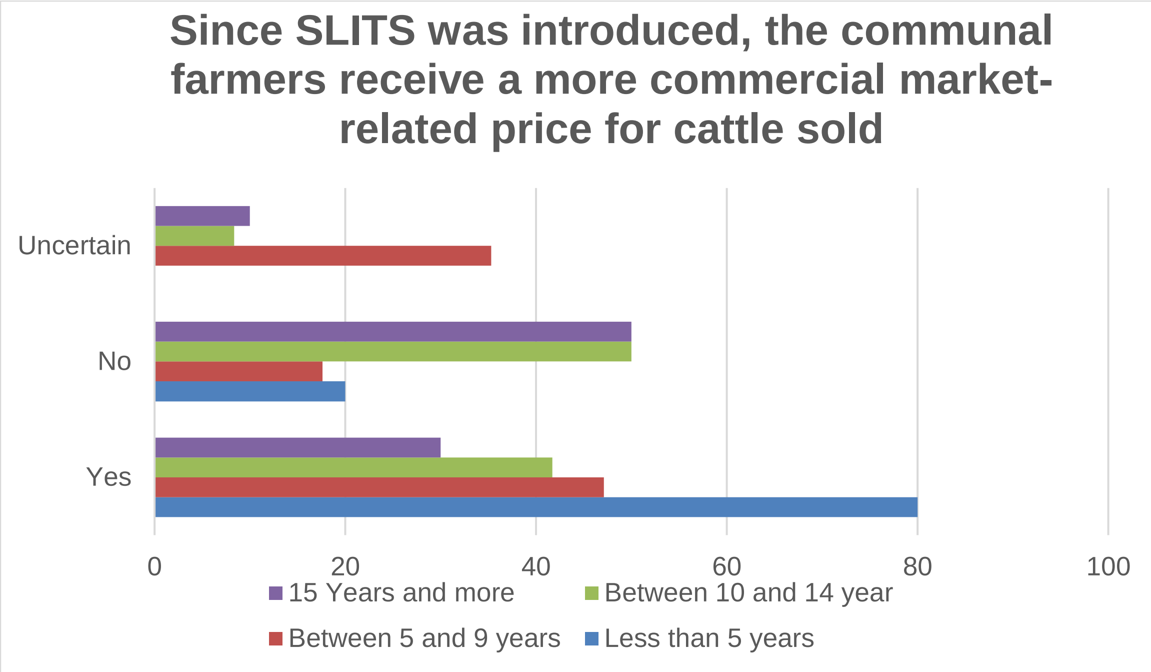


Figure 75. Since SLITS was introduced, communal farmers had received a more commercial market-related price for cattle sold

Of all the responses received relating to the question whether communal farmers received a more commercial market-related price for cattle sold, 21 respondents out of 45 said that they disagreed on the statement, and felt that the animal's health was not satisfactory when sold; 46.7% agreed, and 33.3% indicated that the animals were not sold at an optimal age.

From the resulting Pearson Chi-square tests conducted on the data from figures 73, 74 and 75, the p-values of 0.581, 0.55 and 0.254 all reject the H_1, resulting in the conclusion that one could simply compare all the answers from all the veterinary assistants to determine a trend and that differentiating between gender, age groups and years of experience made no significant difference in the results obtained.

The next set of graphs focuses on the following three statements:

1. Cattle vaccinations are accurately documented with SLITS as a percentage.
2. SLITS simplifies the process of accurately tracking vaccinations of communal farmers' cattle as a percentage.
3. SLITS improves Veterinary Service's ability to contain/manage disease outbreak as a percentage.

Just as in the previous examples, the responses were measured against gender, age groups and years of experience as a veterinary assistant. In Figure 76, 78.1% of all males and 63% of all females indicated that cattle vaccinations were now accurately documented with SLITS, and no males were uncertain. The Pearson Chi-square test's resulting p-value is 0.198, therefore there is no significant association between gender and the accuracy of cattle vaccination documentation.

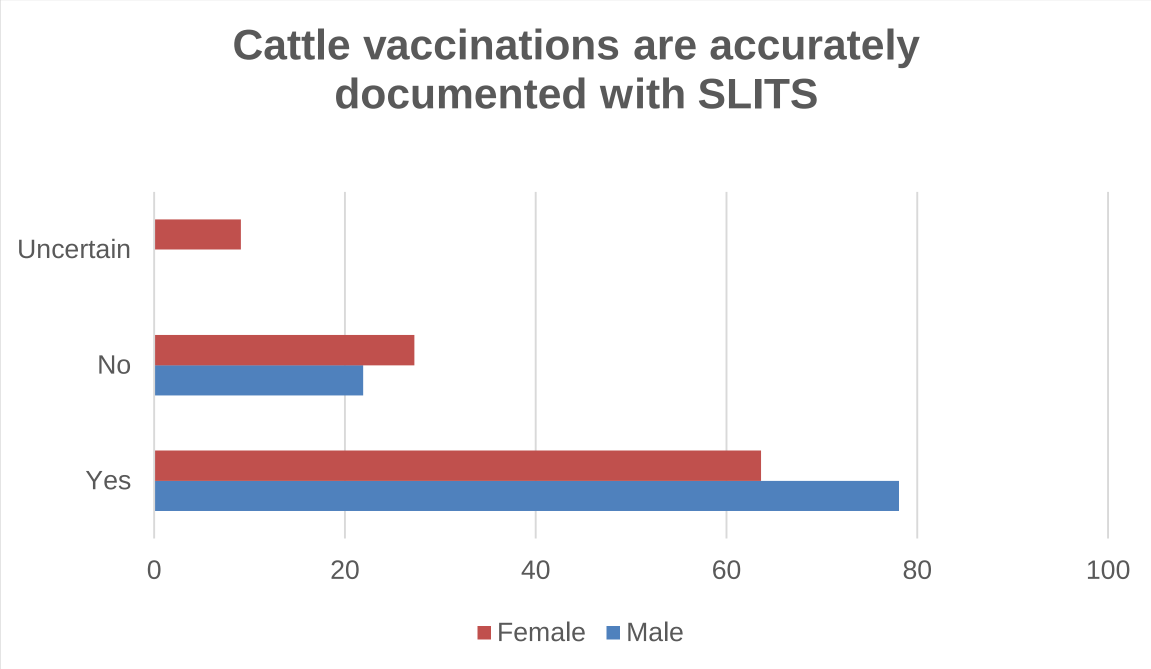


Figure 76. Cattle vaccinations are accurately documented with SLITS

84.8% of all males agreed that animal vaccinations are accurately tracked, with 75% of females in agreement with the males. Again, no males were uncertain; however, 16% of the females were, shown in figure 77. The resulting Chi-square test resulted in a p-value of 0.052, still showing no significant association, but it is almost significant, leading one to assume that with more data, the H_1 will be accepted.

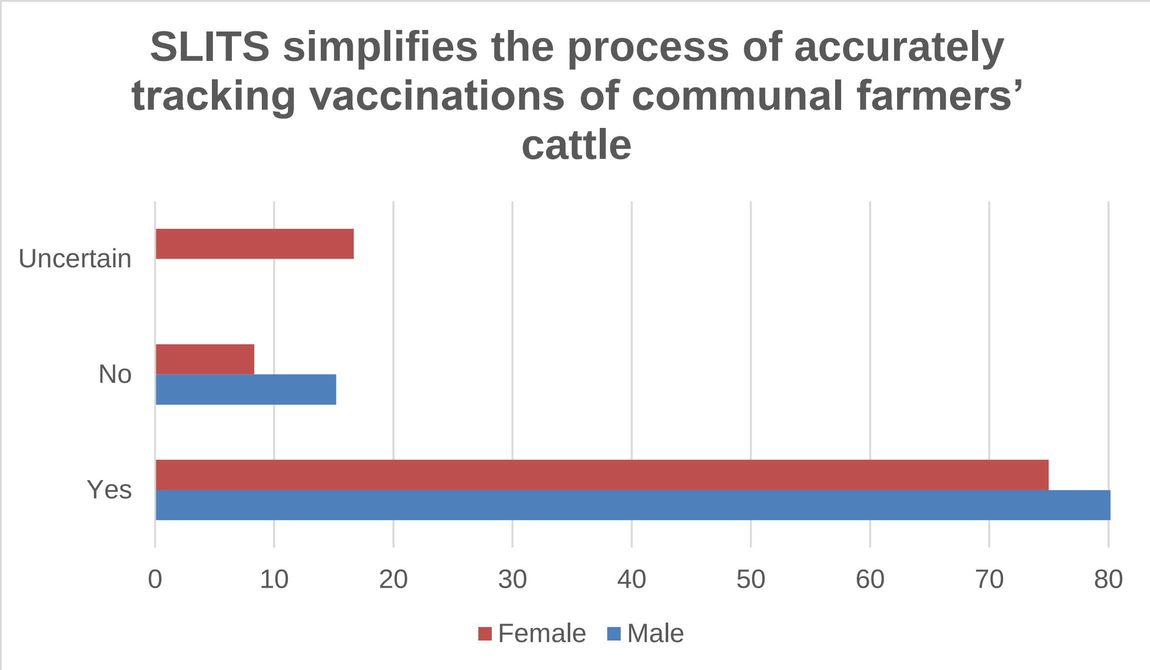


Figure 77. SLITS simplifies the process of accurately tracking vaccinations of communal farmers' cattle

An overwhelming percentage of responses showed that disease outbreaks were better contained and managed, with no males or females being uncertain. 97% of males and 90.9% of females in figure 78 are indicative of a strong consensus. The H_1 is rejected because of the resulting p-value of 0.186

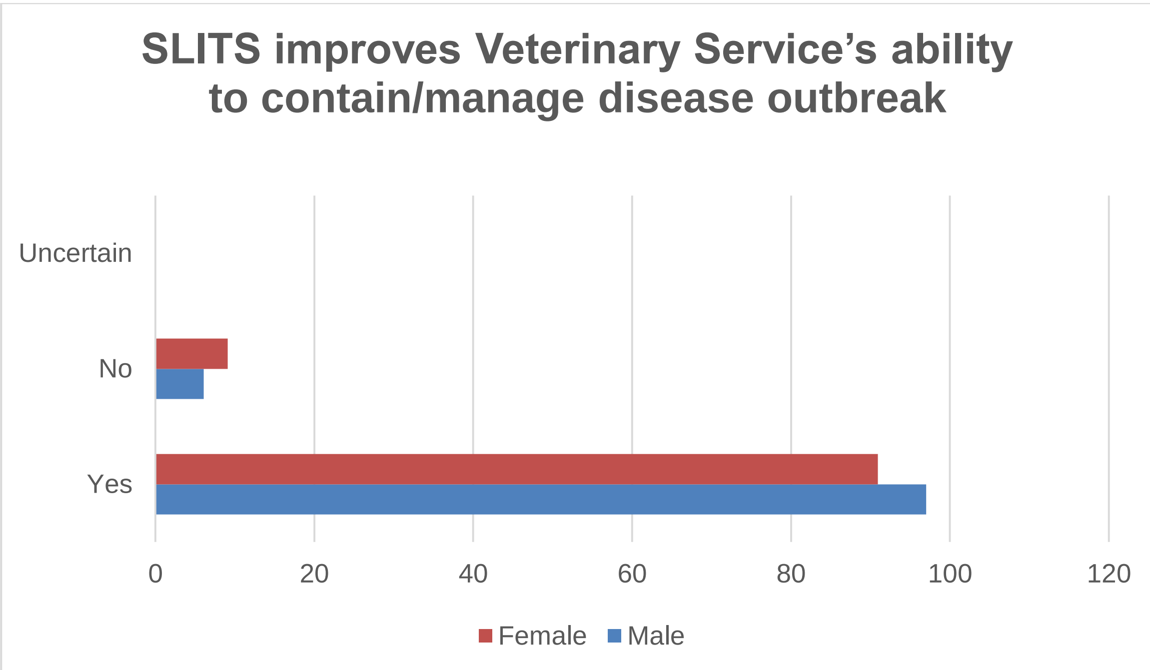


Figure 78. SLITS improves Veterinary Service's ability to contain/manage disease outbreak

In terms of age groups in figure 79, the trend was that cattle vaccinations were documented accurately, with all three categories agreeing at between 66.7% and 82.4%. The Pearson Chi-square test shows no significant association with a p-value of 0.7 for figure 79, 0.987 for figure 80 and 0.787 for figure 81.

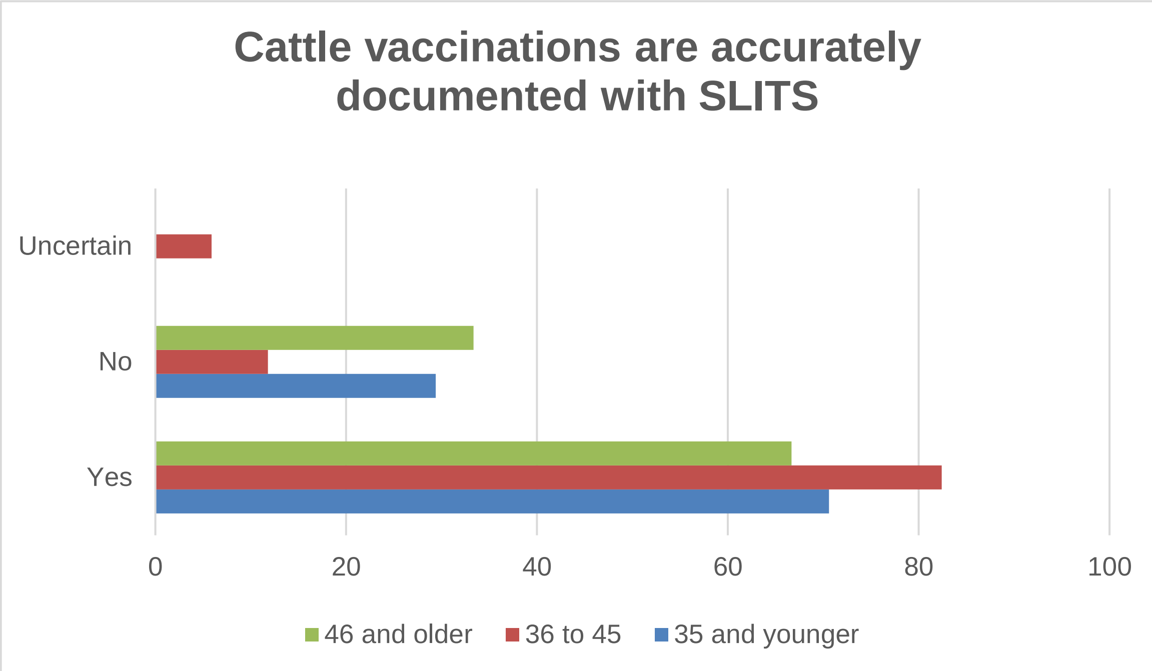


Figure 79. Cattle vaccinations are accurately documented with SLITS

88.9% of the older age group believed that vaccination tracking was accurate, compared to 78.9% of the 35 and younger group and 82.4% of the middle group of 36 to 45 years old, as illustrated in figure 80.

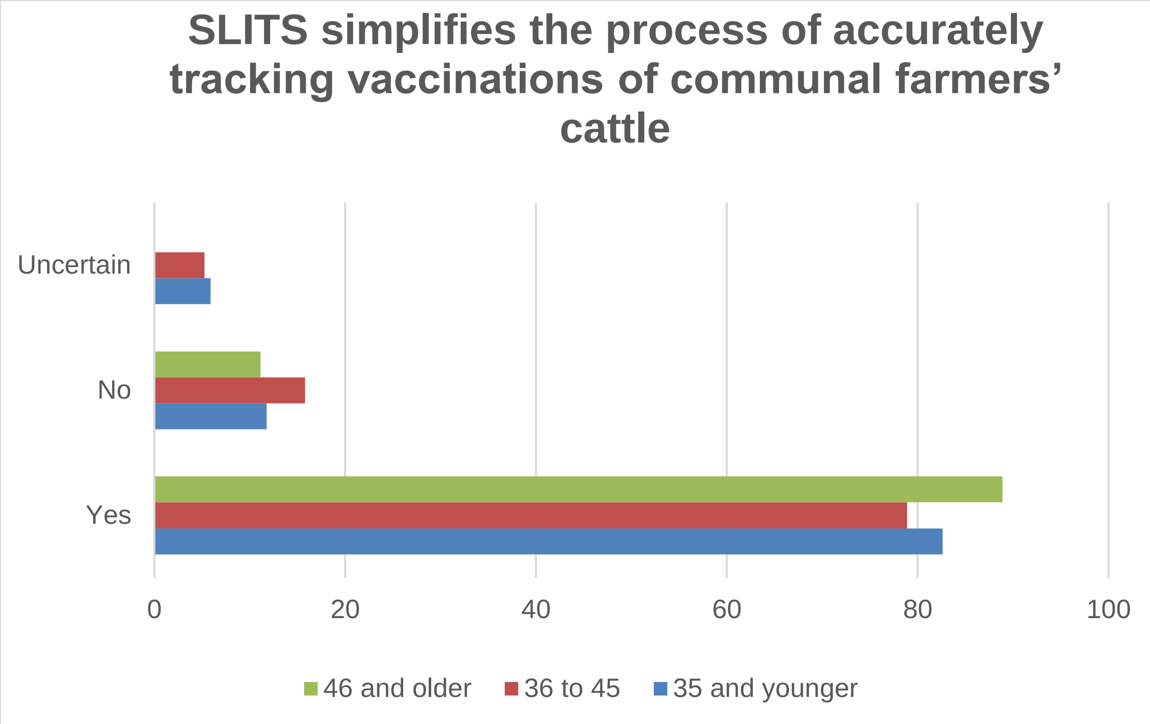


Figure 80. SLITS simplifies the process of accurately tracking vaccinations of communal farmers' cattle

There was only a small percentage of veterinary assistants, shown in figure 81, who stated that disease outbreaks were not better contained, with 5.6% of the age group 36 to 45 years, and 0% of the youngest group, and no one feeling uncertain about their opinion. 100% of the older group agreed.

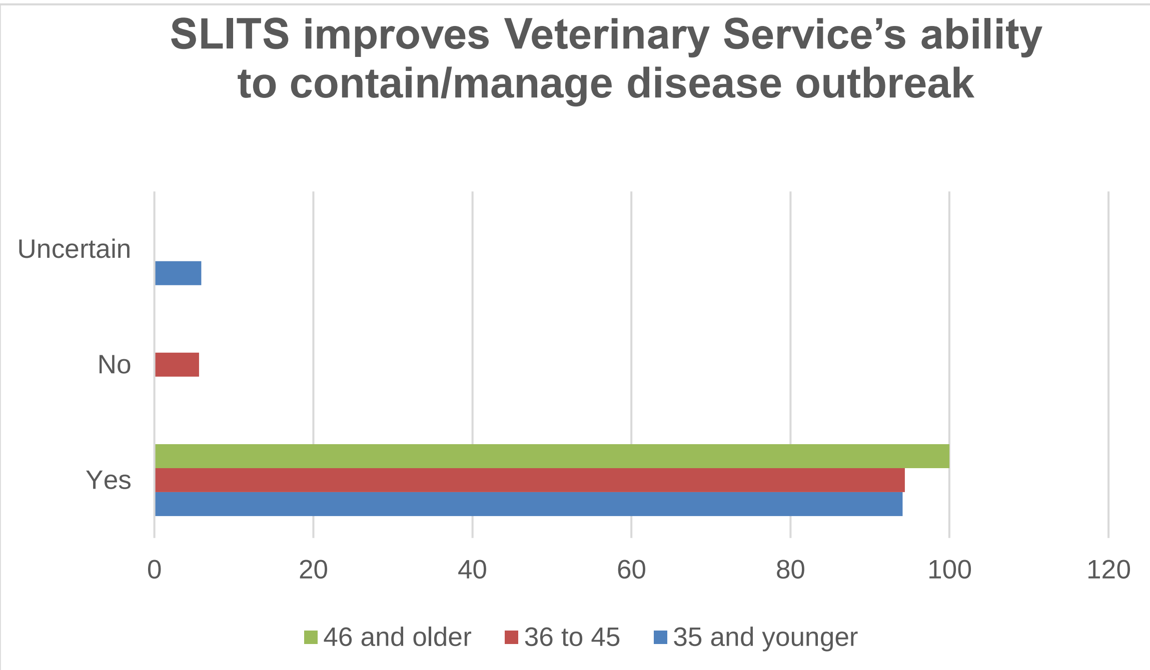


Figure 81. SLITS improves Veterinary Service's ability to contain/manage disease outbreak

In Figure 82, although all veterinary assistants agreed that cattle vaccinations were accurately documented, 33.3% of the veterinary assistants with 15 years and more experience disagreed. Seventy-six per cent of all veterinary assistants with working experience of between 5 and 9 years agreed; only 27.3% disagreed, and no one in that age group was uncertain.

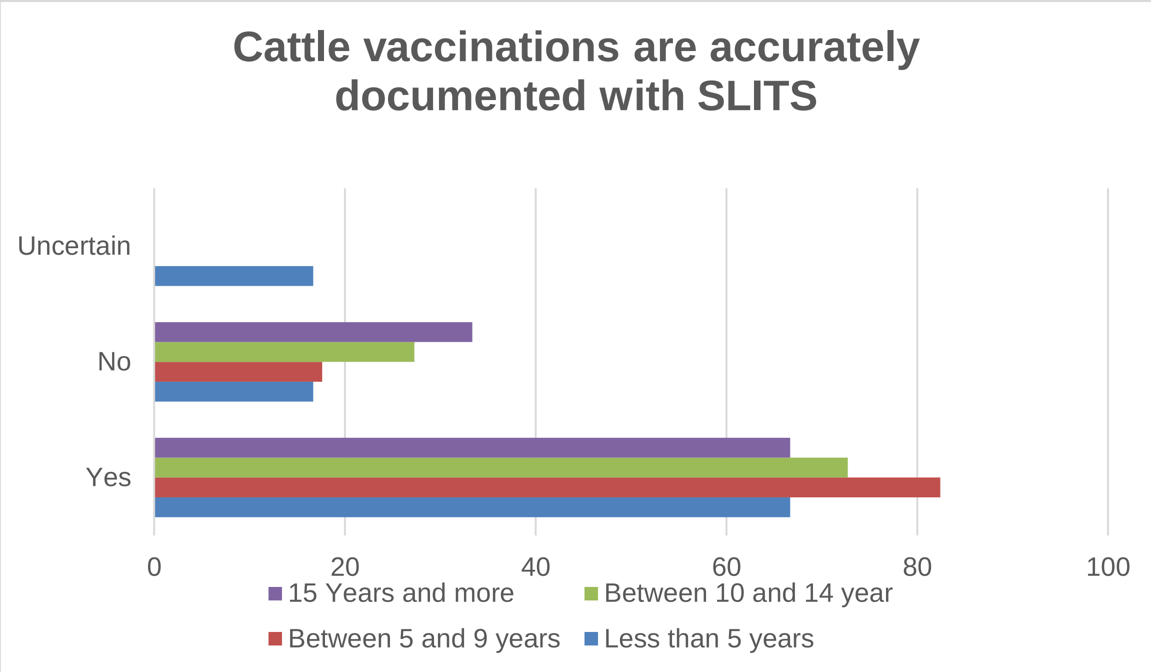


Figure 82. Cattle vaccinations are accurately documented with SLITS

Figures 83 and 84 respectively illustrate the overall positive response of the veterinary assistants when asked about simplifying the tracking of vaccinations and improvement in containing disease outbreaks. In Figure 84 the groups with 15 years and more experience, as well as the group with less than 5 years' experience were of the opinion that SLITS enables the veterinary services in 100% of the cases to contain disease outbreaks.

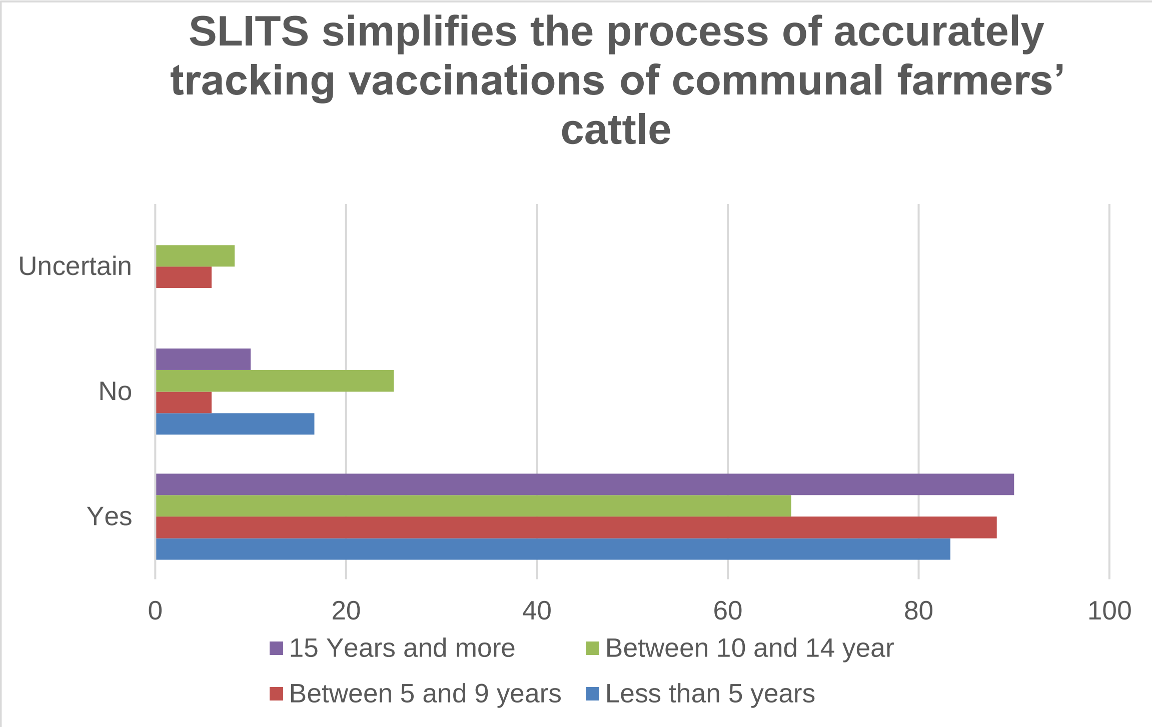


Figure 83. SLITS simplifies the process of accurately tracking vaccinations of communal farmers' cattle

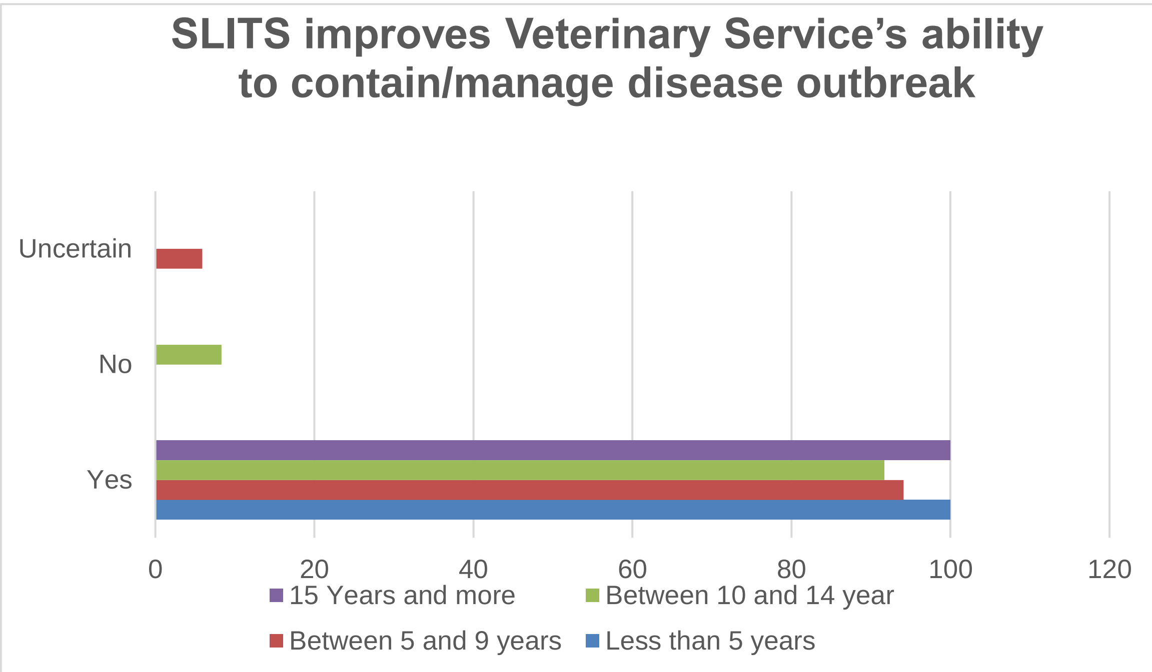


Figure 84. SLITS improves Veterinary Service's ability to contain/manage disease outbreak

Again, the Pearson Chi-square test shows no significant association between years of experience and accurate cattle vaccinations, simplifying the accurate tracking of vaccinations and improving the Veterinary Services in containing/managing disease outbreaks with p-values of 0.458, 0.852 and 0.814.

- Section D: The veterinary assistants' interactions with SLITS

A few comments in this section indicate that 95% of all respondents expressed the opinion that SLITS does assist in disease outbreak investigation; 96% said that SLITS assisted in recovering stolen cattle and 98% indicated that SLITS helped with identifying stray animals.

All the respondents said that their overall attitude to SLITS was positive, and their reasons included that stolen animals can be located and that cattle identification is easy. When asked if the veterinary assistants had any general comments regarding SLITS, the answers were categorised as follows:

- Seven respondents indicated that there was a general lack of proper and sufficient computers and internet resources, and recommended that new equipment be provided.
- Three respondents indicated that they needed access to the SLITS database at the dip tank, and that data should not be captured by hand at all.
- One respondent indicated that each veterinary assistant should be assigned to fewer dip tanks.
- Two respondents were of the opinion that SLITS needed more time to prove its efficiency.
- One respondent said that the information on the ear-tag should also be branded on the animal.

In summary, the overall attitude to and effective use of SLITS is apparent, and no real problem areas have been identified in this study that should be addressed as a matter of urgency. The respondents were in no way forced to provide their given answers, and all the statistical analyses shown in the graph were checked by a statistician. The Pearson Chi-square test for significant association between gender, age groups and years of experience compared to the descriptive statistics as shown in figures 65 to 84 all reject the H_1 to show significant association between the variables. The graphs do still show trends and are therefore not deemed unnecessary or of no value to the study.

The final step in this section on the results from the case study, interviews and analysis of the questionnaires, is to identify the context, state how changes in behavioural precursors came about, how they influenced the changes in behaviour, and finally to explain the broader developmental impact, and in so doing, conclude the second layer of the proposed framework. In every sub-section of the analysis of the results, the main contexts are highlighted and categorised in their various changes and impacts. Table 11 summarises the main findings.

Context	Change in behavioural precursors	Change in behaviour	Broader developmental impact
1. Lack of animal identification / traceability.	Communal farmers' cattle are ear-tagged and their animals' data captured on SLITS.	More animals are now ready for export.	Traceability system is fully implemented in 2014.
2. Lack of the communal farmer benefitting fully from traceability.	Awareness of the benefits of ear-tagging and animal data captured on SLITS.	The benefits of the traceability system are becoming more apparent.	Communal farmers are empowered to sell more cattle to feedlots / Swazi Meat Industries.
3. Lack of knowledge of how to operate a traceability system.	Veterinary assistants are unsure of how to use SLITS to gain the most benefits.	Veterinary assistants become more confident with using SLITS.	A small group of veterinary assistants are trained; they then train other veterinary assistants at their regional offices.
4. Lack of sufficient disease outbreak contingency measures.	The need for better management of disease outbreaks is identified.	Disease outbreaks are recorded on SLITS.	SLITS simplifies disease outbreak management and manages it effectively.
5. Lack of ownership of SLITS.	Communal farmers are introduced to ear-tagging and veterinary assistants are exposed to SLITS.	The project team and veterinary assistants are empowered by learning new skills and applying their skills.	The project team driving SLITS is fully committed to making a success, and the veterinary assistants use SLITS on a regular basis.
6. Not all cattle are tagged yet.	There is a growing need for all cattle to be traced.	The veterinary assistants are working on getting each and every animal tagged.	The project team with the veterinary assistants are ensuring that very animal will be tagged as soon as possible.
7. A large number of animals were not slaughtered for the export market.	For the economy to grow, more traceable meat needs to be exported.	The veterinary assistants are informing the communal farmers of the new export markets available to them.	There is a growing number of cattle that are being sent for slaughtering for the export market.
8. Communal farmers were unaware of the monetary value of their cattle.	Communal farmers are told by the veterinary assistants that they can sell less traceable animals and receive more money for each animal.	Communal farmers can now grow their herds by selling less animals at a higher price.	Communal farmers play a bigger role in the overall economy of Swaziland.

Context	Change in behavioural precursors	Change in behaviour	Broader developmental impact
9. Communal farmers were unaware of the optimal time to sell their animals and kept them for too long, trying to sell them when they are worth less money.	The veterinary assistants play a key role in educating communal famers on the optimal time to sell their cattle.	More communal farmers are realising that it is better to sell your younger animals at an optimal age.	Communal farmers are selling their cattle at an optimal age.
10. The communal farmers are willing to sell their animals, leading to more animals bring incorporated in the red meat value chain.	There are now more work created because of growing cattle numbers.	With more cattle, the economy is growing and with more jobs, a better life for the communal farmer is becoming viable.	The GDP of the country is growing.
11. More traceable animals can now be exported.	With more animals being exported, the communal farmer can play a bigger role in the economy.	As more communal farmers sell their cattle for export, social conditions are improving.	More and more animal meat products are exported annually.

Table 11. Concluding the second layer of the framework by summarising the main results

7.3.5. Concluding the case study

The case study and all its components act as evidence to validate the second layer of the framework. The summary in Table 11 is intended to highlight a number of key areas, with the true depth of the data gathered underpinned by the detailed descriptions. The data is discussed in a structured, chronological manner, illustrating how the data was gathered by firstly discussing the case study in-depth, followed by the interviews, and then the analysis of the responses to the questionnaires. The data should be studied as a whole, not as isolated entities. The next section discusses the final layer of the framework.

7.4. The impact on communal farmer in order to ensure sustainability

The final layer of the framework demonstrates the impact of the proposed model on communal farmers, shown in figure 85.

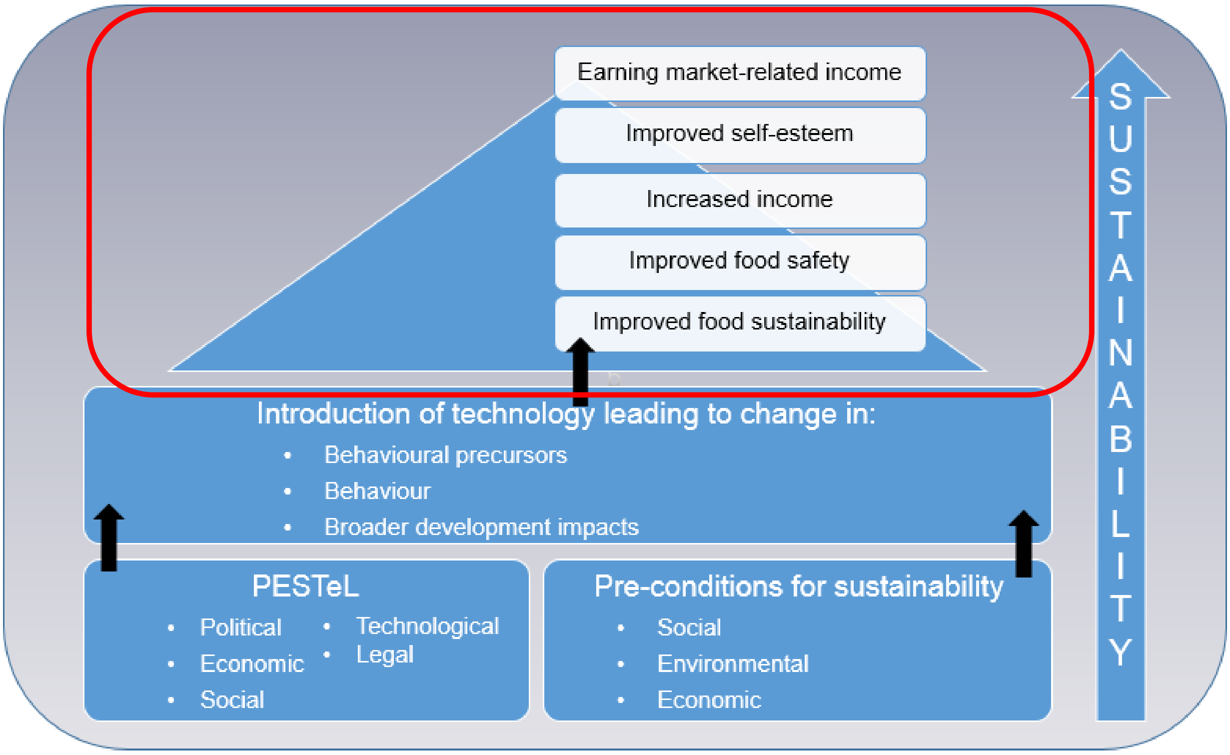


Figure 85. Applying the final layer of the framework to SLITS

There are other impacts to consider above and beyond the broader developmental impacts identified in table 11. One should keep in mind that SLITS only became fully operational in 2014, leaving room for the impact on communal farmers to further develop and evolve. The four impacts are discussed in terms of Maslow's hierarchy of needs, as the final layer to the framework, starting at the bottom, and working its way upwards.

1. *Improved food sustainability*

- Communal farmers gain from free ear-tagging and traceability of cattle, leading to new opportunities and revenue streams.
- Communal farmers benefit from traceability, and can now sell their cattle at a more commercial market-related price.
- If one refers back to Figure 17 and the cost/benefit analysis of traceable meat products, it will be possible for the communal Swazi farmer to provide food for his/her family with the livestock now achieving a higher price when sold for export.

2. *Improved food safety*

- Traceability ensures trust in meat products and guarantees that meat is safe for human consumption, including meat for local consumption.

3. *Increased income*

- By referring back to figures 16 and 17 in Chapter 3, one has to look at the farm management system holistically and look for job creation throughout the red meat value chain. If one takes into account the growing number of cattle sold for export from 2014 to 2016, with meat sold for export almost doubling from 6320 cattle to 11490, one can conclude that the GDP of Swaziland has increased, stimulating the economy that in turn leads to more employment opportunities.
- More animals are sold for export, increasing production. Increased production grows all areas in the red meat value chain, creating sustainable job creation.
- Interviews with veterinary assistants working directly with the communal farmers and the representative of SMI indicated that the communal farmers were being paid more money for their cattle, leading to an overall increase in GDP, higher dispensable income, which in turn grow entrepreneurs in rural areas.

4. *Improved self-esteem*

- Swaziland has become known for its traceability system, and more export markets open up to them.
- Communal farmers can access the cattle export market.
- Communal farmers and veterinary assistants take ownership of SLITS, expanding its use and effectiveness.

5. *Earning market-related income*

- The more export markets available to the Swazis, the greater the potential to grow the economy.

- Disease outbreaks are better addressed, making the meat safe for export to Europe and many other emerging markets.
- Swaziland is becoming a world player in the traceability market.

It is concluded that the introduction of SLITS benefitted all farmers, but specifically the communal farmers. This conclusion is based on:

1. The GDP increased as more cattle is exported. Refer to Figures 46 and 47.
2. Interviews with veterinary assistants working directly with the communal farmers and the representative of SMI indicated that the communal farmers were being paid more money for their cattle, leading to an overall increase in GDP, higher dispensable income, which in turn grow entrepreneurs in rural areas.
3. The Government of the Kingdom of Swaziland's goals as outlined in Section 7.2.2. with the implementation of the livestock traceability system were met and benefitted the communal farmers in the following ways:
    - Both communal and commercial farmers have larger access to export markets.
    - Animals are uniquely identified and is recovered easier if lost or stolen, which in turn assists with a reduction in stock theft and ownership disputes.
    - In cases of disease outbreaks, traceability assists in disease containment, as was the case with the foot-and-mouth disease outbreak of Namibia of 2015 (Prinsloo, De Villiers & Van Niekerk, 2017).
    - More animals are sold for export, increasing production.
    - Government controlled movement permits are handled more efficiently.

7.5. Application of the impact-for-sustainable-agriculture framework to SLITS

It is necessary to piece together all the different layers of the framework to determine their relevance and applicability. In the discussion of the different layers, one can clearly follow the intention of mainly sketching the scene of Swaziland and the Swazi culture, with its richness in all the components. In order to ensure sustainability, the foundational layer needs to be in place. To ensure further sustainability, the case study and all its facets provides insight into SLITS, and how it is used, applied and useful, finally summarised in Table 11.

The third layer of the framework with its impact directly on the communal farmer aims to ensure ultimate sustainability of the project, with the belief that once the intended stakeholders of the project feel the impact on their everyday existence, it will lead to development, and ownership of the project will lead to a sustainable and successful initiative, wrapping up the discussions surrounding the framework, as illustrated in Figure 86 below.

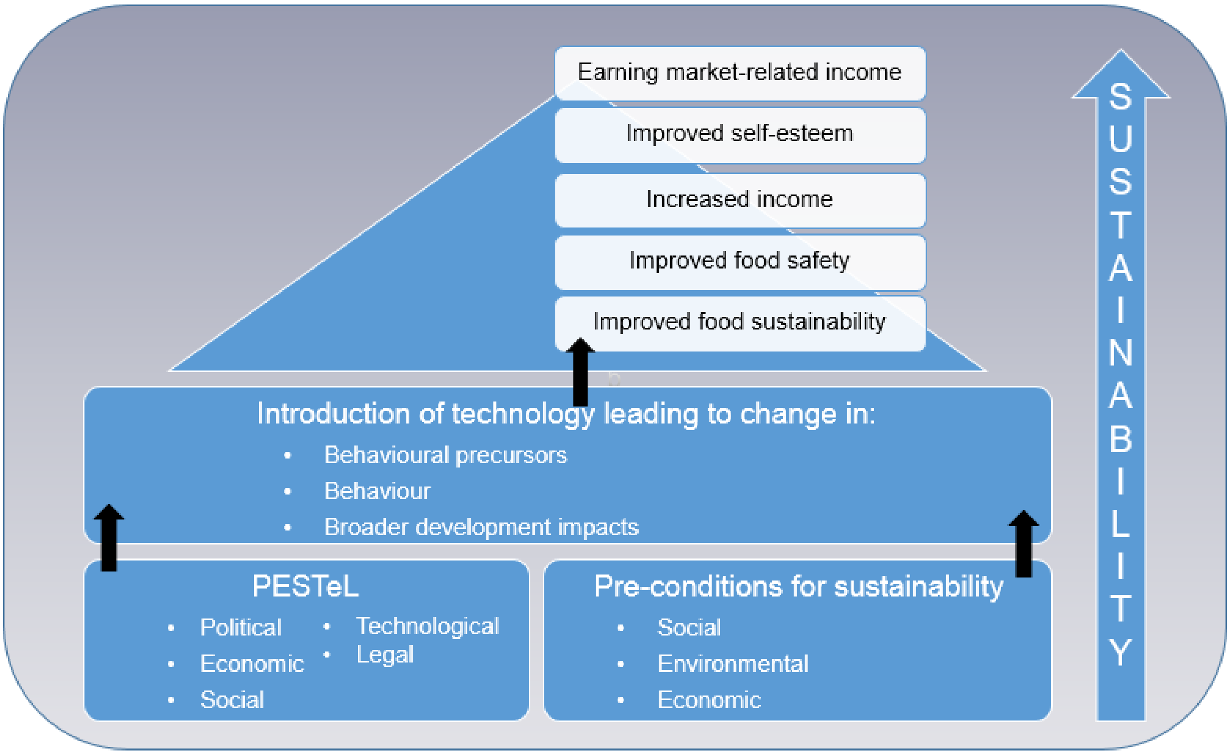


Figure 86. Bringing the evidence together in a single framework for SLITS

7.6. Conclusion

Chapter 7 concludes by emphasising the usefulness and validity of the proposed framework, and its building blocks in order to consolidate the model. SLITS is discussed layer upon layer, and the overall theme of the framework can be summarised as follows: to ensure a sustainable agricultural technology initiative, one has to gain a deep understanding of the context, build a solid case study and illustrate to the stakeholders the impact of the new technology on improving their everyday lives. Chapter 8 follows the same train of thought, but is applied to the Namibian context, specifically the sustainable impact it has on the NCAs.

8. Chapter 8: Discussion of evidence collected from Namibia, focusing on the Northern Communal Areas and its traceability system

Once a new technology rolls over you, if you're not part of the steamroller, you're part of the road.
Stewart Brand

8.1. Introduction

Chapter 8 introduces the Namibian case study in a similar format and layout as that of Swaziland, ensuring consistency and identifying similarities and differences between the two case studies and traceability systems. Namibia is a more diversified country, with NamLITS introduced in phases, and the NCAs the last phase of the implementation of NamLITS. The main focus of this chapter is on communal farmers and their experiences with new technology. The entire NamLITS system is explained to provide the necessary context. The first section looks at all the relevant background aspects of Namibia.

8.2. Background of Namibia

The foundational level of the NamLITS framework is discussed, as is shown in figure 87

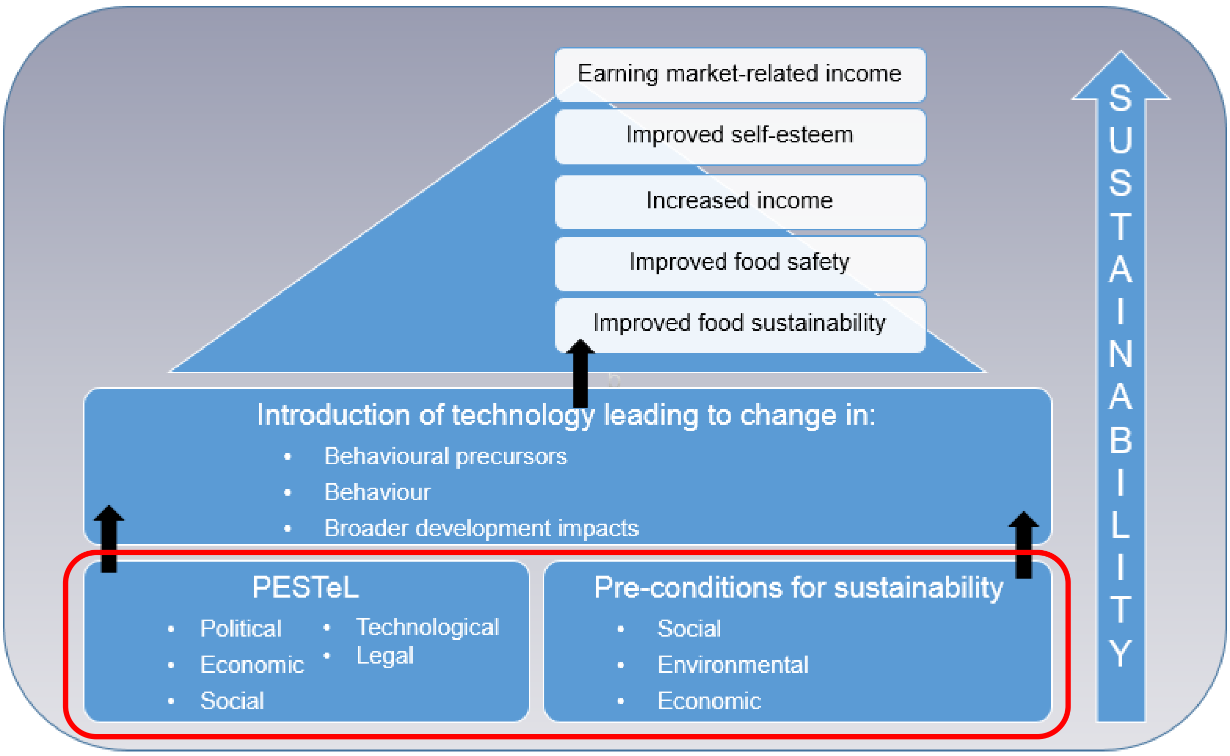


Figure 87. Applying the foundation of the framework to NamLITS

8.2.1. PESTeL

Political

In figure 88, the geographical location of Namibia is shown.

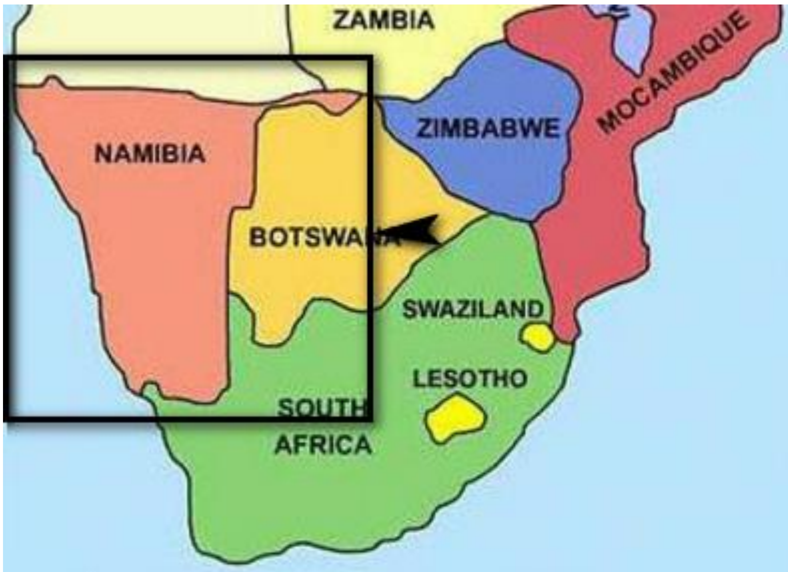


Figure 88. Geographical location of Namibia (Adopted and adapted from Maps-Africa (2012))

At 825 418 km² Namibia is the world's thirty-fourth largest country and after Mongolia, Namibia is the least densely populated country in the world with 2.56 inhabitants per square kilometre (World Bank, 2015) because of the vast Namib desert spanning most of the country. It shares land borders with Angola and Zambia to the north, Botswana to the east and South Africa to the south and east. Namibia has a population of 2.1 million people and a stable multi-party parliamentary democracy, a form of governance where the citizens of the country vote in a free and fair election, voting for their choice of political party (Melber, 2015). The South West African People's Organisation (SWAPO) has been the governing political party since its independence from South Africa in 1989 (De Visser, 2013), with the first president of Namibia, Dr Sam Nujoma, popularly referred to as the "Father of the Nation" (Melber, 2003). Dr Nujoma was president for three consecutive terms from 1990 until 2005, followed by Hifikepunye Pohamba for two five-year terms until 2015, and Hage Geingob, who is currently the president (Kössler, 2015). There are 72 members of the National Assembly and 26 seats in the National Council, consisting of two members of every regional council. Approximately half the population live below the international poverty line, and the nation has suffered heavily from the effects of HIV/AIDS, with 18.8% of the adult population infected with HIV in 2010 (Hedimbi & Chinsembu, 2012), among the ten highest in the world. Namibia has an unemployment rate of above 50% (2013 Index of Economic Freedom, 2013a).

Economic

The Namibian currency is the Namibian Dollar (N$) that is linked to the South African Rand. Namibia's biggest economic pillar is mining, generating almost 10% of the country's roughly N$57 billion GDP annually. The country produces mostly diamonds, over a million carats of diamonds every year, but is also rich in uranium, copper, zinc, lead, gold and coal, to name a few other mining products (Fernandes, 2015). The other three economic pillars are agriculture, contributing 4.2% of the GDP, fishery contributing 3% of the GDP and finally tourism, a smaller role-player, but attracting nearly one million tourists annually.

The ten economic freedoms of Namibia are shown in the four figures below, as was done in the Swaziland case study, comparing Namibia to the rest of the world.

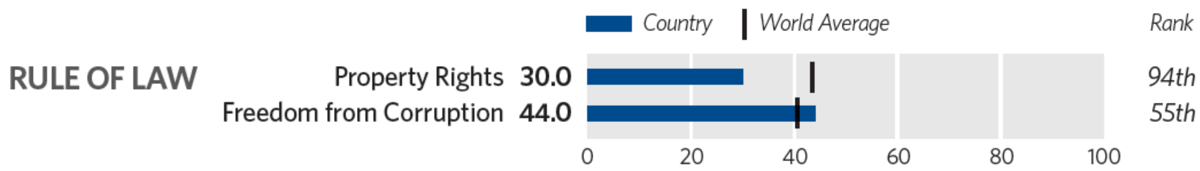


Figure 89. The economic freedom of law in Namibia (Adopted from 2013 Index of Economic Freedom (2013a))

Namibia's property rights are not very well-protected, with government aiming to redistribute land to the previously disadvantaged, leading to a few expropriation cases (2013 Index of Economic Freedom, 2013a). Government does not alleviate corruption, and prefers to appoint someone from an affiliated tribe in an official position.

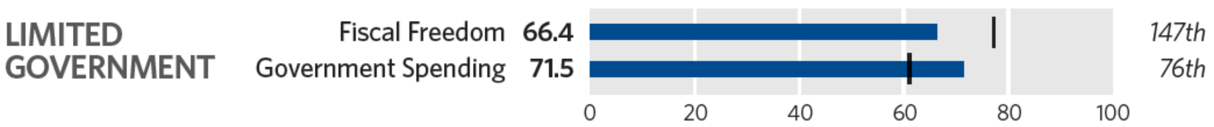


Figure 90. The economic freedom of government in Namibia (Adopted from 2013 Index of Economic Freedom (2013a))

The tax rates of 37% for individual tax and 34% for corporate tax are moderately low, with government spending at 30.8% of the GDP. The government spent a lot of the money in stimulating the economy, trying to create employment opportunities.

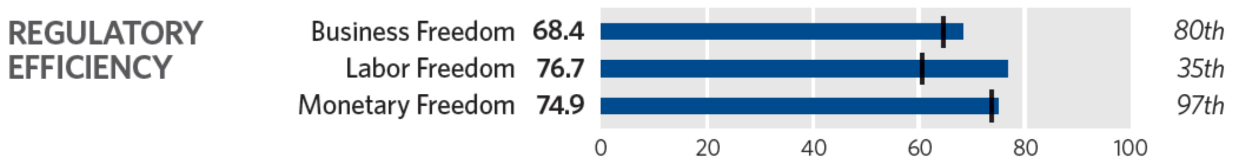


Figure 91. The economic freedom of the regulatory system in Namibia (Adopted from 2013 Index of Economic Freedom (2013a))

The inflation rate is moderate, but it remains a challenge to register a new business, taking more than 60 days, and the associated costs are high.

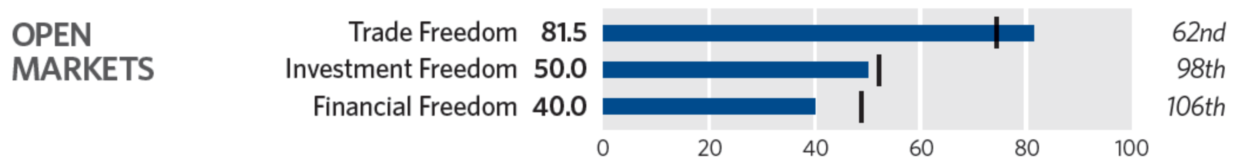


Figure 92. The economic freedom of markets in Namibia (Adopted from 2013 Index of Economic Freedom (2013a))

Trade freedom is high, but importing various goods is tedious and often delayed. Namibia is encouraging foreign investment, but does not achieve the growth it needs. The population requires more readily available access to financial services and credit.

Social

Namibia's official language is English, adopting it from being both Afrikaans and English in 1990, in preparation of its independence from South Africa. Namibia has a strong German influence because of being under Germany's control from 1884 until 1915, and there are still active German communities, more in the Southern regions of the country (Chavez, 2016). The majority of the population live in the NCAs where the most common languages are Oshiwambu and Otjiherero (Countries and their Cultures, 2016a). The traditional Bantu tribes have certain customs; for example the Himba tribes found in the Kakaoland are more nomadic, with the women mostly bare-chested and their hair smeared with mud and braided in a specific manner (Bollig & Heinemann, 2002). Figure 93 below gives examples of their customs.

Figure 93. Examples of traditional women in the Himba tribe

For the Ovambu tribes, found mostly in the NCAs, weddings are very important social gatherings, with both a traditional and a Western element. The bridesmaids are dressed identically and there are singing and dancing (Countries and their Cultures, 2016a). Figure 94 illustrates a typical wedding celebration. The men are the head of the household and take care of the livestock, with the women doing the household tasks, taking care of the children and do most of the agricultural labour. The Ovambu tribes are the most prominent tribes in the northern parts of Namibia.

Figure 94. A typical wedding celebration in the Ovambu tribe

Technological

In Namibia there are 110 mobile telephone subscriptions per 100 residents and eight fixed-line subscriptions, with 22.3% of the population having access to the Internet (United States Central Intelligence Agency, 2016a), a private and state-run television, with a variety of international television stations and multiple radio stations. Namibia is connected with fibre-optic cable to both South Africa and West Africa.

Legal

Windhoek is the capital of Namibia, gaining its independence from South Africa on 21 March 1990, and celebrates that day annually. It has a mixed legal system, with civil laws based on Roman-Dutch law, but also recognising customary laws. One has to be a descendent of the country to be a recognised citizen, with at least one parent born in Namibia and one cannot have dual citizenship (United States Central Intelligence Agency, 2016a). The capital of Namibia is Windhoek, shown in figure 95.

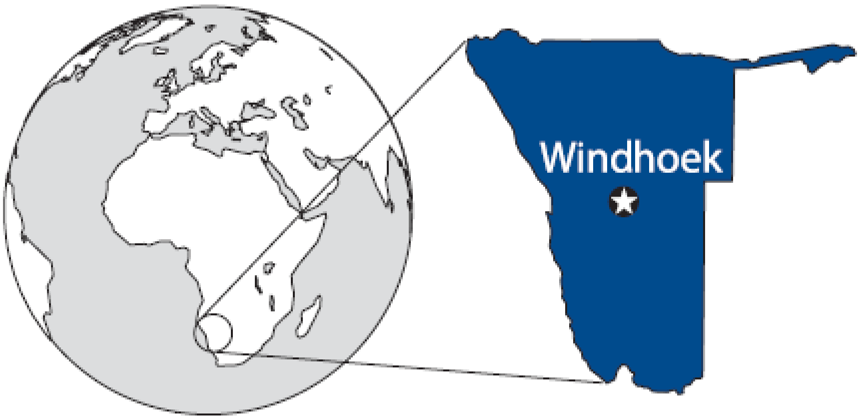


Figure 95. The capital of Namibia is Windhoek (Adopted from 2013 Index of Economic Freedom (2013a))

8.2.2. Pre-conditions

The PESTeL conditions are shown together with the pillars of sustainability, with the thirteen sustainability different factors discussed in terms of Namibia; where the main focus is on the NCAs.

Social

1. Using ICT to enhance existing rural development activities

The NCAs are difficult to access, with roads in poor conditions, if there are any roads at all. The different tribes living there live a secluded life, and have their own traditions and religious customs.

2. Cultivating and influential project champion

Namibian commercial livestock farmers have been using NamLITS since 2004, and the project is driven by government, the Namibian Meat Board as well as being fully supported and continuously enhanced by the NamLITS developers. It has now also been adopted in the NCAs, with buy-in from government and communal farmers.

3. Incorporating socially excluded groups

NamLITS is now providing traceability to the entire Namibian farming community, creating opportunities and economic growth to the poorest communal farmers.

4. Focusing on local needs

The NCAs have a different lifestyle to that of their counterparts in the southern parts of Namibia. Some of the tribes are nomadic, while others have traditional as well as Western traditions. Communal famers have the choice to sell their animals to feedlots, commercial farmers, at auctions and to the local communities for consumption.

5. Building local partnerships

A one-day trip was undertaken to the NCAs, where a general meeting of animal technicians was attended. It was an eye-opener to observe how the workers worked in unison in the face of a crisis – the unthinkable outbreak of foot-and-mouth disease. The partnerships witnessed, the support from government and the buy-in of the workers were touching. The events witnessed showed how the people take ownership of traceability and banded together.

Economic

1. Simple and clear project objectives

NamLITS implemented their first phase in 2004, bringing traceability to commercial farmers. From 2010 traceability was introduced to the NCAs with NamLITS II. The project is successful, with the policies and procedures also applied to the NCAs. The project objectives are complex, but are clear and can be implemented with the necessary assistance from project stakeholders.

2. Appropriate training.

All the animal technicians receive training on NamLITS and use it in the field every day. They are equipped with the necessary equipment to simplify their tasks.

3. Choosing the appropriate technology.

NamLITS is written in Progress OpenEdge, similar to SLITS, but with more complex functionality. The developers support and maintain the system.

4. Building on existing facilities

The expansion of NamLITS to include the NCAs uses the same system as the NamLITS as is the case in the southern regions. The system was expanded to incorporate the extra data.

5. Ongoing monitoring and evaluation of the project

NamLITS is still expanding, the project is successful, but new challenges in the NCAs are addressed and the project success continuously monitored.

Environmental

1. An understanding of the local political context

The political context, as discussed in the previous section, enables NamLITS to function well, with buy-in from the government and other stakeholders. There are no negative political influences on NamLITS and the project is widely supported. The Namibian farming population has a sense of pride regarding the well-implemented traceability system.

2. Focusing on self-sustainability.

NamLITS is being sustained by funding from the Namibian government after initially being funded by the EU. NamLITS does not rely on any additional funding bodies to continue.

3. Encouraging local ownership

Every animal technician, commercial and communal farmer, government official and NamLITS developer is working hard to ensure that the system ensures traceability, but provides monetary value and is successful. They see its worth and want to ensure that it remains successful, partnering with all stakeholders.

8.3. Introducing the new technology leading to change and the findings from the data gathered as a result of the change

The second layer of the framework is discussed in the following sections, and highlights the evidence gathered with the interviews, and data collected with the case study and analysis of the questionnaires. Finally, the data is summarised to show the developmental impacts of the project, before introducing the third and final layer of the framework as applied to the Namibian context. The next section will focus on the second layer, shown in figure 96.

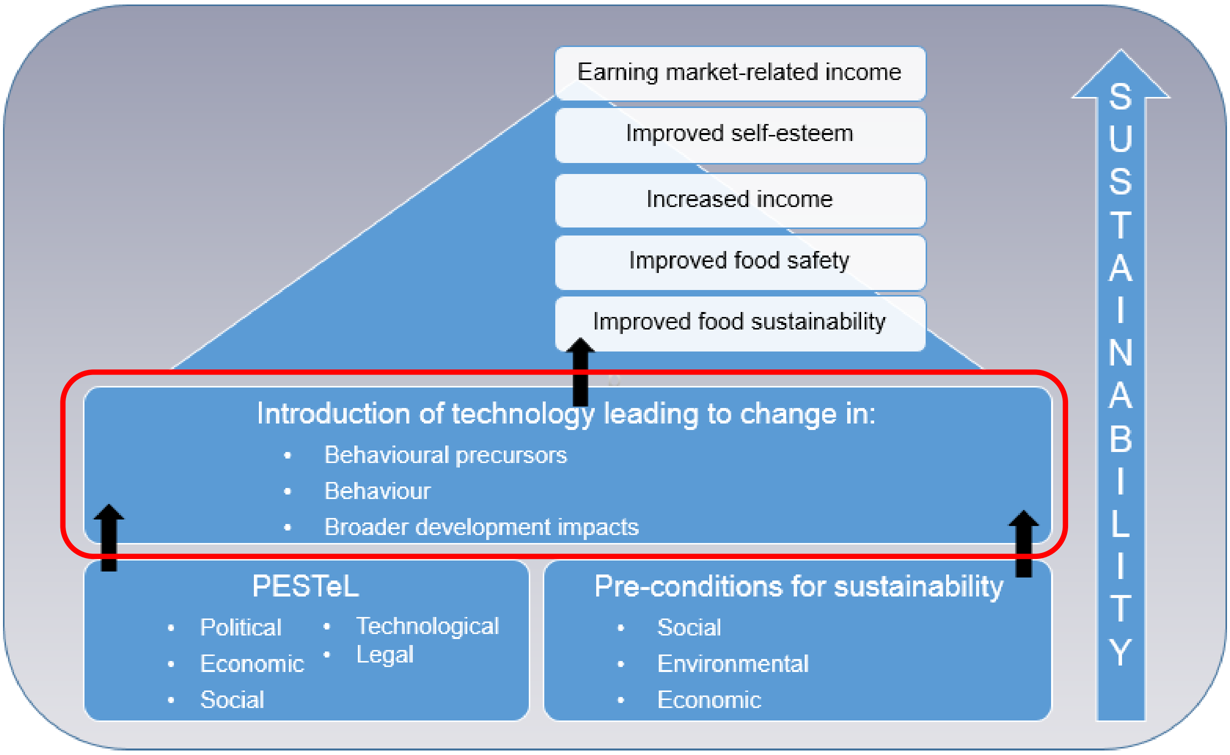


Figure 96. Applying the second layer of the framework to NamLITS

8.3.1. The context-rich case study: NamLITS and the Northern Communal Areas

In 2004 Namibia introduced a computerised system called NamLITS so that it could remain an exporter of meat to the European Union and other countries. It involves the animal technicians reaching out to the communal farmers to assist the farmers with animal ear-tagging, where specific equipment is needed, as well as branding of the animal if the communal farmers are unable to perform the branding themselves. This system enables the key beneficiaries of NamLITS, the communal farmers, to work with the animal technicians to prevent stock theft with unique animal identification, enforces better movement control and allows for more efficient system governance (eTransform Africa, 2012). It is a very comprehensive system, and adheres to strict regulations, including the controlling of animal movement, monitoring animal health, controlling disease outbreaks, managing nutrition and identifying animals uniquely (Boy, n.d.). The NamLITS system was expanded in 2010 to allow communal farmers' cattle, north of the red line, to be ear-tagged and captured on the NamLITS database. This paved the way for the previously excluded communal farmers to be able to export to overseas markets, not only to markets in Namibia and South Africa.

The country is divided into two main livestock regions: the Southern area, with commercial and communal farmers, and the NCAs, with mainly communal farmers, where 52% of Namibia's entire cattle population is found ((Thomson & Penrith, 2011). This division of regions is often referred to as being below or above the Red Line, also known as the Veterinary Cordon Fence (VCF). The

Red Line is as an imaginary line, where communal farmers north of the Red Line cannot export beef because of the risk of exposure to foot-and-mouth disease (Kumba, 2003), but the full roll-out of the traceability system in the NCAs will be able to start export within the shortest possible timeframe . Namibia borders Angola, Zambia and Botswana. Buffalo are one of the carriers of FMD and pose a risk for Namibia. Buffalo can move freely from Zambia into Namibia, and once a buffalo is spotted in the North East of Namibia, that area is quarantined for 21 days. If the disease is transmitted to other game or livestock, the area can be quarantined for up to six months (Fourie, 2013). The southern areas are known as free zones where cattle can move and be sold without restrictions. Just below the VCF there is a surveillance zone and above it is the buffer zone, where animal movements are more restricted and diseases are more accurately tracked and monitored. The infected zone, the Caprivi, is the zone where exporting is not allowed because of the constant exposure of cattle to buffalo that may potentially spread FMD seen in figure 97 below.

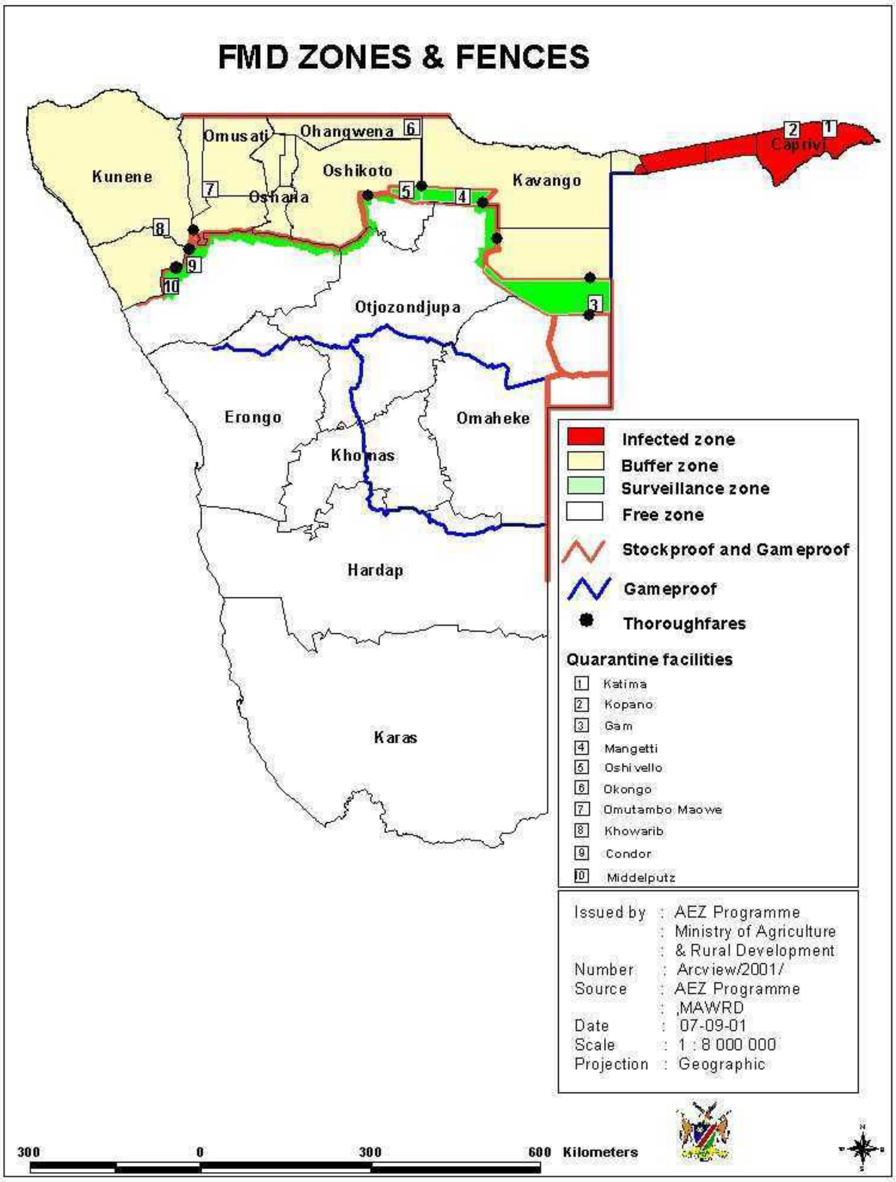


Figure 97. Namibia's foot-and-mouth disease zones and fences (Adopted from Kumba (2003))

More than 2 500 cattle in Caprivi, Kavango and Oshikoto regions were tagged during the pilot phase in December 2010. The project continues to reach more and more communal farmers. All cattle are tagged with two sets of ear-tags; on the right ear a conventional visual plastic ear-tag and the RFID tag on the left ear. The livestock information collected during the tagging is registered on the NamLITS database. The data captured includes full names and details of the livestock owner/keeper, the unique animal identification number on the ear-tag, date of tagging, age of the cattle, breed, sex and production type, for example beef or dairy. All the data is necessary to track livestock, and enables easy identification of the animal. Figure 98 shows how cattle are chased through a crush pen to have their ear-tags scanned, and figure 99 shows the RFID reader used to read the ear-tags.

Figure 98. Cattle in a crush pen, waiting to have their ear-tags scanned

Figure 99. An example of an RFID tag reader

In Namibia, NamLITS has proved to be widely used and accepted, a project that has been sustainable since 2006. Not only the traditional commercial farmers benefit from NamLITS, but also the traditional excluded communal cattle owners because of the recent expansion to the NCAs. The expansion has led to further opportunities that can augment Namibia's export numbers.

A recent outbreak of foot-and-mouth disease in the NCAs had a devastating effect, but the NamLITS system provided information on animals and geographical areas that helped to contain the disease. The NCAs recovered much more quickly from the outbreak, and are again able to export their meat products. Namibia exports about 950 000 tons of beef to Norway, a number that can double now that the NCAs also have sufficient traceability in place. Namibia can also infiltrate new markets with its higher export capacity.

NamLITS is the predecessor of SLITS, but has a more complex functionality, since it has to cater for regular auctions and selling of livestock to feed lots, making the movement of animals more difficult to manage. NamLITS also has to document any exposure to or outbreaks of foot-and-mouth disease, which has a severe impact on the quarantine measures and subsequent ban on exports for specific areas.

The tracking of animal movement is complex, and every detail needs to be captured. The following needs to be in place when moving an animal:

- Whenever an animal is moved from the original farm to the new farm, the documentation, including the movement permit, which is also used to update the movement register, must accompany the animal. This is also the case when moving an animal from the original farm to a livestock auction. The movement register must also reflect whether the animal is sent to a feedlot or an abattoir.
- The tracking of animal movements is very important to ensure that it complies with the 90/40 day rule. This rule implies that an animal cannot be slaughtered within 90 days after entering the country, or 40 days since its last move from farm-to-farm or farm-to-abattoir.
- All the information must be kept in a centralised database for auditing purposes and to ensure compliance with the set requirements.

During informal discussions with the developers of NamLITS, the one element of NamLITS found to be different form SLITS, was the legislative angle. In Swaziland there are not yet strict laws and procedures in place to regulate traceability, but this is not the case in Namibia, with a longer-running system and various acts, for example the Stock Brands Act 24 of 1995, catering for the registration and branding of cattle, transfer and cancellation of ownership, investigations and prohibition. Offences and penalties are enforced by the Act. In 2004 the Stock Brand Act

Regulations were added, focusing on traceability documentation, stock brand areas and brand methods of imprinting.

Namibia has three export abattoirs, namely Windhoek, Witvlei and Okahandja, where A grade meat is exported to the EU and Norway and B and C grade exported to South Africa and locally distributed. The NamLITS system has a similar computer interface to SLITS. Figures 100 to 102 below illustrate some of NamLITS functionalities:

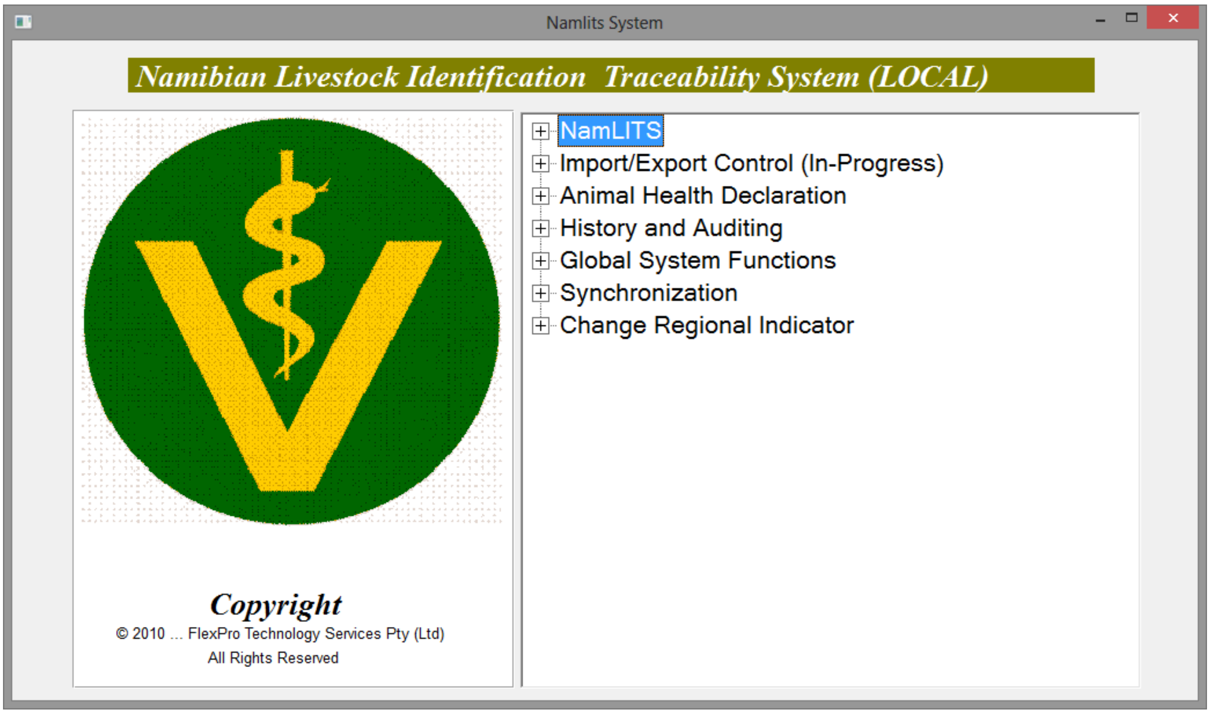


Figure 100. The NamLITS main menu

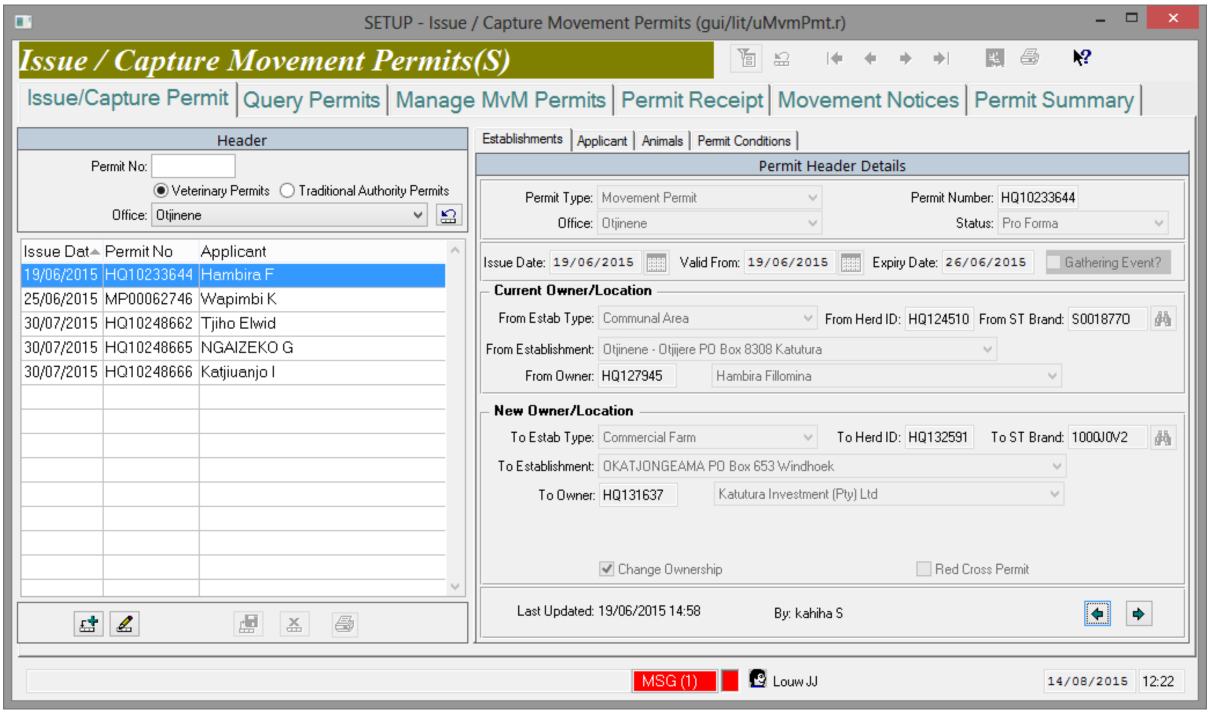


Figure 101. Issuing and capturing of movement permits

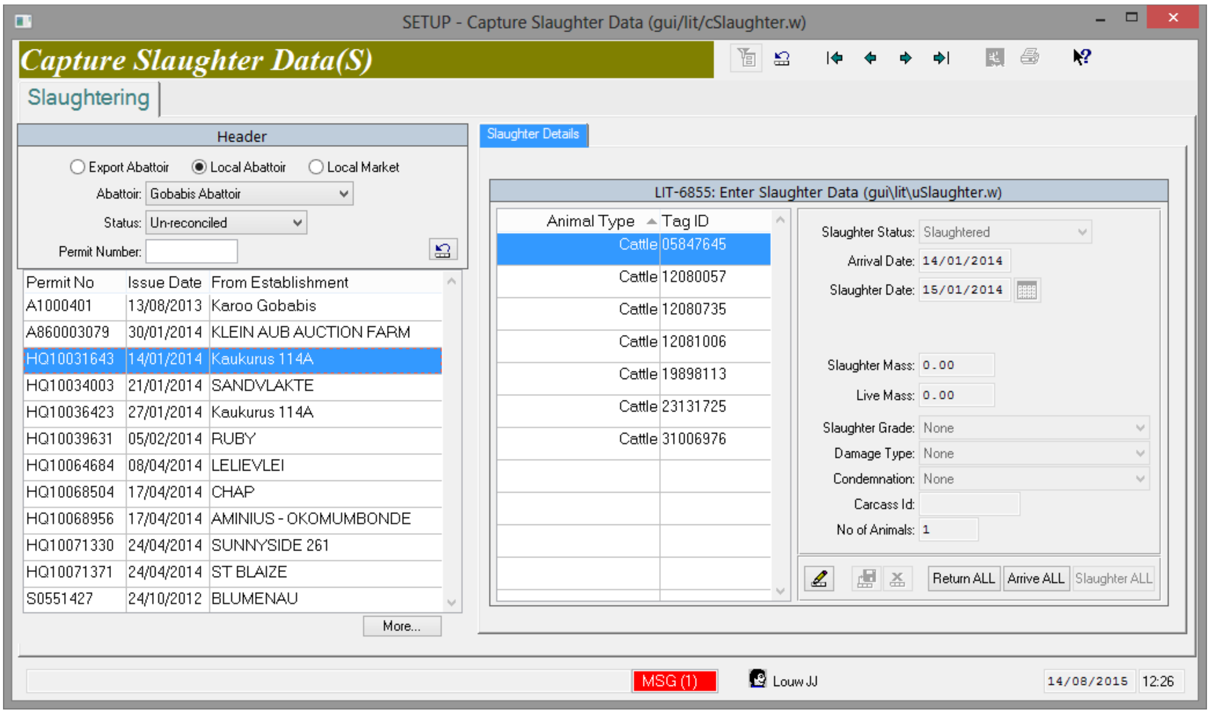


Figure 102. Capturing slaughter data

8.3.2. A discussion of evidence gathered from interviews

Three interviews were conducted over a two-year time period, but informal discussions continued for a third year, with the visit paid to the NCAs in August 2015. The interviews sketch the Namibian environment, and provide depth to the case study. The first interview took place on 27 January

2013, with background information from two developers, one involved in NamLITS and SLITS, and the other a developer of SLITS, but with extensive knowledge of NamLITS.

Interview 1

What are the main differences between SLITS and NamLITS?

> "Overseas markets need to ensure that disease control is accurately monitored and enforced."
>
> - Participant 9

NamLITS was introduced in Namibia in 2005, with SLITS becoming compulsory only in 2014. NamLITS has been adopted successfully, and has since expanded to the NCAs. In essence the two traceability systems perform similar functions, but differ mainly in terms of the diseases and disease outbreaks that need to be monitored, as well as the occurrences of dipping events. Namibia is mostly desert, and the cattle are dipped, tagged and registered on NamLITS typically once a year, where in Swaziland, because of the climate – the summer rainfall and humidity – cattle are dipped much more frequently to prevent tick-borne diseases. Another difference is that NamLITS focuses very strongly on the tracking of animals, and where the animals come from. Namibia exports their quotas of beef to Europe and America, and those regions need reassurance that all meat is foot-and-mouth disease free.

What regions are there in Namibia and how do the cattle's ear-tags differ?

> "An imported bull with a red ear-tag can never be slaughtered for export."
>
> - Participant 9

There are certain regions in Namibia with a higher incidence of foot-and-mouth disease, and the animals are tagged accordingly. In summary, the colour ear-tags are stipulated as follows in table 12:

Region/ Area	Colour of ear-tag
Kunene North	Blue
Opuwo and Epupa constituencies	Blue
Sesfontein constituency	Blue
Omusati	Orange
Oshana	Orange
Ohangwena	Orange
Oshikoto	Orange

Region/ Area	Colour of ear-tag
Ukwangali	Green
Mbunza	Green
Sambyu	Green
Gciriku	Green
Mbukushu	White
East of Kwando River	White
West of Kwando river	White
Tsumkwe	Purple
Imported animals	Red
Rest of Namibia	Yellow

Table 12. Colour of ear-tag depending on region in Namibia

"The colour of the animal's ear-tag does not change if it is moved to another area in Namibia."

- Participant 10

When did NamLITS start?

Participant 10 explained that NamLITS started in 2004, and during the process up to now, the system has changed, evolved and expanded, with lessons learnt and continuous improvement. What makes the NamLITS system unique, is the cattle auctions. Cattle are regularly auctioned, and the cattle arrive with a departure register. When farmers send their animals to the auction, they complete a departure register, and when the new owner takes ownership, an arrival register is issued, stating that the cattle have arrived at the new owner. Those permits are reconciled and consolidated, and the process is complex and cumbersome. All cattle need to be captured on NamLITS, all ear-tags correctly transferred from old to new owner, and sorted according to destination, with the correct colour-coded ear-tags being documented.

Cattle are put in designated camps, and the ear-tags are read in batches. The one challenge is to scan the ear-tags. Cattle need to be put in a crush pen, and the ear-tags scanned individually. The cattle's ear-tags are then scanned with a transponder that updates the database, because ear-tags have a built-in RFID chip. This process simplifies the data capturing, but the equipment is expensive, and the ear-tags are more expensive compared to Swaziland's ear-tags. All notebooks that are used in the auctions are registered on NamLITS, ensuring that all transactions generate unique numbers in the system, and that the numbers do not clash. According to legislation, an animal needs to be ear-tagged before six months, where in the past it was only required that the animal was tagged before being moved to another farm, abattoir or auction.

What are the different phases of NamLITS?

Again, participant 10 explained that NamLITS had a first phase, called NamLITS 1, and only commercial farmers' animals were tagged and added to NamLITS. Currently NamLITS is completing the second phase, NamLITS 2, and communal areas' animals are now being tagged and added to the database.

How many cattle are in Namibia?

> "We estimate that Namibia has 2 000 000 cattle, but it might be more, even double that, as we are uncertain of the exact number of cattle up in the North."
>
> \- Participant 9

How does the branding process work?

A stock brand needs to be registered by the registrar, under the control of the head of the Directorate of Veterinary Services. There are strict administrative processes where the correct forms need to be issued, accompanied by the unique brand symbols. Brands can also be transferred or cancelled. It is a prerequisite that one brands animals within 14 days of ownership.

Commercial farmers have one area indication symbol allocated by the minister and listed in the regulations. The form of the brand is a triangle. The brand has a combination of one indication symbol and two characters and there is only one brand per area per owner; an example is shown in Figure 103:

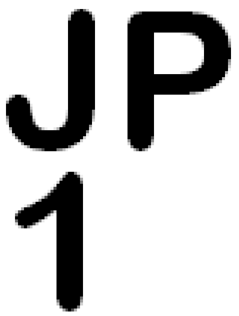


Figure 103. An example of a commercial farmer's stock brand

Communal farmers' stock brands differ because the brand has two area indication symbols and the branding is linear. The brand has a maximum of three characters per line, with the area indication symbols always listed first and last. Figure 104 shows an example of a communal stock brand.

S12
3F

Figure 104. An example of a communal farmer's stock brand

All cattle are re-branded if the brand becomes invisible, and the brand needs to be applied in the correct position. The cattle can be branded either by using hot iron branding, freeze branding or chemical branding.

Figure 105 is an example of an animal being branded using hot iron branding.

Figure 105. An animal branded with a hot iron

Branding is also done in a specific sequence, with the first owner applying his/her brand on the left thigh, followed by the left shoulder, the left neck, right thigh, right shoulder and right neck. One is fined N$2 000 if one does not comply with the requirements. Figure 106 below is one of the pamphlets circulated to assist the farmers when applying their stock brand.

Loss of original certificate:

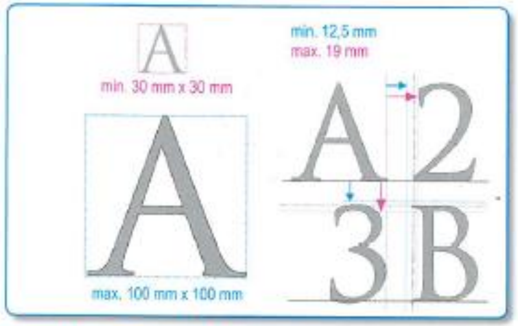
In the case of the loss of the original certificate, producers can apply for a Duplicate of a stock brand certificate by providing the following:
- ID
- N$ 60.00
- Police declaration stating the loss of the original certificate
- Duplicate application form

Branding irons

The stock brand owner is responsible for the branding iron. The iron can be manufactured by the owner himself or by a company/another person.
The owner of a Stock Brand is responsible for the safekeeping of the branding iron.
To prevent unlawful use of branding irons, Traditional Authorities may request their community members to surrender them for safekeeping.

What does a brand look like?

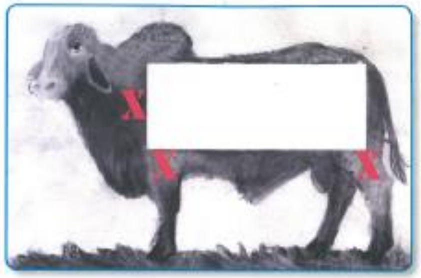
- The sketch on the Stock Brand certificate shows the correct arrangement of the stock brand characters.
- A character of a brand mark on cattle must be not less than 30 mm or more than 100mm high or wide.
- The allowable space between characters must be at least 12.5 mm, but not more than 19.0mm.



Where must the cattle be branded?

- The brand must be clearly visible.
- Please refer to the picture below – the brand should be placed anywhere outside the square.
- Do not put the mark lower than necessary since this is more painful for the animal.
- Remember that you can lose money by putting the brand mark on the valuable hide areas.
- Order of branding in case of change of ownership, if the brand becomes illegible or the animal has been erroneously branded.

1. left hind leg	4. right hind leg
2. left shoulder	5. right shoulder
3. left neck	6. right neck



Branding with a hot iron

Step 1 - Have all equipment prepared before you start branding.
Step 2 - Make sure you have enough people to assist you. Assistants must bring the animal closer and restrain it firmly. Branding will be easier if the animal is restrained in a crush pen.
Step 3 - Heat the iron well in a fire or a gas flame. When the iron becomes reddish it is hot enough. Test the heat of the iron on a piece of wood.
Step 4 - Make sure the animal cannot injure anyone when being branded.
Step 5 - Hold the iron against the animal by applying slight pressure. Count three seconds and take off the iron.

MY STOCK BRAND / 4 5 / MY STOCK BRAND

Figure 106. A pamphlet distributed by the Namibian Meat Board explaining the branding process

What is a Toughbook?

> "A Toughbook is apparently so tough that you can drive over it with a truck without damaging it."
>
> \- Participant 9

Animal technicians spend a week or more in the field, visiting several crush pen areas and documenting all the animals' details by making use of a Toughbook to synchronise the data to the NamLITS server. The crush pens are similar to the Swazi dip tanks, but the number of cattle at a specific crush pen is much larger, making the process slower. A Toughbook is a very robust piece of equipment, and can withstand dust and water damage, as shown in figure 107.

Figure 107. A Toughbook used by animal technicians

NamLITS encountered problems with one Toughbook stolen and the data lost, and another with damaged software, but all data is now sent to a memory card where a backup is done automatically. There are strict policies in place to prevent theft. A traditional notebook is not robust enough to use at a crush pen and the screen is not easily visible because of the sunlight reflecting on the screen. A mobile phone's battery life is too short. The Toughbook has the added benefit that it has a built-in Global Positioning System (GPS), making the coordination of the crush pen areas simpler.

What happens if you cannot trace the origin of a specific animal?

Participant 9 explains that if an animal is not traceable, it cannot be exported. There is also not an easy way to determine if the animal has been in contact with any animals with diseases, and this will result in the entire crush pen area to remain in quarantine until the animal is declared healthy.

What cattle diseases are prominent in Namibia?

> “Previously, there was insufficient movement control of animals in the NCAs, but the areas are now better regulated to ensure that there was no contact with an animal with foot-and-mouth disease.”
>
> \- Participant 9

Namibia has difficulty mainly with foot-and-mouth disease, because of stray buffalo or wildebeest.

Who sponsored NamLITS?

The EU originally sponsored NamLITS I, but from NamLITS 2 it has been sponsored by a fund – the Millennium Fund – sponsoring a large number of Namibian state departments, including education.

The second interview took place on 8 February 2013 with a representative of the Namibian Meat Board, at their offices in Windhoek.

Interview 2

What is your beef export quota annually?

In terms of cattle, Namibia exports 950 000 tons of beef to South Africa annually, says participant 11, and around the same number of tons to Norway and the EU. They also export 150 000 weaners to South African feedlots.

Do you export your full quota?

> The only place where we have a quota is Norway. We share the quota with Botswana.”
>
> \- Participant 11

Exports to the EU are quota- and duty-free, but to South Africa it is only quota-free. The meat exported to Norway is of a very high quality and Namibia receives high prices for it.

What do you do in terms of disease controlling?

Participant 11 explains that the different zones in Namibia are treated differently, with the infected zone tracked often. The different zones are separated by game fences ad in the case of an outbreak, either the zone, entire area in the game fence, or the entire country is quarantined.

When last did you have an outbreak of foot-and-mouth disease?

At the time of the interview, Namibia's last foot-and-mouth disease outbreak had been in 2011 in the Caprivi, as stated by participant 11. However, the country was devastated by such an outbreak in 2015, the worst in 40 years. The first seven cases were reported on 29 January 2015 in the far North Eastern Kavango regions, close to Angola (The Beef Site, 2015), but in May, spread to three other regions:

> *"In a press release last week, the acting permanent secretary of the ministry, Abraham Nehemia, said this disease was detected on 11 May at Ondama yOmunghete crush pen and on 12 May at Okalupalona and Onehanga crush pens in the Okongo constituency of the Ohangwena region. The second outbreak was detected on 13 May at Okakango village in the Onkankolo constituency of the Oshikoto region. According to Nehemia, the presence of the disease that can also spread to other central northern regions, was confirmed by the central veterinary laboratory in Windhoek on 12 May."*
>
> (The Namibian, 2015)

The FMD battle cost N$180 million and Namibia was declared FMD free only on 23 January 2016 (Xinhau, 2016) and the ban on the exporting of beef was subsequently lifted. A meeting was attended in Omuthiya where a group of animal technicians were discussing contingency plans. While travelling to the NCAs during the outbreak, one had to leave one's vehicle and step onto a wet blanket, treated to prevent the spread of the disease, as well as had one's vehicle's wheels sprayed with the same chemical. Figure 108 shows the wet blanket one has to wipe one's feet with and figure 109 shows how the officials spray the vehicle's wheels with chemicals.

Figure 108. The wet blanket one has to wipe one's feet on when entering the NCAs

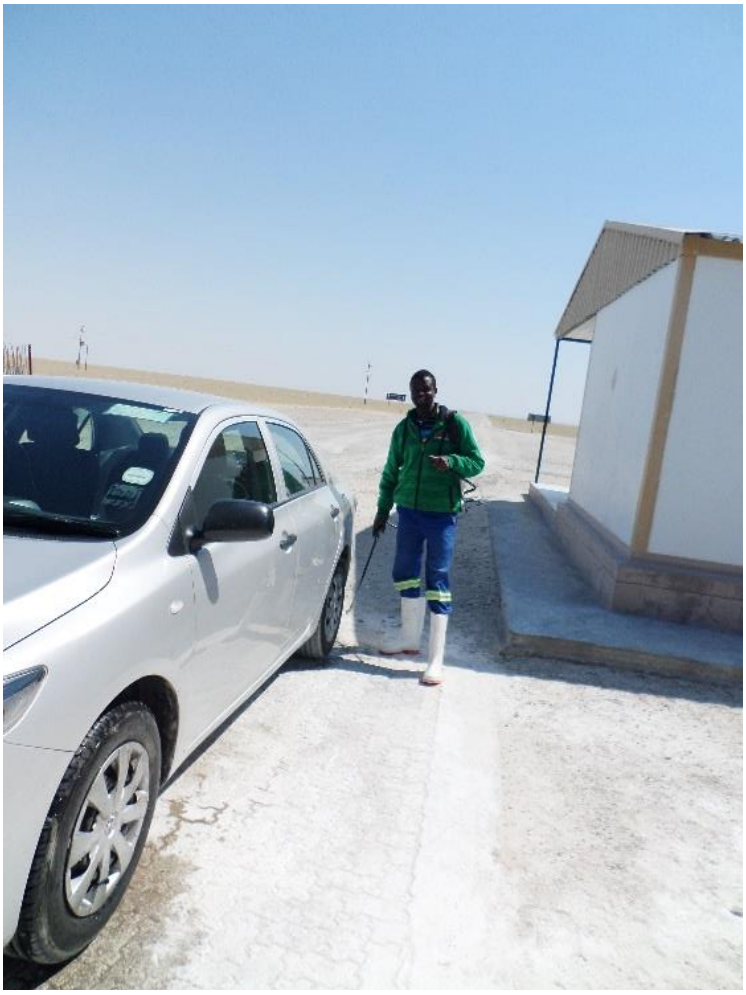


Figure 109. All vehicle's entering the NCAs wheels are sprayed

During time of crisis, the veterinary officials meet to discuss the FMD outbreak, and figure 110 illustrates how the animal technicians arrive in their numbers for the meetings.

Figure 110. The animal technicians gathering at the regional offices

Figures 111 and 112 show the signs of FMD:

Figure 111. Ulcers in the mouth Adopted from The Namibian (2015))

Figure 112. Foot lesions (Adopted from The Namibian (2015))

What are your agricultural policies and laws?

"We have a lot of legislation for instance we administering here quality insurance scheme and the people will have to comply with."

- Participant 11

Apart from the Stock Brands Act of 1995 and the Stock Brands Act Regulations of 2004, the following laws and policies are in place in Namibia:

Pedigree Identification

- Cattle – Breed Society Rules and Regulations
- Sheep and Goats – Breed Society Rules and Regulations

Traceability Identification

- Animal Diseases and Parasites Act (Act 13 of 1956)
- Animal Identification Regulations (No. 29 of 2009)

Interview 3 also took place on 8 February 2013 with a representative of the Directorate of Veterinary Services in Namibia, at their offices in Windhoek.

Interview 3

How many animal health technicians are in Namibia?

Unfortunately, the number of animal technicians could not be given at the time of the interview by participant 12, and after a number of requests no additional correspondence was supplied.

What is the impact on the Namibian communal farmer?

> "Basically, there is yearly farm inspections for specially the commercial farms, but for communal areas we strive to have two community visits, but at least we try to visit all 80 percent of farms, we strive to have 100% but it is acceptable if it is 80%, and during this inspections all animals should have been inspected, at least 80% of them if you really miss it out, but then you look at all the things that needs to be done, that is like the NamLITS part of it, whether the animals are branded, tagged and all the registers are in place and so on. Then you also look at the health of the animals as well as the animal welfare".
>
> - Participant 12

How often does a livestock auction take place?

> "Depending on the need like let us say there is some natural disaster or like drought and they try to have other auctions but they have to apply from the DVS officials."
>
> - Participant 12

Livestock auctions take place weekly, mainly on a Friday in the southern regions and on Thursdays in the NCAs. Three different auctioneers operate in Namibia. The auctions do not take place on weekends, because the veterinary officials need to be present. There are no auctions on Mondays.

Do these auctions take place countrywide?

The auctions take place countrywide, says participant 12, with ad-hoc auctions possible in certain cases. The DVS administers the entire auction, ensuring that all the requirements of traceability are met.

How do stock permits work?

"This cow, it is a female then it is a beef breed, it is a cross-breed or whatever and indicate the name of the farm where it is. Because if you have six farms you have to tick exactly where it is and that means that we are registering that animal in that particular farm. If you want to move that animal to another farm you need a permit for that. You have to apply for a permit."

- Participant 12

When a farmer orders the ear tags, a registration card for the ear tags is completed and the ear tags are applied to the cattle. The registration card is returned to the DVS within fourteen days.

The paperwork is only a small part of the entire application; an electronic permit is generated from the paperwork, scanned and sent to the farmer. All the animal's details are captured within the following fourteen days on NamLITS, with all the movement information, such as being moved from an auction or to an abattoir.

If there is an outbreak of foot-and-mouth disease, what are the procedures you have in place to minimise the effects?

In short, the entire area is quarantined, no animal is moved from that region or moved into the infected region, explains participant 12.

What are your contingency plans?

"They then ask the NamLITS system to trace for example which animals moved from that spot point to out of that spot point for the last month or something and then we recall all those animals or the permits if they are not used and then we close then all those farms that took animals from that spot point."

- Participant 12

If an animal is exposed to any other animal like buffalo with FMD, an area with a radius of three kilometres is immediately quarantined. Subsequently, the wider areas are examined, and as is necessary, a larger area is quarantined for 21 days. After 21 days, the situation is re-assessed and the quarantine is lifted, or the area is again quarantined for 21 days. The director will give permission for the lifting of the quarantine.

8.3.3. Summarising the results from the interviews

Namibia has successfully implemented traceability in the Southern areas and expanded their system to also include the NCAs, with the main aim of lifting the movement restrictions between the VCF. Currently, the communal farmers in the NCAs cannot yet export beef, but what the traceability system showed with the severe FMD outbreak, is that it can in a short period of time, quarantine the specific regions and subsequently can stop the spread to the entire country. NamLITS is more advanced than SLITS and has more money invested in the system, learning from past mistakes. The Government of Namibia has a vested interest in keeping NamLITS fully functional and the developers of NamLITS ensure that it adheres to the strictest regulations.

8.3.4. An analysis of the results obtained from the questionnaires

During August 2015 a meeting was held with the animal technicians of the NCAs, a rare occurrence for such a large group to come together. Unfortunately, the reason for their gathering was because of a foot-and-mouth disease outbreak, where contingency measures and execution plans were discussed. It was during this meeting that questionnaires were distributed, and the animal technicians willingly agreed to complete them. Northern Namibia is a vast open space, and to be able to travel to only one town, Omuthiya, to get a large group together, made the data collection process much easier. A total of 39 animal technicians attended the meeting, and although the ideal was to gather 50 questionnaires, the sample size was sufficient to draw the necessary conclusions. The sample sizes are shown in table 13.

	Target	Actual/Returned	Variance
Sample Size	***50***	***39***	***11***
Questionnaires distributed by the NamLITS project team	0	0	0
Questionnaires distributed by the researcher	50	39	11

Table 13. Summary of the sample size of the NamLITS questionnaire

The questionnaire was split into four sections:

Section A: Biographical information of the animal technician

Section B: Information on the crush pen area

Section C: Information on NamLITS

Section D: The animal technicians' interactions with NamLITS

The questionnaire detailed the interaction of the animal technicians with NamLITS, as well as with communal farmers in their crush pen areas. The questionnaire was very similar to the questionnaire distributed in Swaziland, and is found in Appendix 2.

Results from the analysis

- Section A: Biographical information of the animal technicians

Of the 39 participants, 28 were male and 11 female, seen in figure 113.

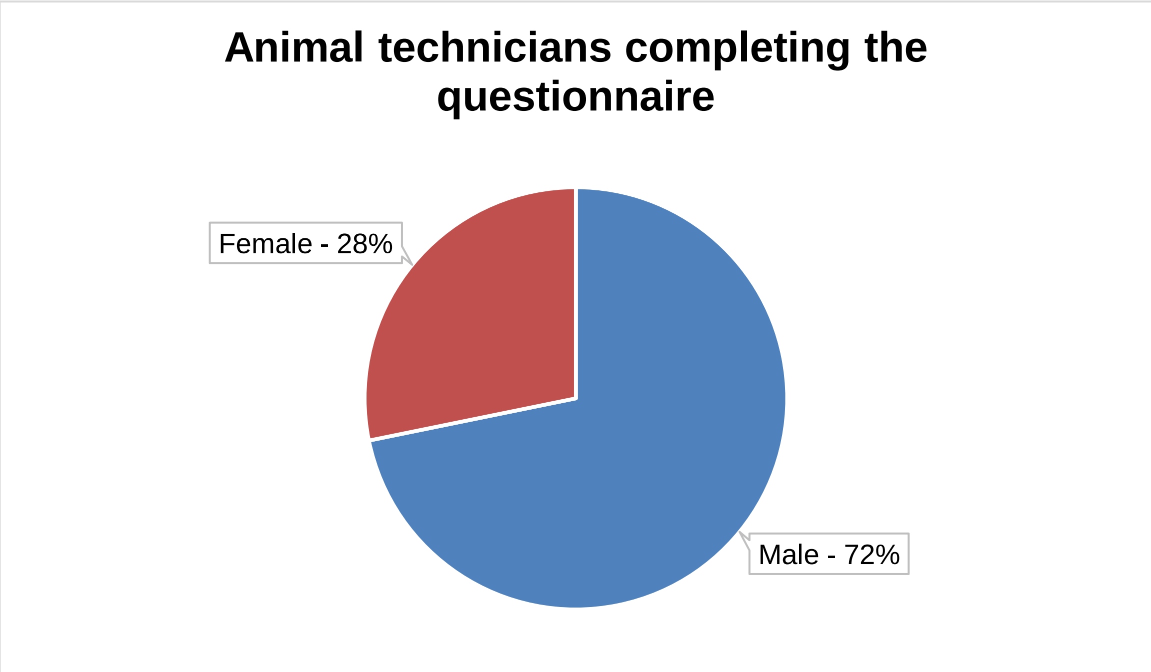


Figure 113. Animal technicians completing the questionnaire

As with Swaziland, the animal technicians were asked their age, and then placed in the following four categories, shown in figure 114:

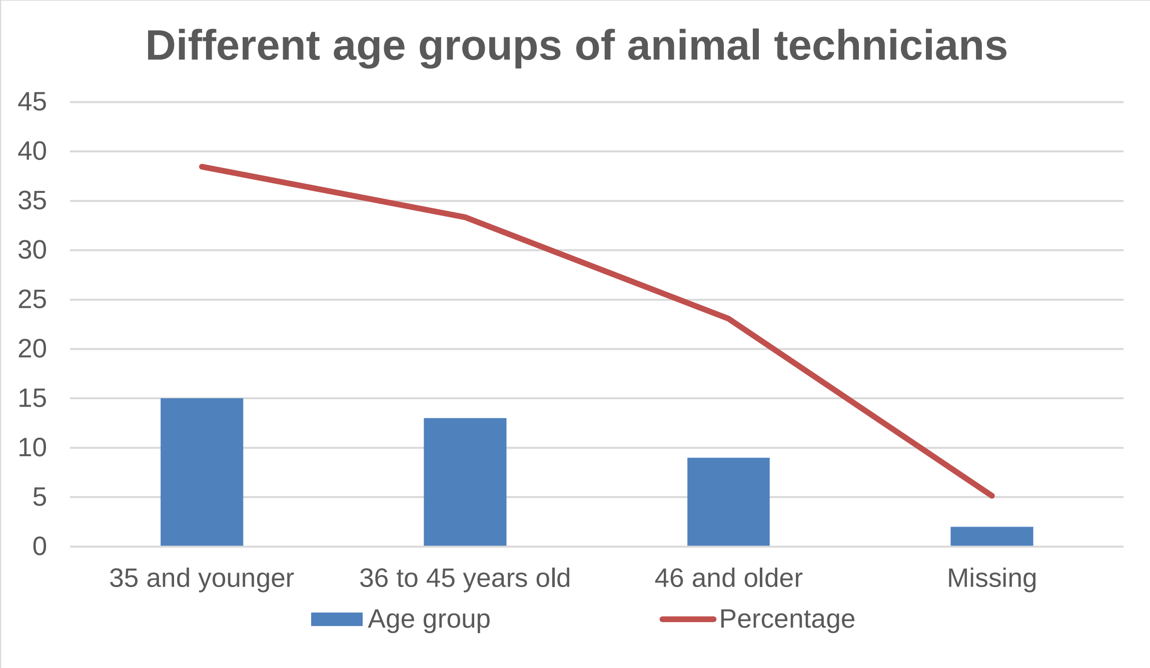


Figure 114. Different age groups of animal technicians

The number of years working as an animal technician was asked and categorised in Figure 115. It is interesting to see that more than 35% of the animal technicians had been working in this position for 15 years or longer.

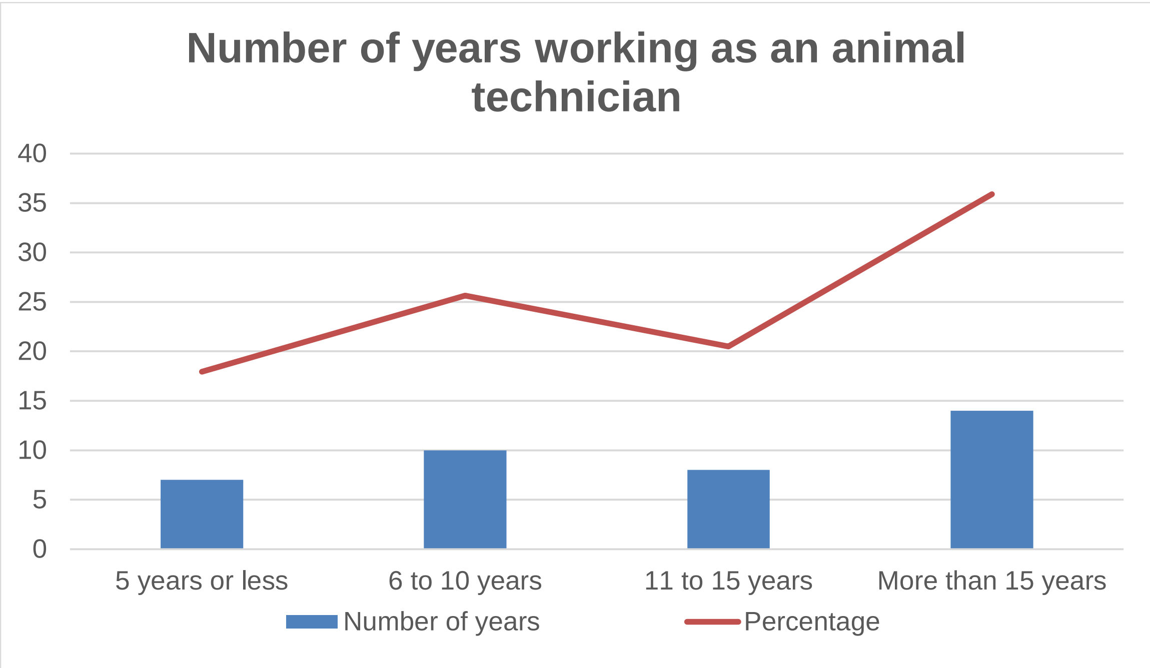


Figure 115. Number of years working as an animal technician

- Section B: Information on crush pen area

The animal technicians came from fifteen different regions: Eenhana, Isandi, Okahao, Okongo, Omanni, Omundaungilo, Omuthiya, Onamulunga, Onavojaba, Ondangwa, Opuwo, Oshakati, Outapi, Tsumeb, Walvis Bay and one animal technician did not disclose her region, as seen in figure 116.

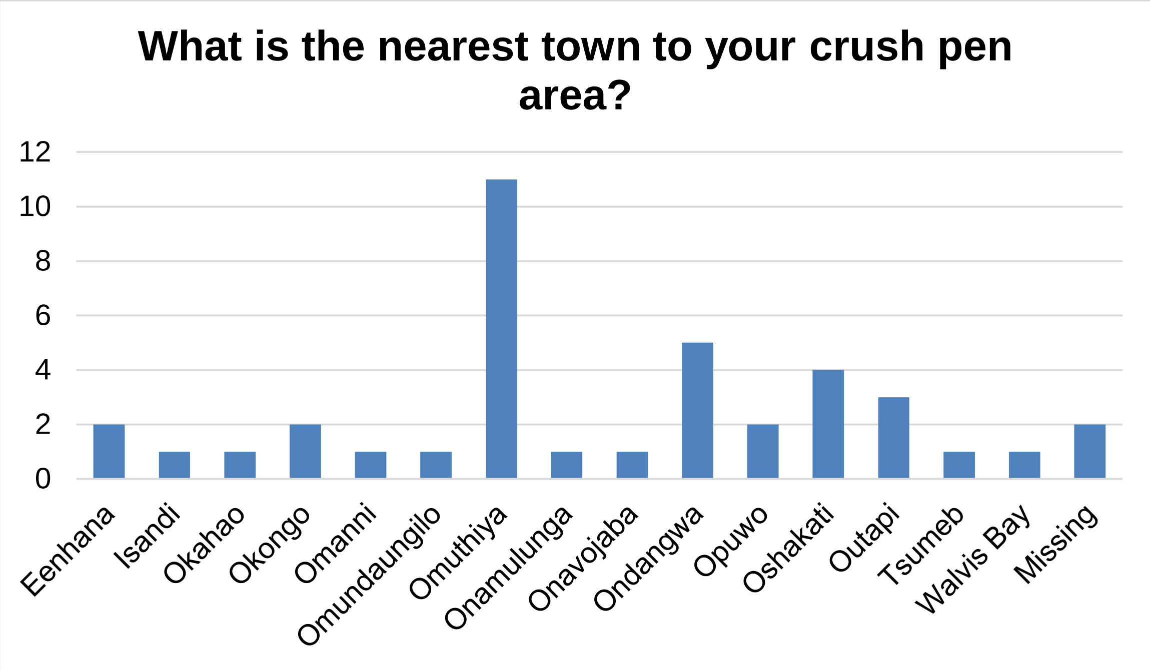


Figure 116. The nearest town to the animal technician's crush pen areas

Of the farmers in the animal technicians' areas, 35% were female and 65% male, shown in figure 117. One would not expect such a high number of female farmers, as the men and boys herd the cattle.

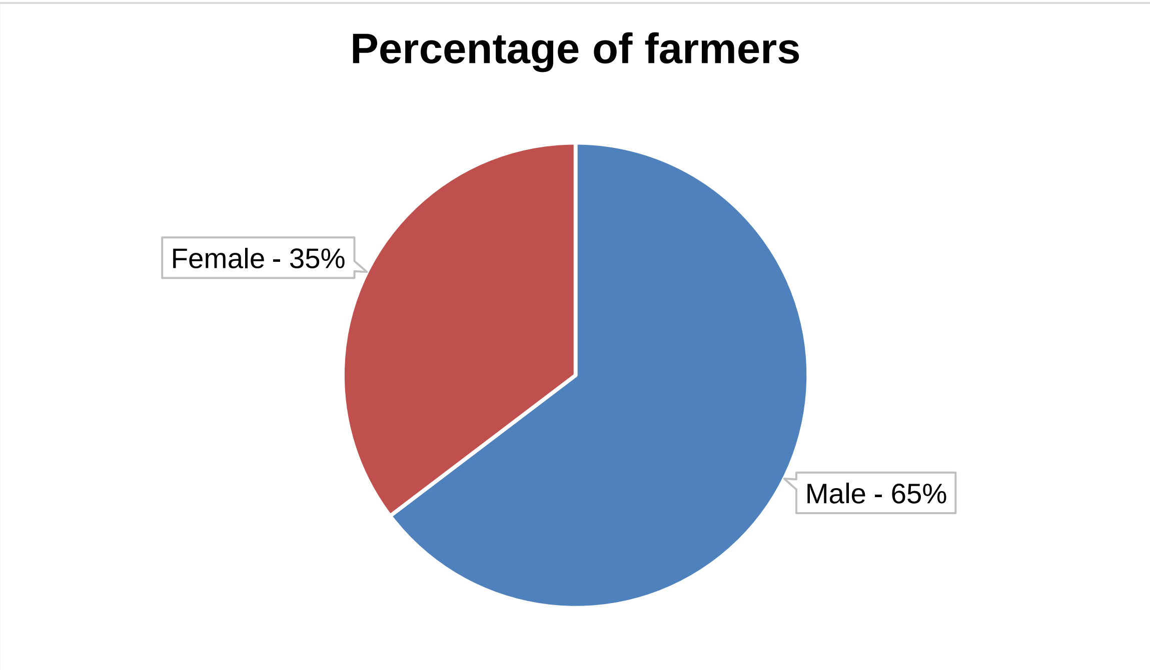


Figure 117. The average number of farmers in crush pen areas

In Figure 118 the percentage of male and female farmers per crush pen is shown. The mean guides one in determining whether the male or female distribution is dominant. The standard deviation is the smallest in Omuthiya, where the female farmers are only slightly more than the male farmers. Some of the regions did not clearly indicate the male / female ratios and were omitted from the graph.

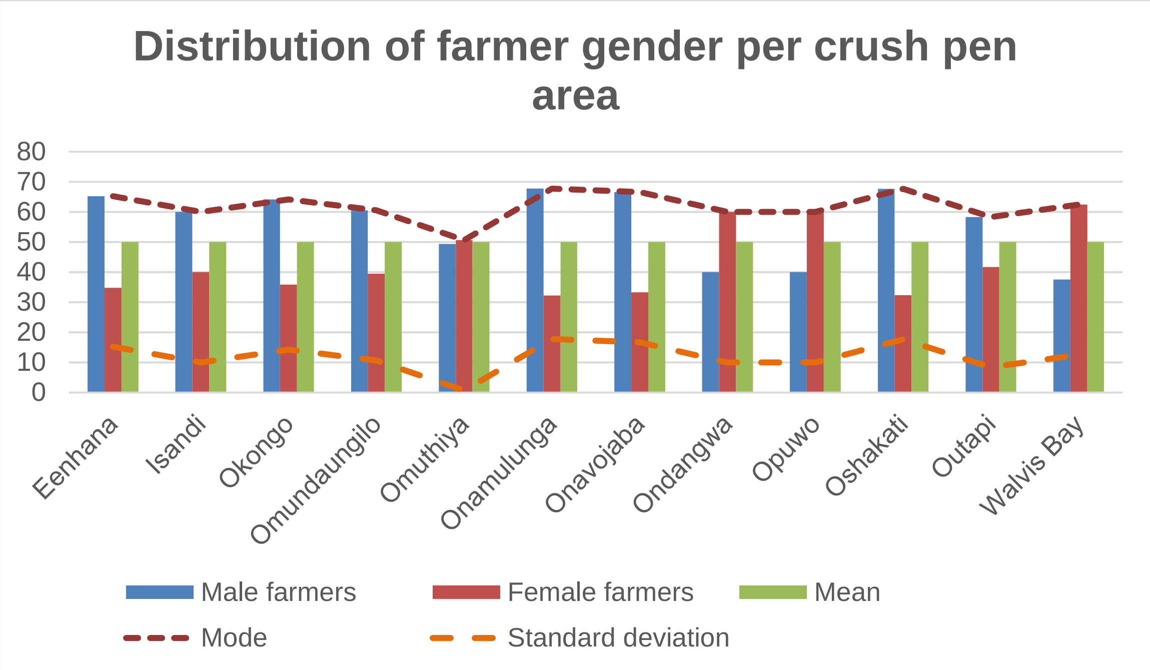


Figure 118. Distribution of farmer gender per crush pen area

In figure 119, almost 90% of all communal farmers keep livestock and grow crops, but one farmer farms with mainly pigs, and is shown under "Other" in the graph below.

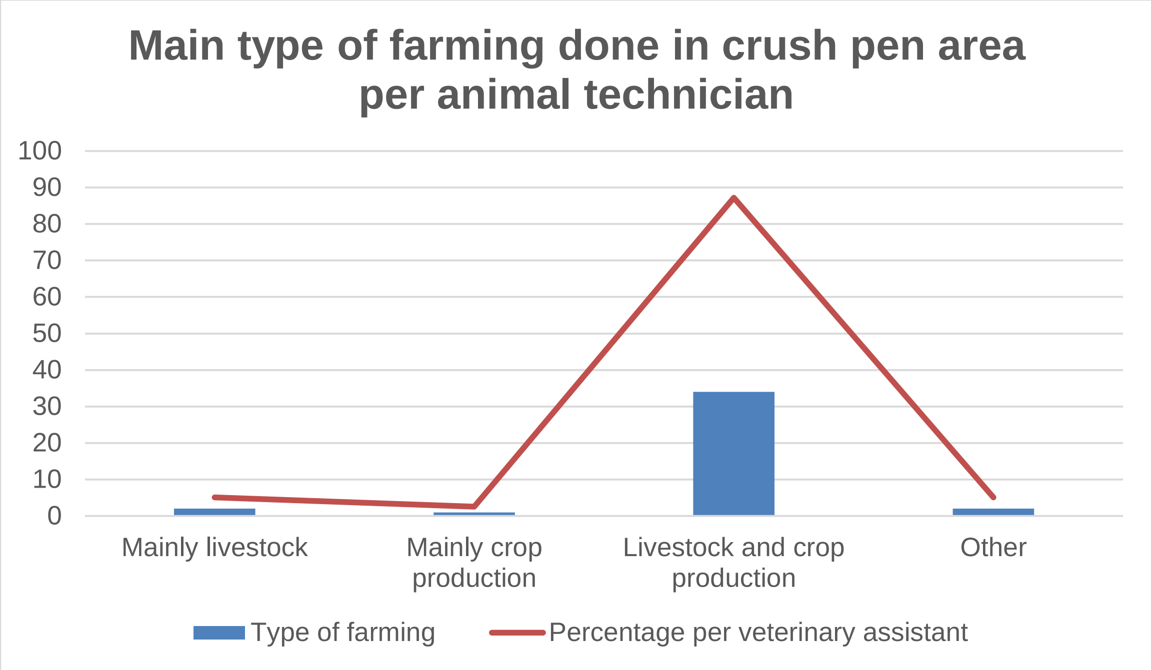


Figure 119. Main type of farming done in crush pen area per animal technician

99% of all the farmers living in the NCAs in the animal technicians' crush pen areas are communal farmers, shown in figure 120.

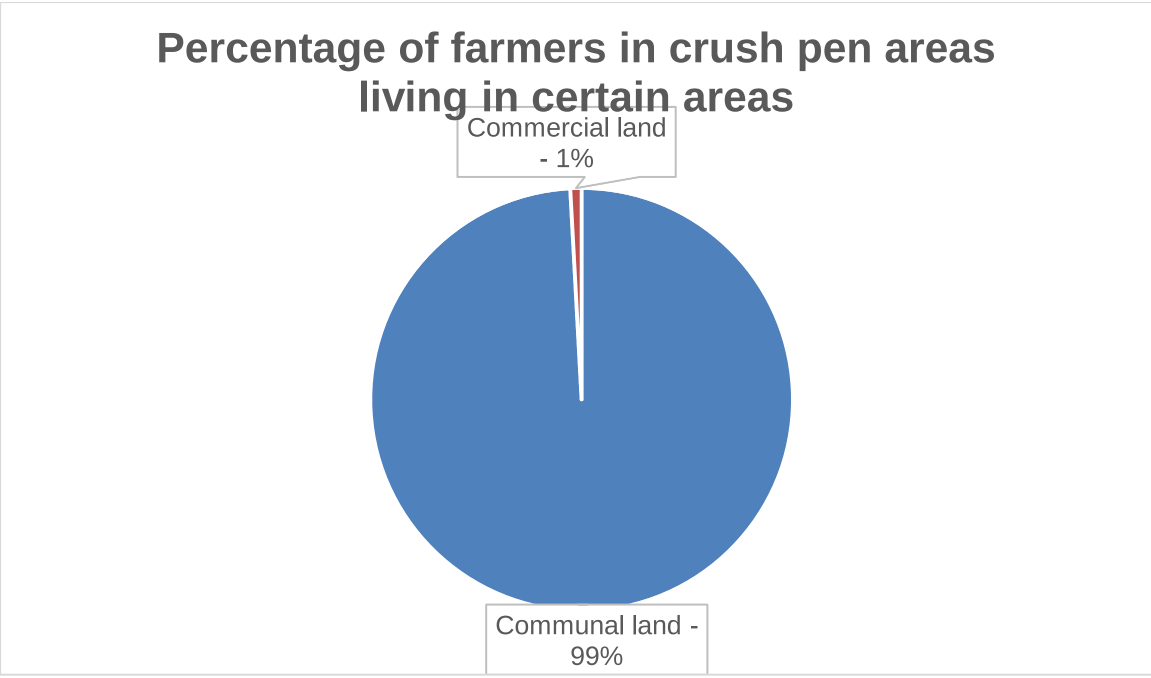


Figure 120. Percentage of farmers in crush pen areas living in certain areas

In informal discussions it was said that the animal technicians visit the communal farmers' crush pens twice a year, but at the time that they answered the questions – during the FMD crisis –

many indicated that they then visited the crush pen areas more than once a week. Figure 121 illustrates the number of visits of the animal technicians to the crush pen areas:

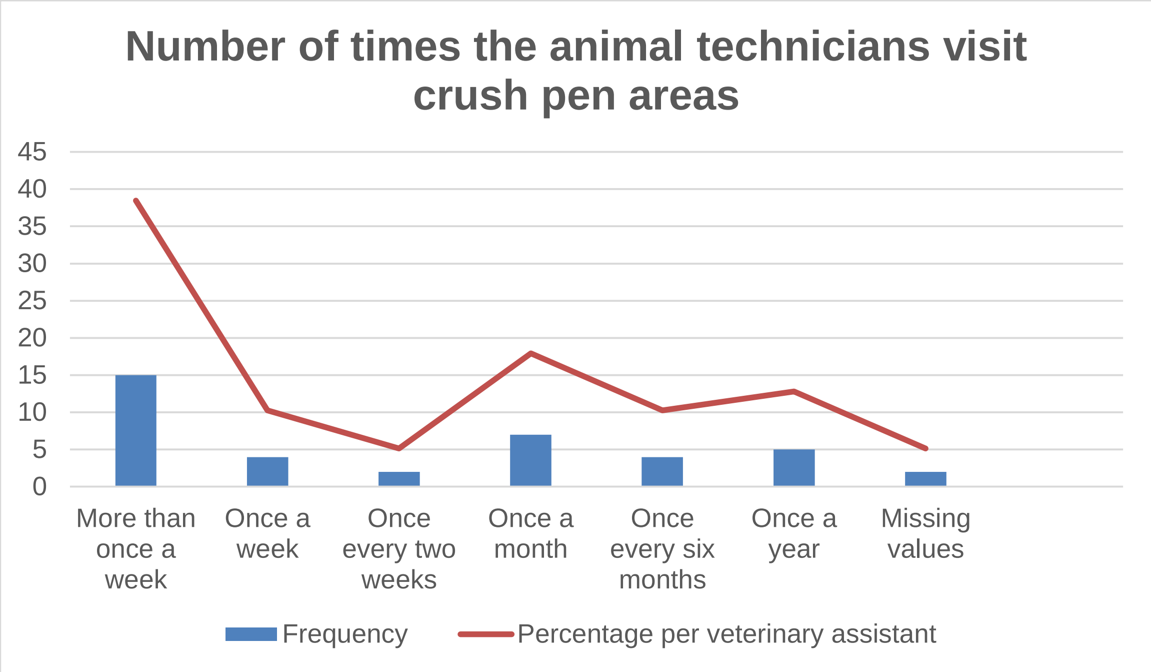


Figure 121. Number of times the animal technicians visit crush pen areas

- Section C: Information on NamLITS

In Section C the perspectives of NamLITS is reflected by asking the animal technicians a number of questions, and grouping their answers in terms of gender, age group and years of experience. The first question made it clear that although most of the cattle in the crush pen areas are ear-tagged, in the majority of the cases, at least some of the animals still require ear-tags, shown in figure 122.

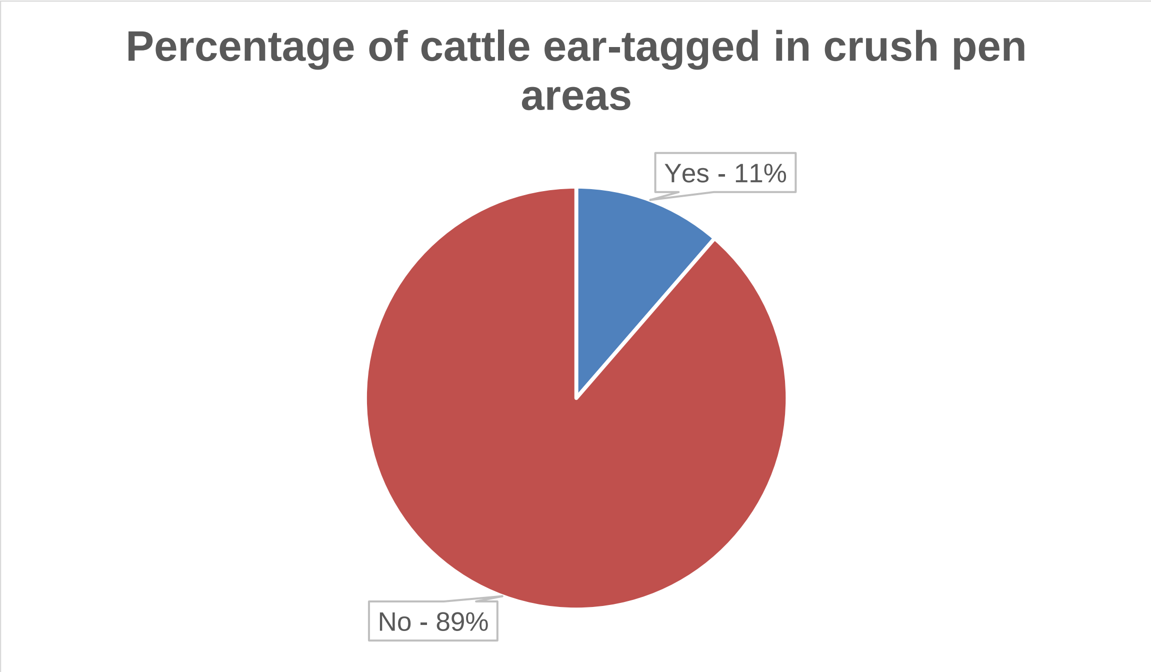


Figure 122. Percentage of cattle ear-tagged in crush pen areas

As in the case of Swaziland, the Namibian animal technicians answered three questions regarding the general health of the herd, the incidence of contagious diseases, in this case, FMD, and the market prices received for cattle sold. The following three graphs show the results obtained per gender:

The data displayed in Figures 123 up to 140 are again cross-tabulations calculated in SPSS and is show in Appendix 6. The Chi-square calculations are also displayed in the appendix 6, directly below the cross-tabulation result, with only certain results highlighted.

In Figure 123 both the males and females were of the opinion that the general health of the herd had improved, with 59.4% and 75% respectively, but 28.1% of the males saw no improvement. The Pearson Chi-square result showed no significant association at 0.377.

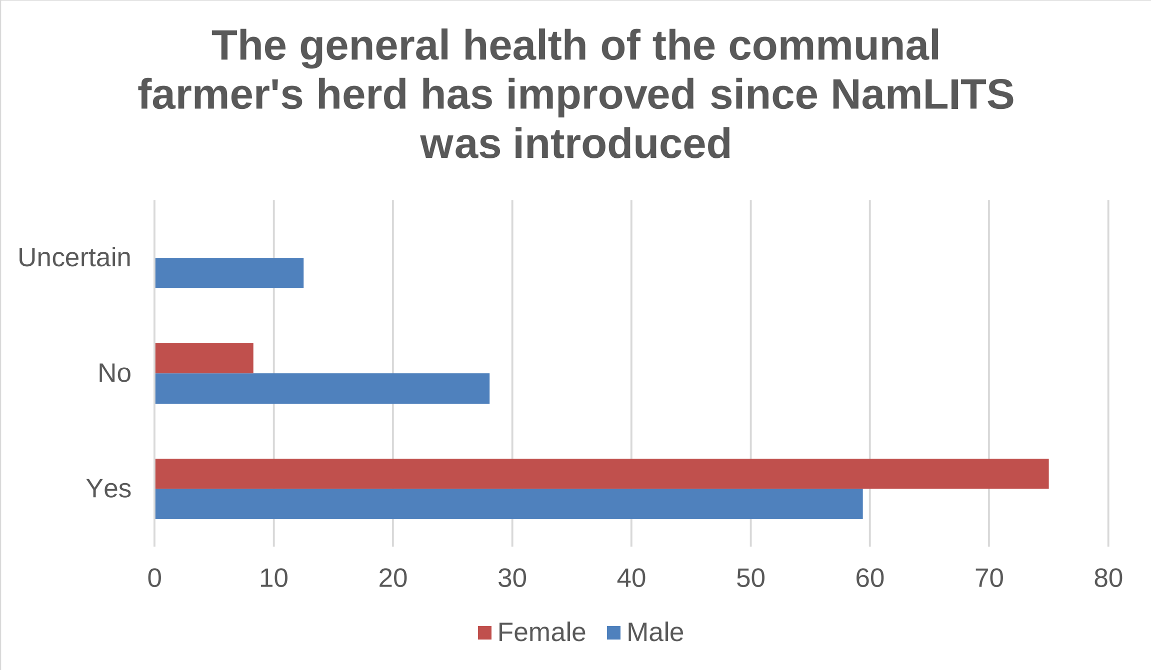


Figure 123. The general health of the communal farmer's herd had improved since NamLITS was introduced

In Figure 124, the females all chose "Yes", "No" and "Uncertain" equally, while 54.4% of males felt that it did not decrease. The timing of the completion of the questionnaires played a role, as it was during the severe FMD outbreak that the animal technicians were asked to give their opinions.

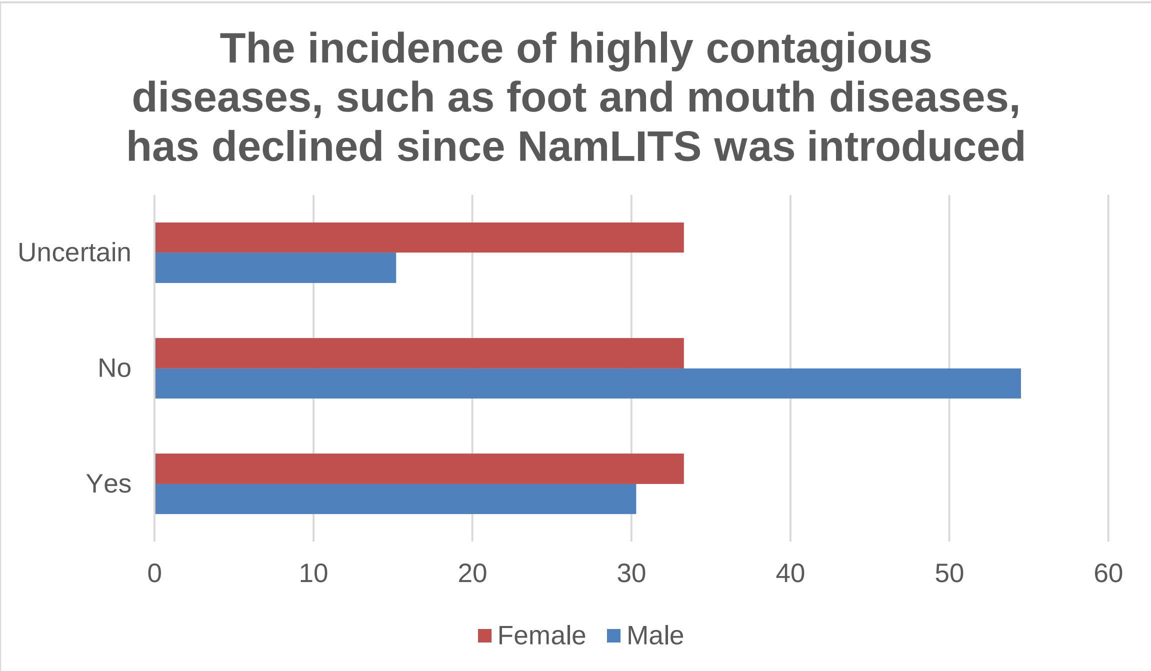


Figure 124. The incidence of highly contagious diseases, such as foot and mouth diseases, had declined since NamLITS was introduced

The majority of males and females agreed that communal farmers did not receive better prices for their cattle sold, as shown in figure 125. The communal farmers in the NCAs are not yet able to export, in order to ensure higher demand and higher prices.

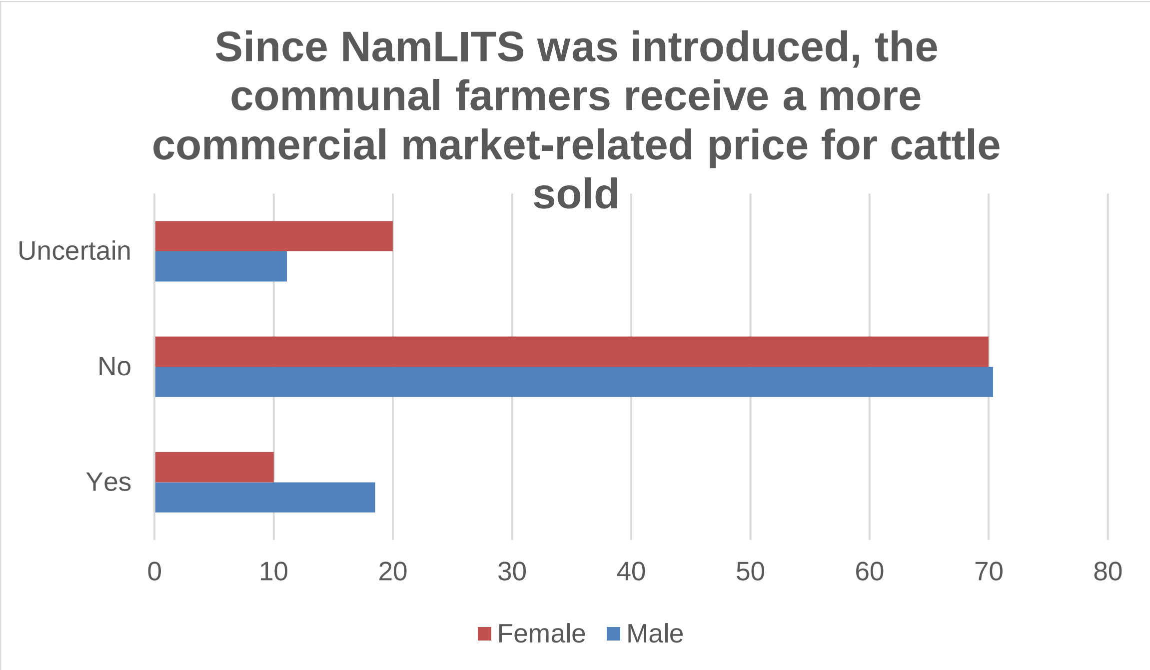


Figure 125. Since NamLITS was introduced, communal farmers had received a more market-related price for cattle sold

The following three graphs categorise the animal technicians' responses in terms of their age group. Overall most of the animal technicians believed that the general health of the herd had improved, but 44% of all the animal technicians 46 years and older were uncertain. The timing of the questionnaire definitely influenced their answers.

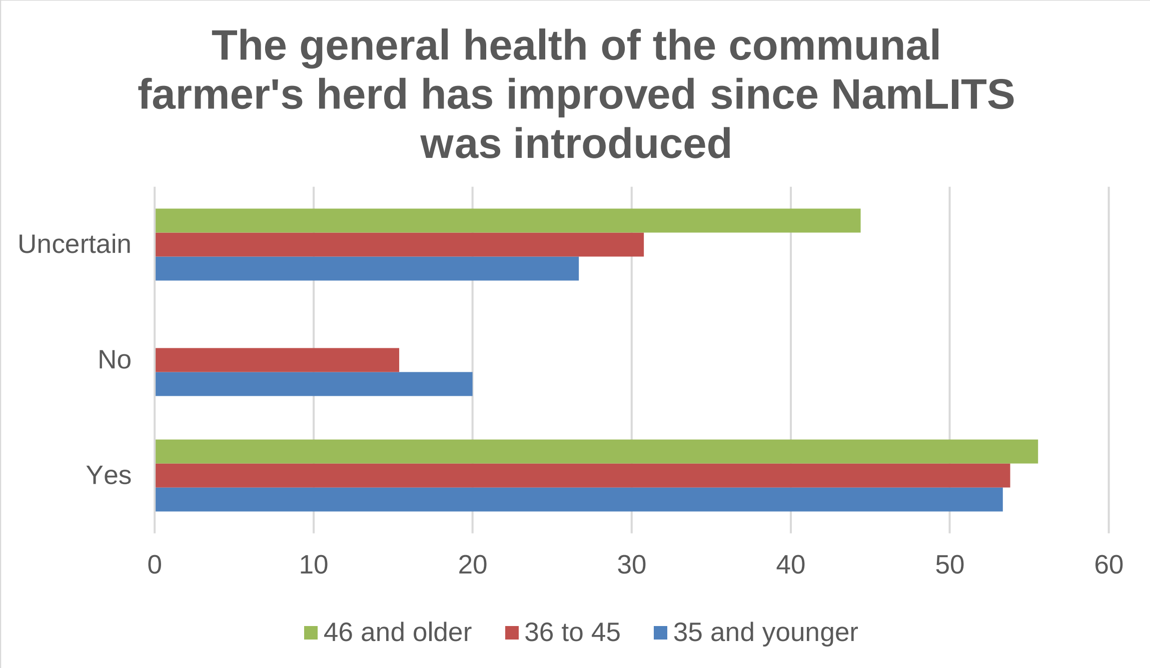


Figure 126. The general health of the communal farmer's herd had improved since NamLITS was introduced

In figure 127 the older age group expressed the opinion that the incidence of diseases had declined, compared to only 23.1% of the age group 36 to 45 years and 33.3% of the 35 and younger group.

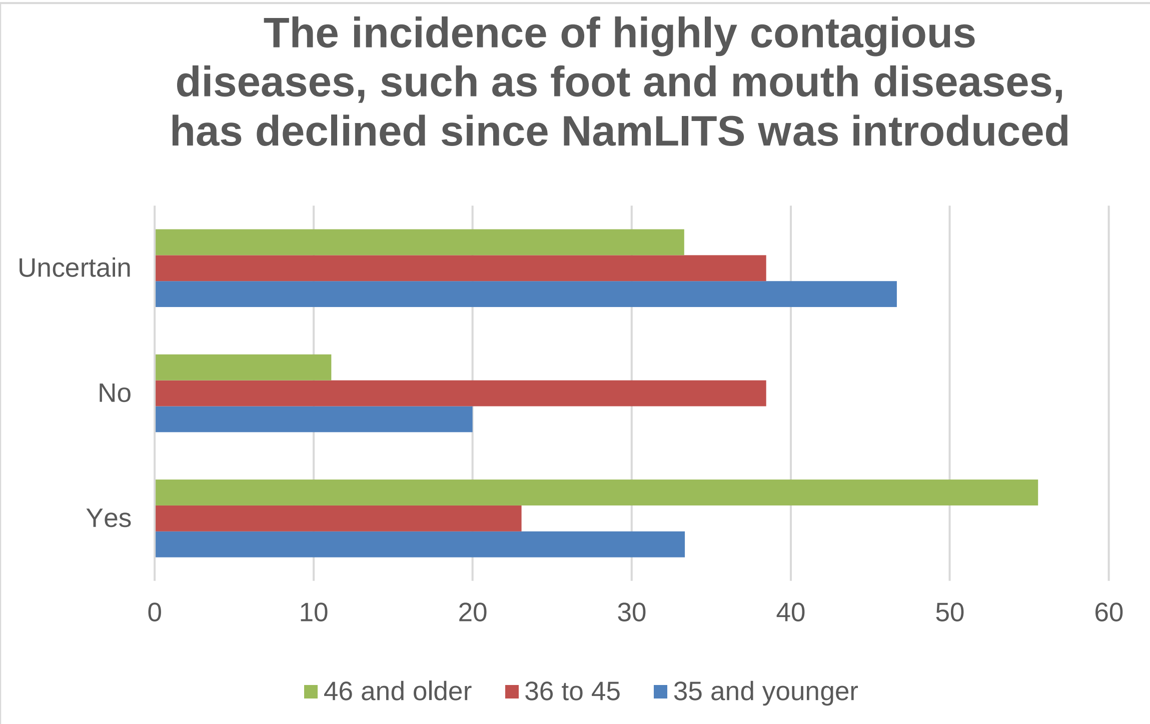


Figure 127. The incidence of highly contagious diseases, such as foot and mouth diseases, had declined since NamLITS was introduced

In figure 128, the general consensus is that of not receiving higher prices for cattle sold. Both Figures 127 and 128 showed that there was no significant association between the answers, with p-values of 0.446 and 0.554 respectively.

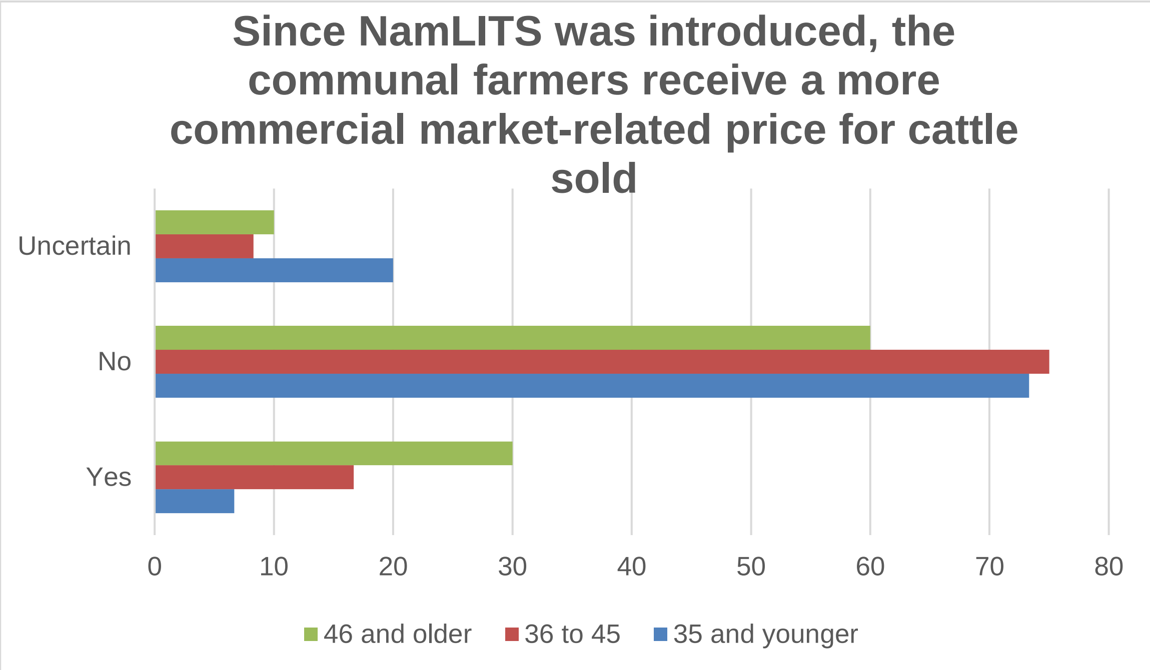


Figure 128. Since NamLITS was introduced, communal farmers had received a more market-related price for cattle sold

The next three graphs show how the animal technicians' answers differed when classified into four different groups of experience. In Figure 129 a number of animal technicians felt uncertain whether the general health of the herd had improved, compared to the other three groups who all answered with an overall "Yes" at 58.3% or more.

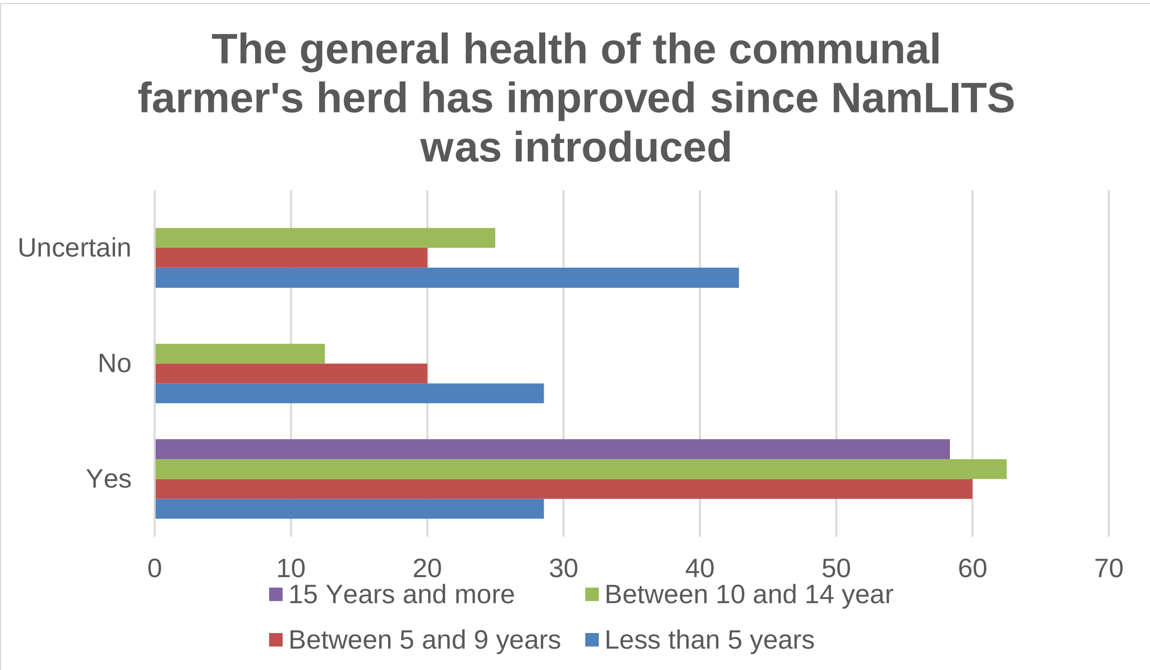


Figure 129. The general health of communal farmer's herd had improved since NamLITS was introduced

In Figure 130 it is clear that the respondents from different years of experience did not agree whether contagious diseases had declined or not. There are quite different opinions, but it can again be expected given the situation in which the data was collected.

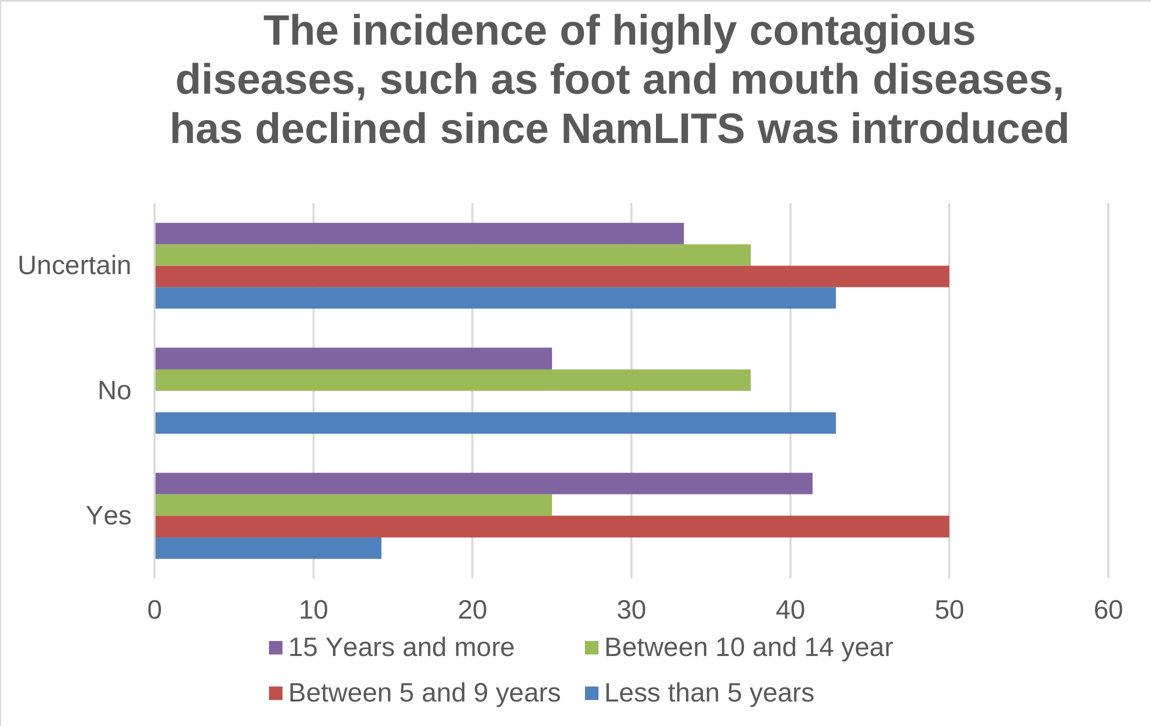


Figure 130. The incidence of highly contagious diseases, such as foot and mouth diseases, had declined since NamLITS was introduced

71.4% of the age group with less than 5 years' experience expressed the point of view that the farmers did not receive more money for cattle sold, with age groups 5 to 9 years and 10 to 15 years also indicating that it was not the case. 25% of age group 15 years and more were positive that they did receive more money, but 66.7% were convinced otherwise, as shown in figure 131.

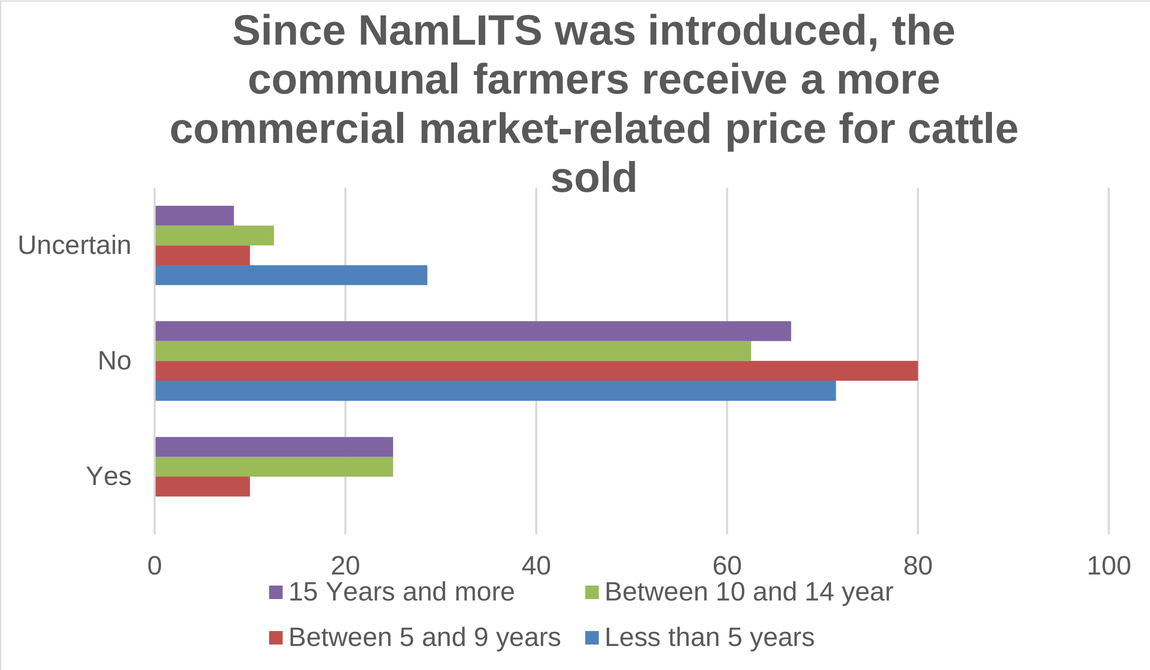


Figure 131. Since NamLITS was introduced, communal farmers had received a more market-related price for cattle sold

The next set of statements measure responses against gender, age group and years of experience. All the females and 96.4% of the males expressed the opinion that the vaccination of cattle was accurately documented, shown in figure 132.

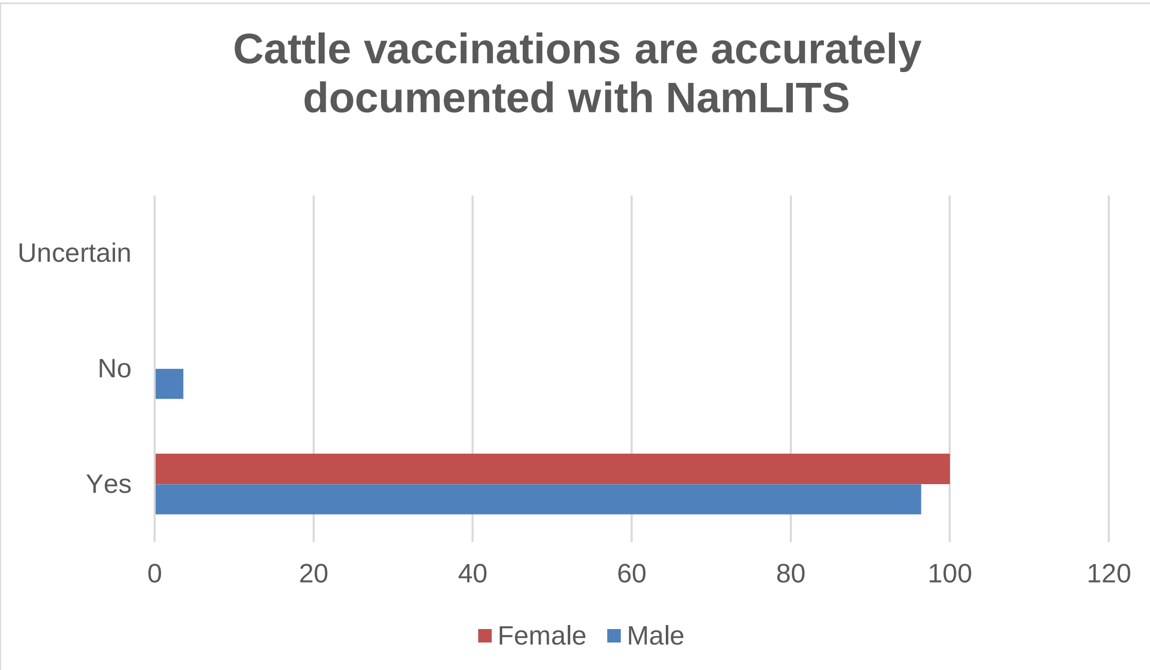


Figure 132. Cattle vaccination is accurately documented with NamLITS

All participants agreed on the statement that NamLITS simplifies tracking of communal farmers' cattle vaccination, seen in figure 133. This is sketching a clear picture of how well NamLITS is functioning in times of crises, with clear consensus throughout. Because of the answers in both cases being 100%, SPSS were unable to calculate a Pearson Chi-square vlaue.

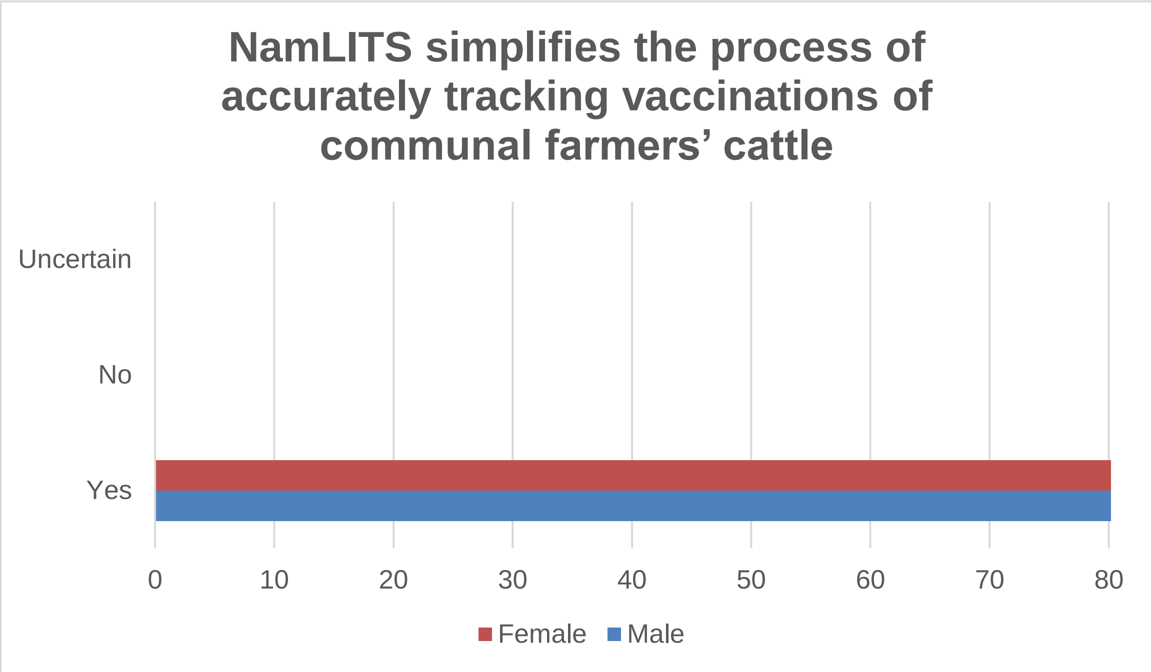


Figure 133. NamLITS simplifies the process of accurately tracking vaccination of communal farmers' cattle

In figure 134, all the males and 90.9% of the females were of the opinion that NamLITS helps with the containment and management of disease outbreaks. This is a very positive response, especially if one keeps in mind that at the time of completing the questionnaires, the animal technicians were struggling with the FMD outbreak. It shows that NamLITS was extremely useful for them.

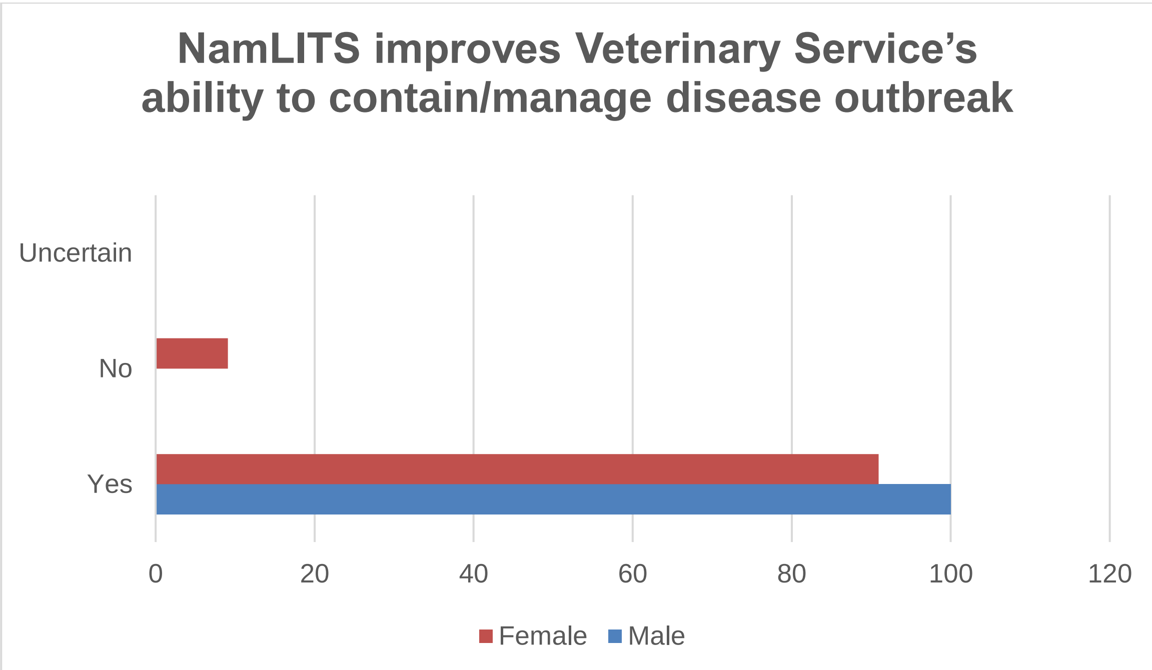


Figure 134. NamLITS improves Veterinary Service's ability to contain/manage disease outbreak

In terms of age group in figure 135, only 7.7% of the participants in age group 36 to 45 years indicated that cattle vaccination was not accurately documented, while all the other participants were 100% in agreement.

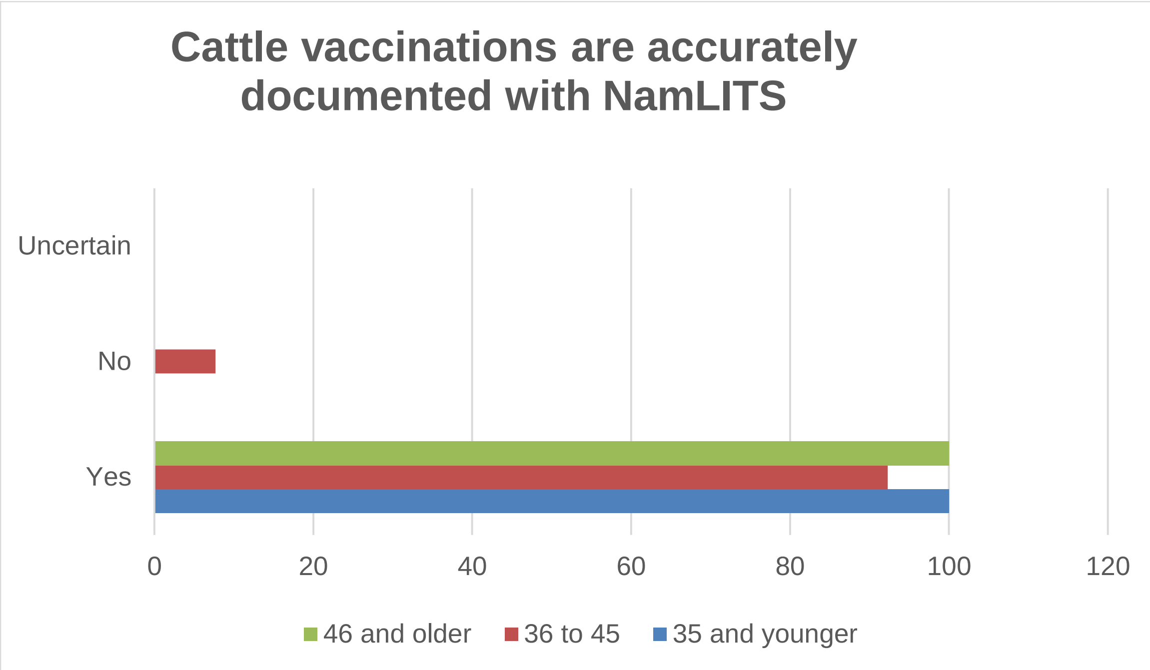


Figure 135. Cattle vaccination was accurately documented with NamLITS

Just as in the graph measuring male and female responses, all the age groups agreed on the simplification of tracking cattle vaccination, shown in figure 136 below, making the calculation of the Pearson Chi-square value incalculable.

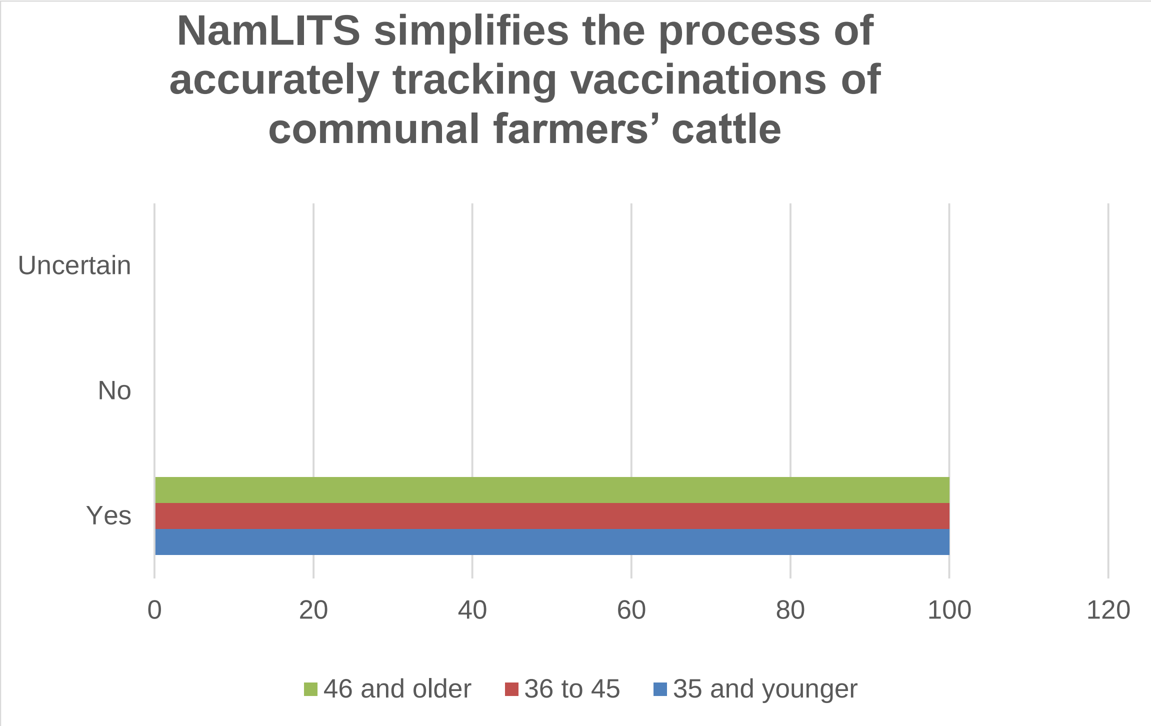


Figure 136. NamLITS simplifies the process of accurately tracking vaccination of communal farmers' cattle

6.7% of the age group 35 years and younger were not convinced that NamLITS assists with disease outbreaks; the rest agreed that it does so, as seen in figure 137.

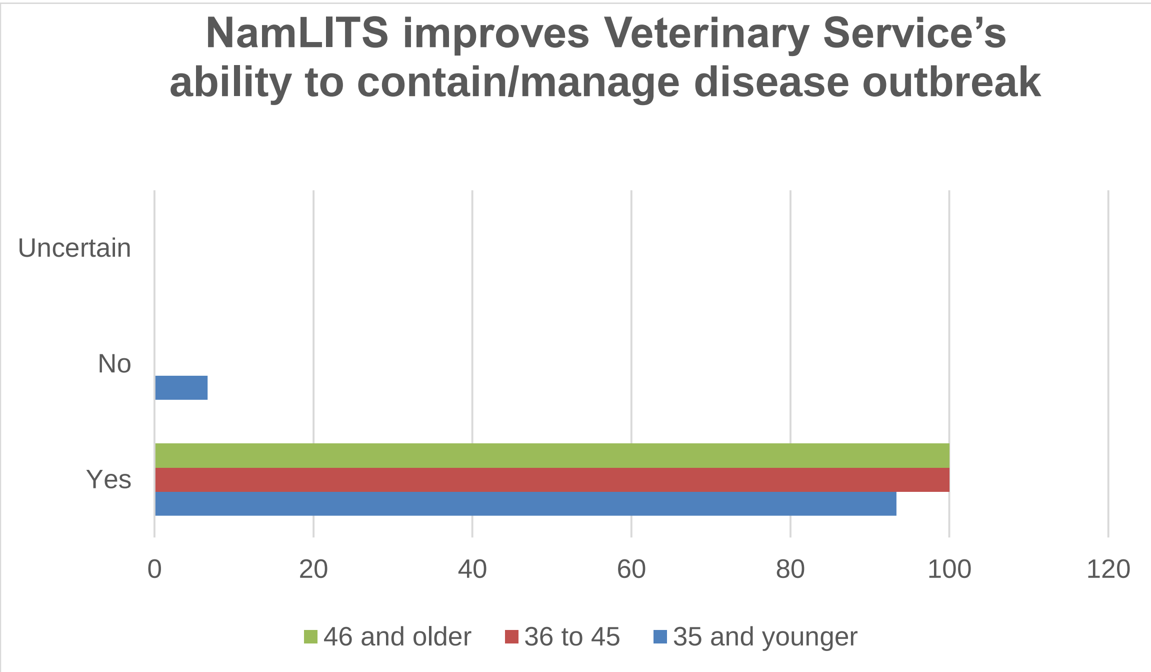


Figure 137. NamLITS improves Veterinary Service's ability to contain/manage disease outbreak

In terms of the different years' of experience, one sees in figure 138 that almost all of the groups agreed that NamLITS assists in documenting cattle vaccination accurately.

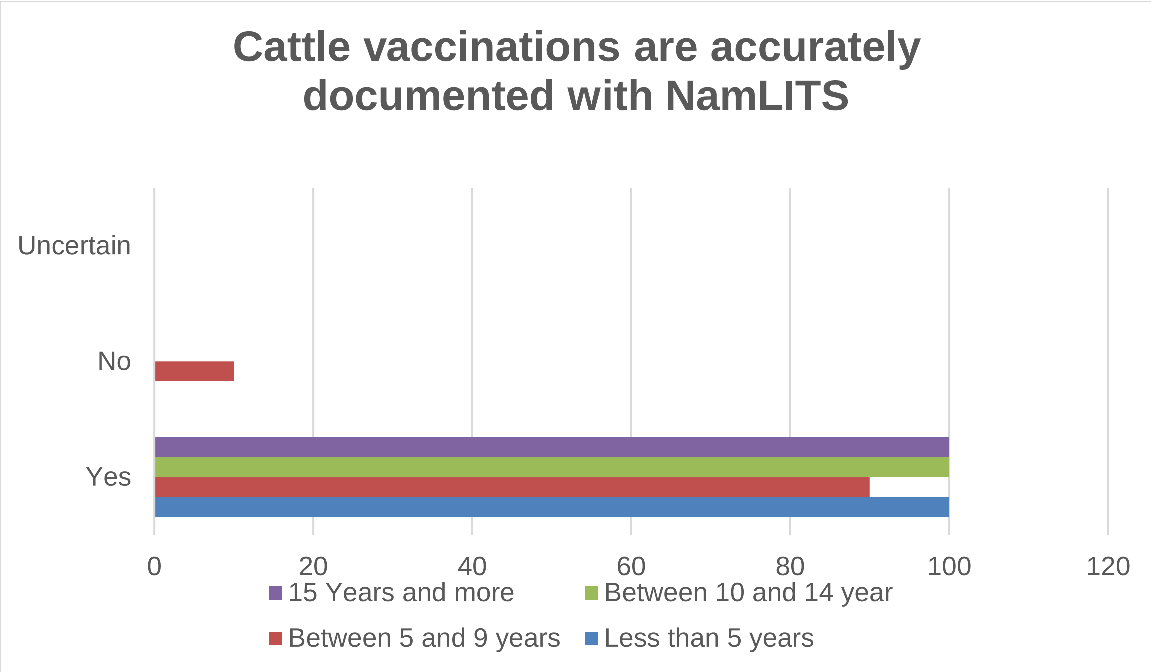


Figure 138. Cattle vaccination is accurately documented with NamLITS

All participants agree, as before, that NamLITS simplifies the tracking of animal vaccinations, seen in figure 139.

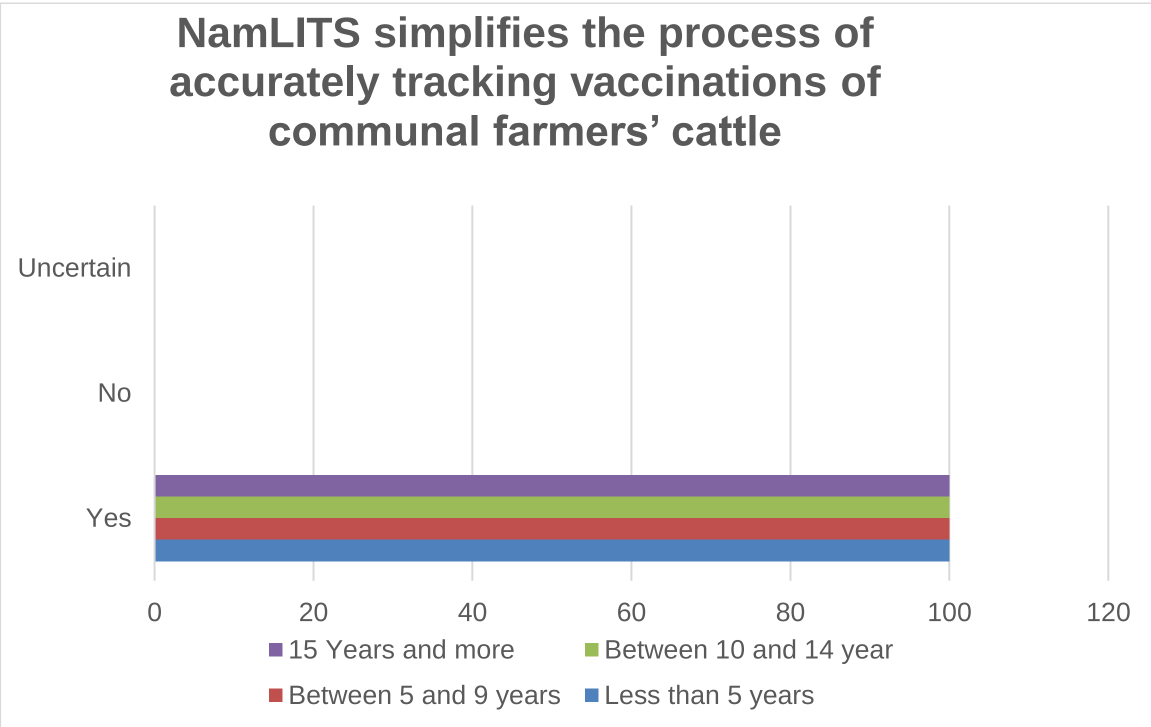


Figure 139. NamLITS simplifies the process of accurately tracking vaccination of communal farmers' cattle

14.3% of the age group with less than 5 years' experience were not 100% convinced that NamLITS assists in containing disease outbreaks; the rest fully agreed, seen in figure 140.

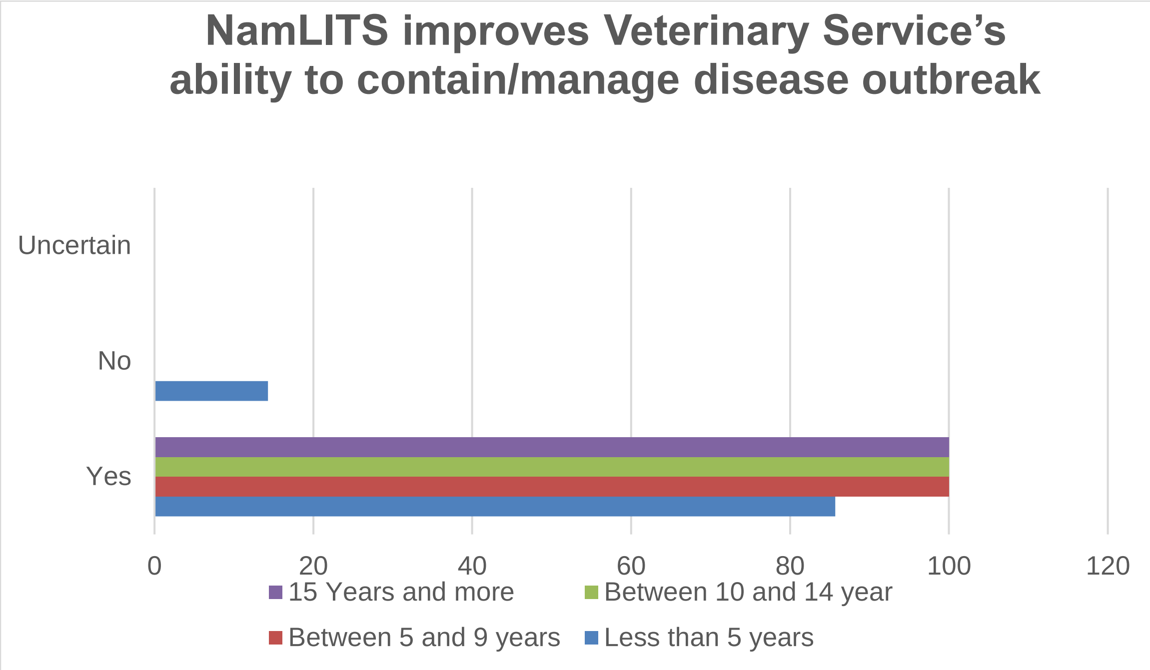


Figure 140. NamLITS improves Veterinary Service's ability to contain/manage disease outbreak

- Section D: The veterinary assistants' interactions with SLITS

Some comments given by the animal technicians follow:

- Seven participants said that NamLITS assists them with identifying lost or stray animals and two participants said it helps with stock theft.
- Three participants mentioned how NamLITS helps in identifying un-vaccinated animals.
- One animal technician mentioned the worth of NamLITS as a tool to negotiate better trade agreements and another said it makes it easy to market one's animals.
- One participant welcomed the fact that NamLITS is now being used country-wide.
- Four participants mentioned that it made their work easier.

NamLITS is welcomed by the NCAs' animal technicians and the system is being adopted with very positive results. Finally, all the evidence collected in the second layer is summarised in Table 14 below, showing the broader developmental impacts by looking firstly at the context, secondly at the change in behavioural precursors and thirdly the change in behaviour.

Context	Change in behavioural precursors	Change in behaviour	Broader developmental impact
1. Lack of knowledge of how the NCAs are affected by the introduction of NamLITS.	Two visits to Namibia, witnessing cattle being dehorned and branded, speaking to NamLITS developers, state veterinarians, members of the Namibian Meat Board and at the Ministry of Agriculture.	Gaining a better understanding of the NCAs through discussions.	Developing a deeper sense of the challenges the communal farmers face in the NCAs.
2. Lack of knowledge of the challenges the animal technicians face in the NCAs.	A visit to the NCAs, where a group of animal technicians were meeting to discuss the containment of the recent FMD outbreak.	Examining the effect of FMD, talking informally to the animal technicians and learning about their fears and hearing success stories.	A new technology is examined to assist the animal technicians to contain the FMD outbreak.
3. Lack of NamLITS system knowledge and all its complexities.	Introduction to the NamLITS interface, an RFID reader and Toughbook.	Hands-on exposure to the NamLITS system.	Gaining a better understanding of what NamLITS is capable of doing for the NCAs.
4. Lack of knowledge of the cultural differences in the NCAs between different tribes.	A visit to the NCAs as well as research on cultures and traditions.	More knowledge is obtained.	The challenges, beliefs and traditions are better understood.
5. Lack of understanding of how the different animal movement zones function in Namibia.	Documentation studied and discussions held with stakeholders to explain the different animal zones – the infected buffer, surveillance and free zones.	Discussions lead to better insight.	A deeper understanding is achieved to appreciate the necessity of the different movement zones.
6. Communal farmers were previously not included in the traceability system.	Animal technicians started ear-tagging animals and are continuing to do so.	More tagged animals lead to better traceability and disease control.	Although communal farmers cannot export yet, with full traceability, this will change.
7. Lack of understanding of the on-going monitoring of the project.	Discussions and visits to key stakeholders to determine NamLITS overall effectiveness.	Better understanding of why monitoring and improvement of the NamLITS system is important and necessary.	Developing a deep appreciation of NamLITS.

Context	Change in behavioural precursors	Change in behaviour	Broader developmental impact
8. The impact of a FMD outbreak.	Discussions and research done on the recent FMD outbreak.	The disease and its impact is researched.	The full impact of the disease, as seen through the eyes of the animal technicians and communal farmers in the NCAs is appreciated.
9. Lack of understanding of the measures involved in the quarantine of a specific region in Namibia.	Discussions with NamLITS developers and veterinarians on why certain areas are quarantined and how it is done.	The reasons for the quarantine measures are better understood.	Why and how quarantine is enforced and understood.

Table 14. Concluding the second layer of the framework by summarising the main results

8.3.5. Concluding the case study

The second layer of the framework is concluded, summarising the evidence collected through the case study, the interviews and questionnaires in a table to show the broader developmental impacts. The next section is the final layer of the framework, before Namibia and its focus on the NCAs is discussed

8.4. The impact on the communal farmer in order to ensure sustainability

The final layer of the framework is applied to the Namibian context, with the various impacts discussed as the four impacts, as shown in Figure 141.

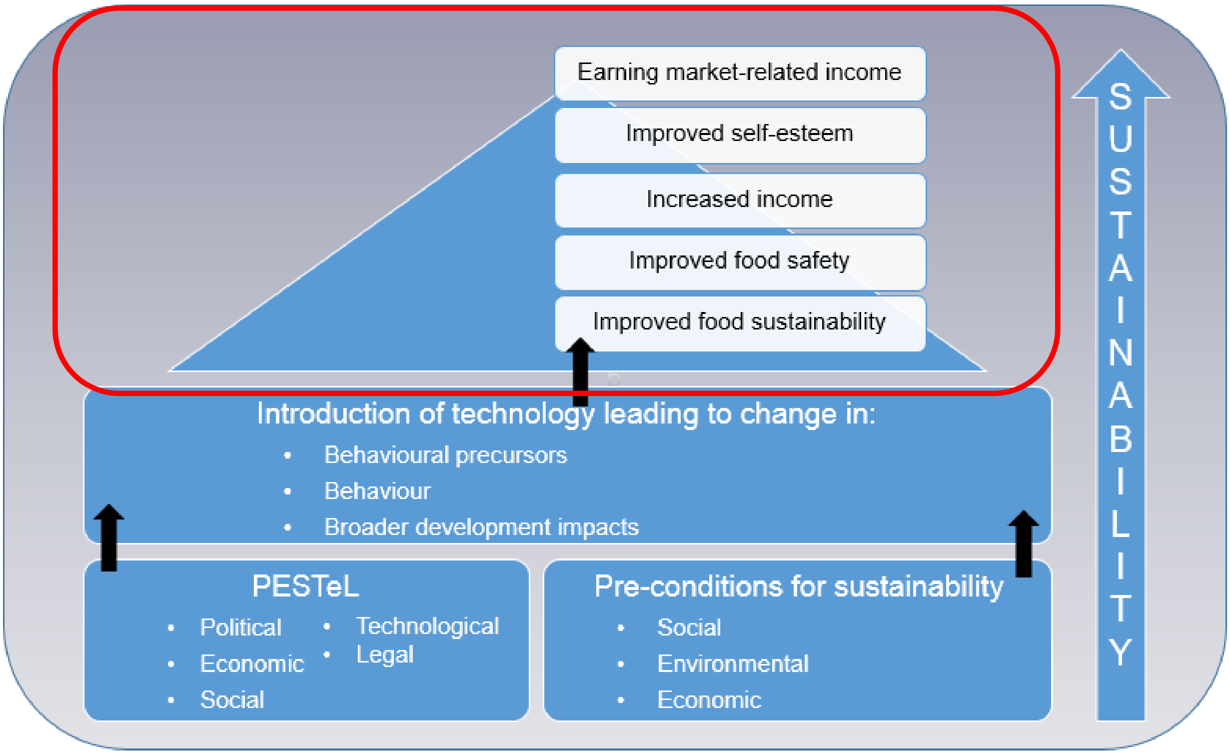


Figure 141. Applying the final layer of the framework to NamLITS

1. *Improved food sustainability*

- Communal farmers in the NCAs finally included in NamLITS can gain from traceability.
- The different tribes in the NCAs, whether nomadic or part of the Ovambu tribe, are empowered by traceability, especially when they are most vulnerable in cases of severe disease outbreaks. The experience significant smaller losses in terms of cattle.
- The animals are easily identified, simplifying cattle ownership disputes and helping curb stock theft, ensuring that farmers' cattle are accurately documented.
- Cattle vaccinations are better documented, leading to better measures to prevent diseases from spreading, as well as assisting in rapid disease outbreak prevention measures.

2. *Improved food safety*

- Traceability ensures trust in meat products, potentially opening new markets in the near future.
- Communal farmers see the value of NamLITS and feel proud of how NamLITS assisted in the recent FMD outbreak, ensuring that it is adopted fully, making more traceable meat available for the export market.

3. *Increased income*

- Communal farmers benefit from ear-tagging and traceability, as it can open-up global markets in future.
- Communal farmers are not yet in a position where they can create more employment opportunities, as they are not yet allowed to export, although this picture will not remain the same for much longer.
- One will be able to only quantify the impact on employment once the markets do open-up. This will form part of future research.

4. *Improved self-esteem*

- The more export markets available to the Namibian farmer, especially the communal farmer, the more potential for growth the economy.
- Disease outbreaks are better addressed, controlled and monitored, making the meat safe for export to Europe and many other emerging markets when the VCF can be removed for good.
- Namibia is a competitor to other African markets, especially by doubling their cattle capacity with the inclusion of the more than 2 000 000 cattle in the NCAs. Future research will report on the findings.

5. *Earning market-related income*

- This section will be expanded on in future research.

8.5. Application of the impact-for-sustainable-agriculture framework to NamLITS

All the different puzzle pieces form a picture of the communal farmer in the NCAs, and together with the three different layers of the framework, form the evidence to support all the layers of the framework as a whole, showing that one starts with understanding the local context and challenges, building a strong case study and summarising the evidence in a table illustrating the developmental impacts that took place. Next, one adds the third layer to illustrate the direct impact on the communal farmer, and the picture is complete, as seen in figure 142.

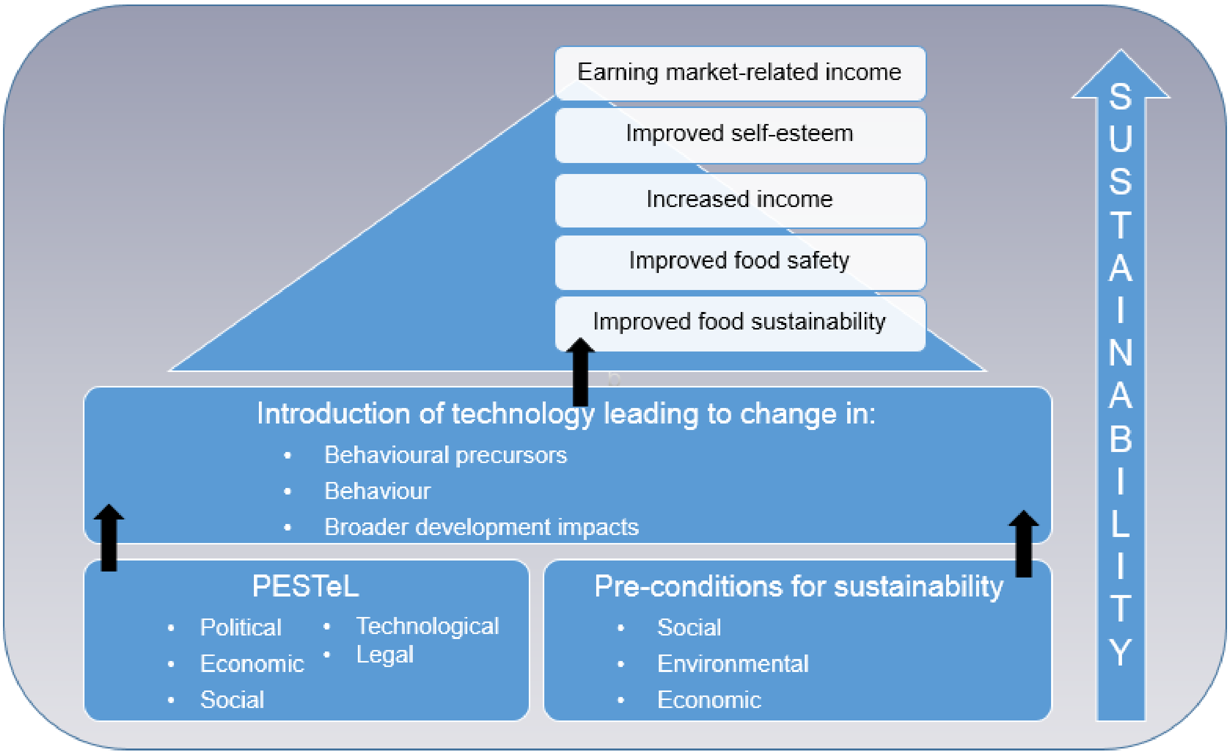


Figure 142. Bringing the evidence together in a single framework for NamLITS

8.6. Conclusion

Chapter 8 takes all the evidence collected in the Namibian case study and places in into the different layers of the proposed framework. It is done in a similar way as the analysis of the case study of Swaziland discussed in Chapter 7. Chapter 9 concludes the thesis by revisits the research questions as a way to answer them, draws conclusions and summarises the main contributions.

9. Chapter 9: Conclusion

Designing is a matter of concentration. You go deep into what you want to do. It's about intensive research, really. The concentration is warm and intimate and like the fire inside the earth, intense but not distorted. You can go to a place, really feel it in your heart. It's actually a beautiful feeling. Peter Zumthor

9.1. Introduction

This final chapter revisits the main research problem and discusses the findings to the research questions. The contributions are summarised and possible topics for future research are identified, concluding the study. The next section briefly compares some of the evidence found in the Swaziland and Namibian case studies.

9.2. Comparison between Swaziland's SLITS and Namibia's NamLITS

Namibia introduced its traceability system, NamLITS I, in 2004 and built on its success by expanding it to NamLITS II, incorporating the NCAs, starting in 2010. Swaziland saw the potential of upgrading their manual system to a similar electronic database, SLITS, and started implementing it in 2012, with it becoming compulsory in 2014. Both countries now enabled previously-excluded communal farmers to benefit from traceability, by applying ear-tags and capturing all animals' details on the livestock traceability systems. What makes this study unique, is that it compares the two countries' communal farmers and the benefits they now receive because of traceability.

The researcher was fortunate enough to be able to interview key role players of the two systems and to visit both countries – Namibia twice and Swaziland four times. During the visits, first-hand experience was obtained regarding the lives of communal farmers and the challenges they face. The data was documented, interviews transcribed and questionnaires analysed to reach certain conclusions. Although both countries form part of Southern Africa, their differences become apparent if one looks at the two case studies. They not only differ in size, culture, language, economic and political aspects, but also in social contexts. In Figure 143 the difference in economic size of both countries relative to their neighbour, South Africa is given. There is however, one similar element in both case studies: how traceability empowers communal farmers, the poorest of poor. Chapters 7 and 8 discuss key aspects of both countries, and the similarities are summarised in their developmental impacts. The next section takes a closer look at the main problem statement.

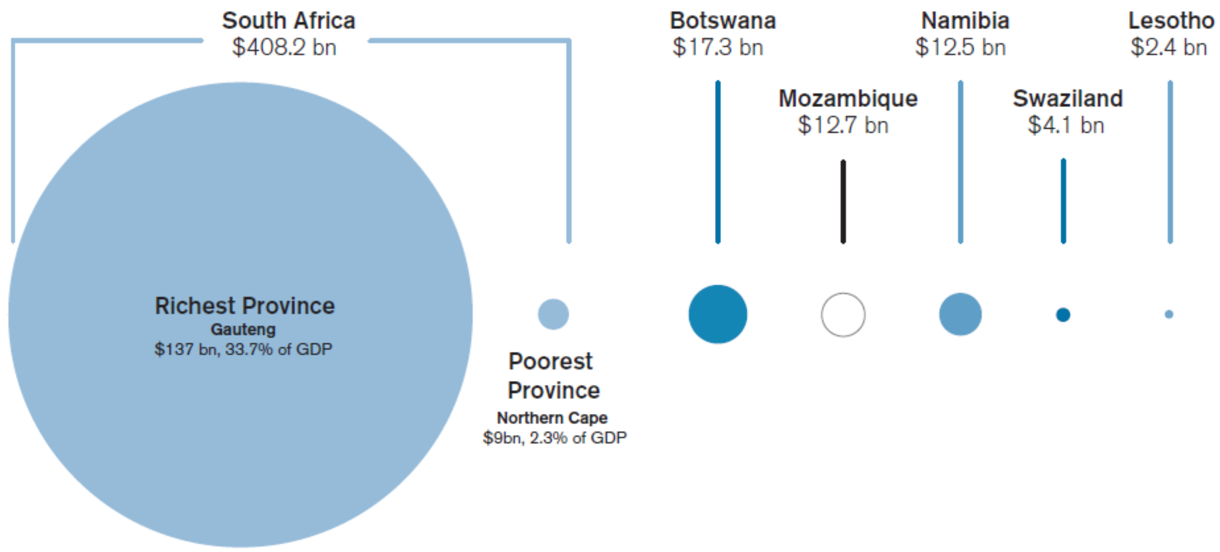


Figure 143. Swaziland and Namibia's regional economic size relative to South Africa (Adopted from Vandome et al. (2013))

9.3. Revisiting the problem statement

The main research problem – ensuring sustainable agricultural development projects by making use of a specific framework – is placed central in order to derive a new framework that incorporates an impact assessment as well as the linear role of sustainability. Both Swaziland and Namibia form part of this study, but the outcome can be applied to other agricultural development projects in future. This study investigates key aspects of sustainability, and how it can be used in a framework to improve the success ratio of ICT for agriculture projects.

The next section looks at the research questions as discussed in the first chapter, and attempts to provide answers to these questions.

9.3.1. Secondary research questions

Question 1: How could ICT-linked livestock traceability be designed and implemented to be sustainable in each country?

This two sub-questions are answered separately:

- *Under what conditions will livestock traceability systems be sustainable in Swaziland?*

Briefly, in the case of Swaziland, communal farmers see the worth of the system, project champions drive the project and have taken ownership, the government supplies communal farmers with free ear-tags, enabling them to identify their animals uniquely, resulting in less stock theft and animal rustling and ensuring accurate traceability. Communal farmers can receive higher prices for cattle with traceability, and sell the animals at a more optimal age, and SLITS still uses existing infrastructure to build the electronic database by asking the veterinary assistants to document their experiences at the dip tanks on SLITS on Fridays.

- *Under what conditions will livestock traceability systems be sustainable in Namibia?*

Namibia is similar to Swaziland in many of the above-mentioned respects, but the tribes of the NCAs are now included in the initiative; the Namibian government supports NamLITS and the developers of the system maintain and update the system as needed, and in the face of a crisis, with the outbreak of FMD in a wide area, NamLITS proved its worth to the state veterinarians and animal technicians, assisting them in rapidly gaining control of the outbreak and lifting the quarantine. The usefulness of NamLITS is experienced in the NCAs, and is sustainable because of its proven success.

Question 2: How could the impact on communal farmers be examined and evaluated?

First, one has to consider the framework provided in Figure 31 as a possible way of measuring sustainability in the two countries.

Second, one can examine the Swaziland case study and the economic analysis and its impact on communal farmers as discussed in Section 7.4. Presently, the NCAs cannot yet export meat, making the measurement only possible in Swaziland in this thesis.

This other sub-questions are answered below:

- *What is a communal farmer?*

A communal farmer is a farmer that lives in shared communal grazing areas, and the communal grazing serves as the main feed resource base for livestock (Food and Agricultural Organization, (n.d.)).

- *Why does the communal farmer have a role to play?*

The world needs sustainable food production to ensure food security for all, where food must be available to access and nutritious (Leroy et al., 2015), but together with the availability of food, food products need to be safe for human consumption. The direct correlation between animal products resulting in fatalities or diseases in humans made it necessary to ensure that the origin of the meat can be traced, but also to ensure accurate tracking of the meat, from the birth of the animal, through all the stages of its life, including feed products, vaccinations, and any movements, up to the point where the animal is slaughtered and the meat products exported. In countries where there is a prevalence of a certain disease, potential exposure to the disease also needs to be documented and all measures stipulated on the lifting of any quarantine areas. Traceability benefits countries in terms of trade and economic and social development (Lewandowski & Faaij, 2006). Legislation, including ISO standards, the Technical Barriers to Trade and GLOBALGAP regulates the safety of meat products.

The tracking of animal meat products is no longer optional for countries wanting to export, but it is seen as a necessary security measure to give the consumer peace of mind. Different countries implemented their traceability systems with allowed variations in their systems, but since recent food scares, especially Mad Cow Disease, affecting the central nervous system of cattle (Karesh & Cook, 2005), it is now mandatory to include traceability.

Swaziland and Namibia spent a lot of time and resources into creating and maintaining livestock traceability systems, both able to export to worldwide markets.

- *The impact on the Swazi communal farmer thus far have shown:*

1. The traceability system is adopted country-wide and also includes the communal farmers.
2. The new development empowers communal farmers.
3. The veterinary assistants have received the necessary training on SLITS and are able to use it as required by legislation.
4. Diseases and disease outbreaks are better monitored and controlled.
5. Project champions are passionate about the project and want to keep it running successfully.
6. Almost all cattle are registered on SLITS and full traceability recorded, ensuring export possibilities.
7. An overall increase in the number of animals slaughtered for export purposes is seen.
8. Communal farmers are receiving more money for their cattle sold.
9. Initiatives undertaken by the Swazi government, using the veterinary assistants as key informants, to educate and inform communal farmers on the best times to sell cattle.
10. The overall red meat value chain is growing, creating employment, socio-economic growth and a better life for the communal Swazi.
11. The potential of reaching higher export targets annually, with a sharp increase in livestock meat products in 2015 and again in 2016.

- *The impact on the Namibian communal farmer thus far have shown:*

1. The challenges of the communal farmers in the NCAs are better understood.
2. The knowledge and challenges faced by the animal technicians are better understood.
3. NamLITS' capabilities are documented, tested and improved on.

4. The challenges facing communal farmers are better understood by studying the different cultures and beliefs of the tribes.
5. Different movement zones are detailed to gain a deeper understanding of the methods of quarantine in cases of disease outbreaks.
6. Communal farmers who were previously excluded from NamLITS are now incorporated into the livestock traceability system.
7. The foot-and-mouth disease of 2015/2016, which would have had a much more severe impact on communal cattle herds without the effective use of the traceability system. Cattle numbers in the NCAs did not drastically decrease, but more important is that the outbreak did not spread to the Southern areas of Namibia, preventing an entire country being quarantined, which would have resulted in massive job losses and an overall reduction in GDP.

- *The potential future impact on the Swazi communal farmer:*

The answer to this question has many facets; the first part is the broader developmental impacts, summarised as follows:

1. The lack of sufficient IT equipment is being addressed.
1. Growth in a stagnant economy.
2. More and better management of livestock countrywide.
3. The expansion of SLITS to include different kinds of technologies, for example using smart phones or tablets at the dip tanks.
4. A possible shift in culture from keeping your livestock purely as a status symbol to an environment where cattle is traded as a commodity, not only by the commercial farmers.

- *The potential future impact on the Namibia communal farmer could include:*

Again, the first part is the broader developmental impacts, summarised as follows:

1. Certain areas in the NCAs will soon be able to move traceable, diseases-free animals towards the Southern parts of Namibia and back, as well as sell the meat for the export market.
2. The goal is to finally rid the country of any quarantine areas, restricting movement of animals and export of meat products.
3. The communal farmers will play a much bigger role in the economy of Namibia, as 51% of all cattle are above the Red Line, which can double the international trade in livestock products.
4. Communal farmers receiving more money for their cattle sold.
5. An overall growth of the GDP and socio-economic development.
6. A life with more opportunities in livestock trade if a communal farmer chooses to become part of international trade, keeping in mind the culture and beliefs of certain indigenous groups.

The different impacts on communal farmers' livelihoods, employment, market access and competitiveness again form an overall holistic picture of the impact of NamLITS on the Namibian communal farmer found in the NCAs.

The red meat value chain, specifically the beef value chain discussed in this study, identifies all the areas where the previously-excluded communal farmer can fulfil a certain role or function. The primary producers can produce more traceable cattle, more cattle can be sent to the feedlots, abattoirs, wholesalers, retailers and become available for consumers with full traceability and declared safe for human consumption. More meat is processed, more hides and skins manufactured and placed in the growing chain of trade and more meat is exported Holistically, the farmer can grow his or her herd by incorporating farm management principles, leading to social upliftment, economic participation and status. The red meat value chain closely ties in with figure 17, where one can increase family income, lower the work load and employ more workers to help with the farming, manage and prevent soil deterioration due to over-grazing, further branching into other areas to include more free time, less health problems, more investment opportunities, better resources and an overall better quality of life. All the elements in the meat value chain are key in creating socio-economic development for the rural poor, but it has to start with the primary produces producing safe meat, which implies adhering to international traceability requirements.

9.4 Main research question

What framework can be designed to evaluate the introduction of ICT-linked livestock traceability on communal livestock farmers in Swaziland and Namibia?

The research question is answered by following a method of combining three different frameworks as well as Maslow's Hierarchy of Needs into a single, new framework. The building blocks of the framework are divided into three layers, with the first layer describing the pre-conditions of sustainability in terms of the three pillars of sustainability: the social, environmental and economic pillars. The PESTeL factors also feed into the first layer, where they are a prerequisite for the C4D framework, the framework that is adapted and used as the second layer of the framework.

The second layer of the framework incorporates the evidence gathered in the case studies, interviews and questionnaires to draw certain conclusions resulting from the change in behavioural precursors, leading to changes in behaviour, ultimately leading to broader developmental impacts being discussed.

The third and final layer of the framework uses the four objectives of the agriculture-for-development framework, taking the four key elements below and describing them as five impacts:

1. Improved food sustainability
2. Improved food safety
3. Increased income
4. Improved self-esteem
5. Earning a market-related income

The five impacts are arranged according to Maslow's hierarchy of needs. Finally the framework aims to illustrate that the further one moves through the three layers, the greater the chances become of creating a sustainable agricultural development project, as seen in Figure 144.

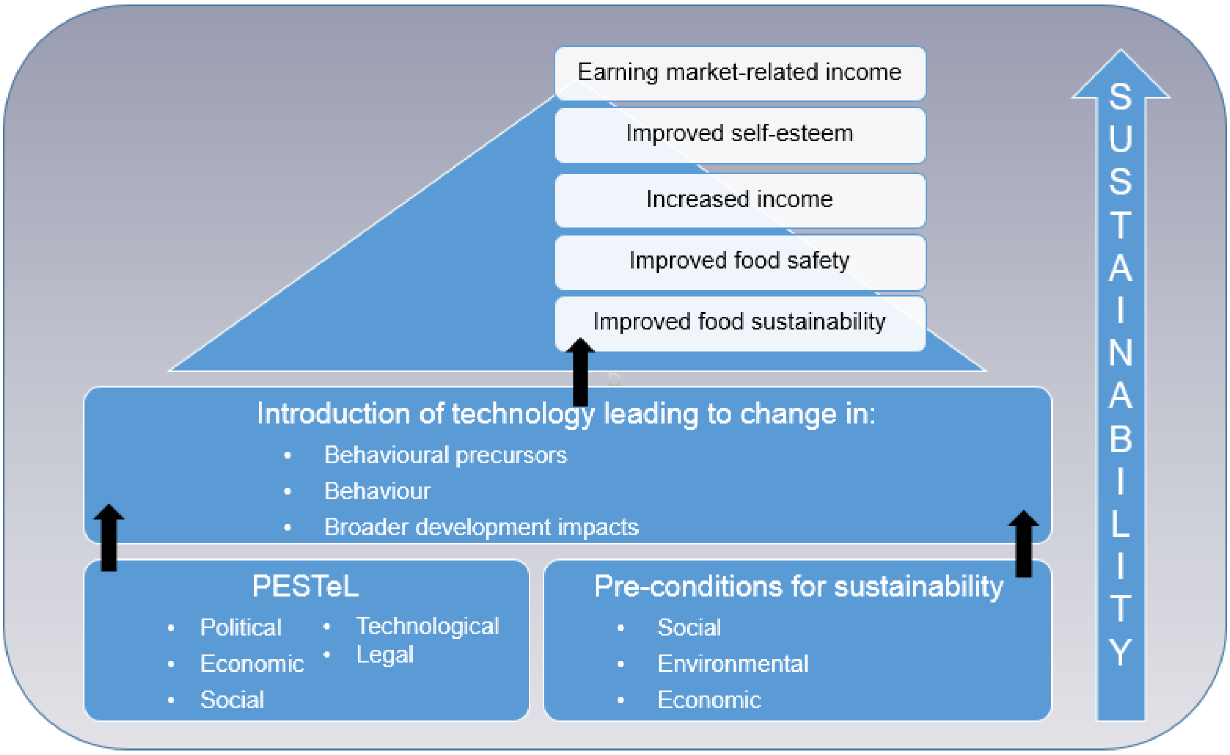


Figure 144. The final framework of the study: The Impact-for-sustainable-agriculture framework

9.5. Summary of contributions

The study makes theoretical, methodological and practical contributions, discussed in the following three sections.

9.5.1. Theoretical contributions

This study makes a number of theoretical contributions:

- The first contribution is bringing the concept of sustainability alongside an impact assessment framework, encapsulating not only the importance of creating sustainable development projects, but also ensuring that it has a tangible impact on the intended beneficiaries of the project in an agricultural context.

- The second contribution is taking the different elements of the agriculture-for-development framework, expressing them as impact factors, and arranging them in Maslow's hierarchy of needs, clearly distinguishing how the project impacts communal farmers.
- The third contribution is the overall framework itself, combining all the different facets into a single framework that can be re-used in similar scenarios.

9.5.2. Methodological contributions

The following methodological contributions are made:

- The level of detail captured in the data collection phases. The two countries were visited a number of times, where interviews were conducted, as well as informal discussions were conducted with system developers, government officials, project champions and communal farmers.
- During the visits questionnaires were distributed, completed by the Swazi veterinary assistants and the Namibian animal technicians, highlighting their experiences with the traceability systems and their interaction with communal farmers.
- The detail captured in the case studies also added to the richness of the lives of communal farmers and documented their everyday environment and experiences.
- Together all the evidence leads one to gain a full picture of the impact of the traceability systems on the communal farmer.

9.5.3. Practical contributions

The practical contributions are the following:

- The researcher undertook visits, spent time with the stakeholders, witnessed a rural dipping event, cattle dehorning and branding and was able to portray the events as accurately as possible.
- A meeting was attended where a number of animal technicians discussed the imminent threat of a FMD outbreak. At that meeting, although the researcher did not actively participate, she was able to feel the tension, understand their fears and experience how they handle a real-life crisis.
- A true Swazi cultural experience made it possible to witness what a proud nation the Swazis are, how they value culture and tradition, and what makes their setting unique.
- To be able to visit the NCAs, to see the landscape, drive the poor dirt roads, see the small children running alongside the vehicle and just experiencing the communal areas, leaves one with a sense of more than theoretical knowledge, but with a commitment to telling their story from a vantage point of true compassion.

9.6. Future research

Livestock traceability systems are not yet fully implemented in all the NCAs of Namibia. One will have to go back to the area to do another round of data collection, once the system has matured. At that point, one can quantify the impact on the communal farmer better and adapt the framework accordingly. Other countries exporting meat products should also become part of this project to see a holistic picture on livestock and the role that traceability can play in uplifting the communal cattle famers. In some countries their traceability systems implementations are only partially successful and reasons why this is the case should be evaluated against the framework to test if the framework can address the issues, countries like Botswana. Future research could include a detailed study of the South Africa context, where talks are currently underway to bring such a system to this country. The proposed framework also needs to be applied to a wider context, starting with other agricultural development projects, and later to developmental projects in general. Further enhancements of the framework should also be considered, and the framework adapted as necessary.

9.7. Conclusion

This journey ends with a reflection on the process of developing a conceptual model, a process that entailed not only looking critically at the data and literature, but also at a new way of interpreting sustainable development. By linking an impact assessment framework with sustainability and specifically agriculture, the thesis makes its main contribution in the form of the impact-for-sustainable-agriculture framework.

10. Bibliography

2013 Index of Economic Freedom. (2013a). Namibia Economic Freedom Score. Retrieved from http://www.heritage.org/index/pdf/2013/countries/namibia.pdf. Access date: 17 November 2016.

2013 Index of Economic Freedom. (2013b). Swaziland Economic Freedom Score. Retrieved from http://www.heritage.org/index/pdf/2013/countries/swaziland.pdf. Access date: 19 November 2016.

Adato, M., & Meinzen-Dick, R. (2002). Assessing the impact of agricultural research on poverty using the sustainable livelihoods framework. FCND Discussion Paper 128, EPTD Discussion Paper 89.

Akram-Lodhi, A. H. (2008). (Re)imagining agrarian relations? The World Development Report 2008: Agriculture for Development. *Development and Change, 39*(6), 1145-1161.

Altmann, J. (1974). Observational study of behavior: sampling methods. *Behaviour, 49*(3), 227-266.

Anderson, J. A., Harrigan, G. G., Rice, P., & Kleter, G. (2016). Challenges and Opportunities in Supporting Sustainable Agriculture and Food Security. Overview of the 13th IUPAC International Congress of Pesticide Chemistry Symposia on Agricultural Biotechnology. *Journal of agricultural and food chemistry*, 381-382.

Andrée, S., Jira, W., Schwind, K.-H., Wagner, H., & Schwägele, F. (2010). Chemical safety of meat and meat products. *Meat Science, 86*(1), 38-48.

Angen, M. J. (2000). Evaluating interpretive inquiry: Reviewing the validity debate and opening the dialogue. *Qualitative Health Research, 10*(3), 378-395.

Avert.org. (2016). Global information and advice on HIV & AIDS: HIV and AIDS in Swaziland. Retrieved from http://www.avert.org/professionals/hiv-around-world/sub-saharan-africa/swaziland. Access date: 16 July 2016.

Babones, S. J. (2006). Conducting global social research. *Global Social Change: Historical and Comparative Perspectives*, 8-30.

Bain, C. (2010). Governing the global value chain: GLOBALGAP and the Chilean fresh fruit industry. *International Journal of Sociology of Agriculture and Food, 17*(1), 1-23.

Bajardi, P., Barrat, A., Savini, L., & Colizza, V. (2012). Optimizing surveillance for livestock disease spreading through animal movements. *Journal of The Royal Society Interface*, 9(76), 2814-2825.

Barbieri, D., Braga, D., Ceri, S., Valle, E. D., Huang, Y., Tresp, V., Rettinger, A. & Wermser, H. (2010). Deductive and inductive stream reasoning for semantic social media analytics. *Intelligent Systems, IEEE, 25*(6), 32-41.

Barker, E. E. (2015). *Surviving the Other War: Group Intervention for Military Sexual Trauma in the Local Church*: Liberty University.

Barrett, M., Sahay, S., & Walsham, G. (2001). Information technology and social transformation: GIS for forestry management in India. *The information society, 17*(1), 5-20.

Bartlett, S., Hart, R., Satterthwaite, D., de la Barra, X., & Missair, A. (2016). *Cities for children: children's rights, poverty and urban management*: Routledge.

Beckerman, W. (1994). 'Sustainable development': is it a useful concept? *Environmental Values, 3*(3), 191-209.

Beghin, J. C. (2015). The Protectionism of Food Safety Standards in International Agricultural Trade. *Agricultural Policy Review, 2014*(1), 5.

Belcher, K., Boehm, M., & Fulton, M. (2004). Agroecosystem sustainability: a system simulation model approach. *Agricultural systems, 79*(2), 225-241.

Bell, M. (2015). ICT–Powering Behavior Change for a Brighter Agricultural Future. *MEAS Discussion Paper*

Benbasat, I. (1984). An analysis of research methodologies. *The information systems research challenge*, 47-85.

Benbasat, I., Goldstein, D. K., & Mead, M. (1987). The case research strategy in studies of information systems. *MIS Quarterly*, 369-386.

Bengis, R., Kock, R., & Fischer, J. (2002). Infectious animal diseases: the wildlife/livestock interface. *Revue Scientifique et Technique-Office international des épizooties, 21*(1), 53-66.

Bharucha, Z. P. (2013). Sustainable food production: Facts and figures. *Spotlight: Producing food sustainability.* Retrieved from http://www.scidev.net/global/food-security/feature/sustainable-food-production-facts-and-figures.html. Access date: 16 July 2016.

Bhaskar, R. (2010). *Reclaiming reality: A critical introduction to contemporary philosophy*: Taylor & Francis.

Bhat, S. S. (2012). Single case study research: The development of www. purenz. com. *Field guide to case study research in tourism, hospitality and leisure, 6*, 177.

Bhatnagar, S., & Schware, R. (2000). Information and communication technology in rural development. *Case Studies From India, World Bank Institute*.

Bhattacherjee, A. (2012). Social science research: principles, methods, and practices. *Textbooks Collection. Book 3.*

Bollig, M., & Heinemann, H. (2002). Nomadic savages, ochre people and heroic herders: Visual presentations of the Himba of Namibia's Kaokoland. *Visual Anthropology, 15*(3-4), 267-312.

Bonoma, T. V. (1985). Case research in marketing: opportunities, problems, and a process. *Journal of marketing research*, 199-208.

Bossel, H. (1999). *Indicators for sustainable development: theory, method, applications*: International Institute for Sustainable Development Winnipeg.

Boudreau, T. (2010). LIFT Swaziland Livelihood Data Analysis. FEG Analysis of Swaziland Livelihoods Data. Retrieved from http://www.feg-consulting.com/resource/reports/FEG%20Preassessment%20livelihood%20analysis%20FINAL.pdf. Access date: 20 July 2016.

Bowling, M., Pendell, D., Morris, D., Yoon, Y., Katoh, K., Belk, K., & Smith, G. (2008). Review: Identification and traceability of cattle in selected countries outside of North America. *The Professional Animal Scientist, 24*(4), 287-294.

Boy, R. L. (n.d.). Cattle Traceability - A threat to sustainable supply of beef to EU: A Botswana Meat Commission. *European Journal of Logistics Purchasing and Supply Chain Management, 1*(1), 1-9.

Boyce, C., & Neale, P. (2006). *Conducting in-depth interviews: A guide for designing and conducting in-depth interviews for evaluation input*: Pathfinder International Watertown, MA.

Bradach, J., & Grindle, A. (2014). Transformative scale: The future of growing what works. *The Bridgespan Group*.

Brand, S. (n.d.). BrainyQuote.com. Retrieved January 29, 2017, from BrainyQuote.com. Retrieved from https://www.brainyquote.com/quotes/quotes/s/stewartbra172275.html

Briner, S., Elkin, C., Huber, R., & Grêt-Regamey, A. (2012). Assessing the impacts of economic and climate changes on land-use in mountain regions: A spatial dynamic modeling approach. *Agriculture, ecosystems & environment, 149*, 50-63.

Brown, L., & Van der Ouderaa, F. (2007). Nutritional genomics: food industry applications from farm to fork. *British journal of nutrition, 97*(06), 1027-1035.

Brundtland, G., Khalid, M., Agnelli, S., Al-Athel, S., Chidzero, B., Fadika, L., Hauff, V, Lang, I., Shijun, M., & De Botero, M. M. (1987). Our Common Future (\'Brundtland report\').

Bukhari, Z., & Nazish, S. (2015). Pebbles (PVT) Ltd sustainable real estate developers: Building hopes. *Building Sustainable Legacies: The New Frontier Of Societal Value Co-Creation, 2015*(7), 102-133.

Burch, D., Lawrence, G., Green, G., Ichijo, K., Nonaka, I., Pimentel, M., Bower, J., Gilbert, C., Couto Filho, V. & Flavio, L. (2007). *World Development Report 2008: agriculture for development* (1845427262). Retrieved from https://openknowledge.worldbank.org/handle/10986/5990. Access date: 12 February 2013.

Burrell, G., & Morgan, G. (1979). *Sociological paradigms and organisational analysis* (Vol. 248): london: Heinemann.

Burton, I., Huq, S., Lim, B., Pilifosova, O., & Schipper, E. L. (2002). From impacts assessment to adaptation priorities: the shaping of adaptation policy. *Climate policy, 2*(2-3), 145-159.

Bush, E. R., Short, R. E., Milner-Gulland, E. J., Lennox, K., Samoilys, M., & Hill, N. (2017). Mosquito net use in an artisanal East African fishery. *Conservation Letters, 10*(4), 451-459.

Cabrera, R., Cochran, M., Dangelmayr, L., & D'Aguilar, G. (2010). African capacity building for meat exports: Lessons from the Namibian and Botswanan beef industries. *Currents: Int'l Trade LJ, 19*, 55.

Caja, G., Ghirardi, J., Hernández-Jover, M., & Garín, D. (2004). Diversity of animal identification techniques: from fire age to electronic age. *Development of animal identification and recording systems for developing countries. ICAR Technical Series*(9), 21-39.

Calvin, L., & Krissoff, B. (1998). Technical barriers to trade: a case study of phytosanitary barriers and US-Japanese apple trade. *Journal of Agricultural and Resource Economics*, 351-366.

Carney, D., & Britain, G. (2003). *Sustainable livelihoods approaches: progress and possibilities for change*: Department for International Development London.

Cartwright, N. (1983). How the laws of physics lie. *Clarendon Paperbacks, Ocford: Oxford University Press.*

Central Bank of Swaziland. (2010). *Presentation on the Financial Sector in Swaziland*. Retrieved from http://www.centralbank.org.sz/currency/index.php. Access date: 18 July 2016.

Central Bank of Swaziland. (2016). *2015/2016 Annual Report*. Retrieved from http://www.centralbank.org.sz/publications/annual/2015-2016.pdf. Access date: 18 July 2016.

Chambers, R., & Conway, G. (1992). *Sustainable rural livelihoods: practical concepts for the 21st century*: Institute of Development Studies (UK).

Chang, A., Tilahun, L., & Breazeal, C. (2014). *Visualisations of Data from the Literacy Tablet Reading Project in Rural Ethiopia.* EVA.Retrieved from http://dx.doi.org/10.14236/ewic/eva2014.17. Access date: 23 April 2016.

Chavez, A. (2016). Rights in Education and Self-Identity: Education and Language of Instruction in Namibia. *International Education Studies, 9*(3), 189.

Cheeseman, J. (2015). Food security in the face of salinity, drought, climate change, and population growth. *Halophytes for Food Security in Dry Lands*, 111.

Chen, A. J., Boudreau, M.-C., & Watson, R. T. (2008). Information systems and ecological sustainability. *Journal of Systems and Information Technology, 10*(3), 186-201.

Chen, R. S., & Kates, R. W. (1994). World food security: prospects and trends. *Food Policy, 19*(2), 192-208.

Chipidza, W., & Leidner, D. (2017). ICT4D Research–Literature Review and Conflict Perspective. *Twenty-third Americas Conference on Information Systems, Boston, 2017.*

Clark, L. (n.d.). BrainyQuote.com. Retrieved January 29, 2017, from BrainyQuote.com. Retrieved from https://www.brainyquote.com/quotes/quotes/l/laurelclar271752.html

Clemens, R. L. (2003). *Meat traceability and consumer assurance in Japan*: Midwest Agribusiness Trade Research and Information Center, Iowa State University.

Clemens, R. L., & Babcock, B. A. (2004). Country of origin as a brand: The case of New Zealand lamb. CARD Reports and Working Paper 11(2004).

Clemens, R., & Babcock, B. A. (2004). Midwest Agribusiness Trade Research and Information Center (MATRIC) at Iowa State University.

Commonwealth Local Government Forum. (2015). The local government system in Swaziland: country profile. Retrieved from http://www.clgf.org.uk/default/assets/File/Country_profiles/Swaziland.pdf. Access date: 17 July 2016.

Connolly-Boutin, L., & Smit, B. (2015). Climate change, food security, and livelihoods in sub-Saharan Africa. *Regional Environmental Change*, 1-15.

Corbin, J. M., & Strauss, A. (2008). Basics of qualitative research 3e: London: Sage.

Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative sociology, 13*(1), 3-21.

Costanza, R., & Patten, B. C. (1995). Defining and predicting sustainability. *Ecological Economics, 15*(3), 193-196.

Coulibaly, A., & Liu, P. (2006). Regulations, standards and certification for agricultural exports. A practical manual for producers and exporters in East Africa. Retrieved from https://cgspace.cgiar.org/handle/10568/76770. Access date: 23 February 2015.

Countries and their Cultures. (2016a). Namibia. Retrieved from http://www.everyculture.com/Ma-Ni/Namibia.html. Access date: 23 October 2016.

Countries and their Cultures. (2016b). Swaziland. Retrieved from http://www.everyculture.com/Sa-Th/Swaziland.html. Access date: 23 October 2016.

Craig, G., & Mayo, M. (1995). *Community empowerment: A reader in participation and development*: Zed Books.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*: Sage publications.

Da Silva, A. P., & Fernandez, W. D. (2013). *Beyond Free Lunch: Building Sustainable ICT4D.* Paper presented at ECIS, p 85.

Dahlborn, K., Bugnon, P., Nevalainen, T., Raspa, M., Verbost, P., & Spangenberg, E. (2013). Report of the federation of European laboratory animal science associations working group on animal identification. *Laboratory animals, 47*(1), 2-11.

Dalvit, C., De Marchi, M., & Cassandro, M. (2007). Genetic traceability of livestock products: A review. *Meat Science, 77*(4), 437-449. doi:http://dx.doi.org/10.1016/j.meatsci.2007.05.027

Danjuma, K. J., Onimode, B. M., & Onche, O. J. (2015). Gender Issues & Information Communication Technology for Development (ICT4D): Prospects and Challenges for Women in Nigeria." *International Journal of Computer Science Issues (IJCSI)* 12.2 (2015): 313.

Davies, G. (2002). Foot and mouth disease. *Research in veterinary science, 73*(3), 195-199.

Davies, T., & Fumega, S. (2014). Mixed incentives: Adopting ICT innovations for transparency, accountability, and anti-corruption. *U4 Issue, 2014*(4).

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 319-340.

De Visser, L. E. (2013). Winning hearts and minds: legitimacy in the Namibian war for independence. *Small Wars & Insurgencies, 24*(4), 712-730.

Dell, M. (n.d.). BrainyQuote.com. Retrieved September 18, 2017, from BrainyQuote.com. Retrieved from https://www.brainyquote.com/quotes/keywords/framework.html

DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information Systems Research, 3*(1), 60-95.

Delone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: a ten-year update. *Journal of management information systems, 19*(4), 9-30.

Devendra, C. (2012). Climate change threats and effects: challenges for agriculture and food security. *Academy of Science Malaysia*, 56.

Dillman, D. A. (1978). *Mail and telephone surveys* (Vol. 3): Wiley Interscience.

Dlamini-Ndwandwe, N. F. (2011). The Constitution and women's property rights in Swaziland. *Southern African Public Law, 26*(2), 408-430.

Dogliotti, S., García, M., Peluffo, S., Dieste, J., Pedemonte, A., Bacigalupe, G., . . . Chiappe, M. (2014). Co-innovation of family farm systems: A systems approach to sustainable agriculture. *Agricultural systems, 126*, 76-86.

Donnelly, C. A., Ferguson, N. M., Ghani, A. C., & Anderson, R. M. (2002). Implications of BSE infection screening data for the scale of the British BSE epidemic and current European infection levels. *Proceedings of the Royal Society of London. Series B: Biological Sciences, 269*(1506), 2179-2190.

Duffy, G., Lynch, O., & Cagney, C. (2008). Tracking emerging zoonotic pathogens from farm to fork. *Meat Science, 78*(1), 34-42.

Dwivedi, Y. K., Wastell, D., Laumer, S., Henriksen, H. Z., Myers, M. D., Bunker, D., Elbanna, A,. ravishankar, M.N. & Srivastava, S. C. (2015). Research on information systems failures and successes: Status update and future directions. *Information Systems Frontiers, 17*(1), 143-157.

EEC. (1990). Council Regulation 2377/90/EEC laying down a community procedure for the establishment of maximum residue limits of veterinary medicinal products in foodstuffs of animal origin. *Official Journal of the European Union., L224, 1−8.*

Ekuam, D. (2009). Livestock identification, traceability and tracking: Its role in enhancing human security, disease control and livestock marketing in IGAD region. *Pretoria: Institute for Security Studies*.

Encyclopedia of the Nations. (2016). Swaziland - Local government. Retrieved from http://www.nationsencyclopedia.com/Africa/Swaziland-LOCAL-GOVERNMENT.html. Access date: 23 July 2016.

Engelbrecht, J. (2012). *Animal Identification and Traceability in Namibia: Farmers Support Program.* Veterinary Services and Farm Assured Namibian (FAN) Meat Presentation.

Einstein, A. (n.d.). BrainyQuote.com. Retrieved from BrainyQuote.com. Retrieved from https://www.brainyquote.com/quotes/quotes/a/alberteins148837.html.

Erek, K., Schmidt, N.-H., Zarnekow, R., & Kolbe, L. M. (2009). Sustainability in information systems: assortment of current practices in IS organizations. *AMCIS 2009 Proceedings*, 123.

eTransform Africa. (2012). Agriculture Sector Study. Sector Assessment and Opportunities for ICT. . Retrieved from http://siteresources.worldbank.org/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/Resources/282822-1346223280837/Agriculture_FullReport.pdf. Access date: 16 November 2015.

European Commission. (1995). Principles for Food Import and Export Inspection and Certification. *CAC/GL*, 20. Retrieved from http://www.fao.org/docrep/009/y6396e/Y6396E01.htm. Access date: 30 March 2015.

European Commission. (1997). Guidelines for the Design, Operation, Assessment and Accreditation of Food Import and Export Inspection and Certification Systems. *CAC/GL*, 26. Retrieved from http://www.fao.org/docrep/009/y6396e/Y6396E03.htm. Access date: 2 April 2016.

European Commission. (2002). Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. *Official Journal of the European Communities L, 31*(1), 1-24.

European Commission. (2006). Principles for traceability/product tracing as a tool within a food inspection and certification system. CAC/GL, 60. Retrieved from http://files.foodmate.com/2013/files_1796.html. Access date: 24 May 2015.

European Commission. (2011). Final Report of an Audit carried out in Botswana from 25 to 28 January 2011 in order to evaluate the operation of controls over the production of fresh bovine meat, and meat products destined for export to the European Union, as well as certification procedures: Health and Consumers Directorate-General, Directorate F - Food and Veterinary Office.

European Commission. (2013). Final report of an audit carried out in Botswana from 04 to 11 March 2013 in order to evaluate the operation of controls over the production of fresh bovine meat destined for export to the European Union, as well as certification procedures: Health and Consumers Directorate-General, Directorate F - Food and Veterinary Office.

Fan, S., Olofinbiyi, T., & Gemessa, S. (2015). Ending hunger and undernutrition by 2025. *The fight against hunger and malnutrition: the role of food, agriculture, and targeted policies*: 295.

Fan, S., Omilola, B., & Lambert, M. (2009). Public spending for agriculture in Africa: trends and composition. *Regional Strategic Analysis and Knowledge Support System, 5*.

Fanikiso, M. (2009). *Animal Identification and Traceability: Public Sector Perspective and Experience from Botswana.* Paper presented at the International Conference on Animal Identification and Traceability (from Farm to Fork), La Rural, Buenos Aires, Argentina.

FAO. (2008). Global NPP Loss In The Degrading Areas (1981-2003). Retrieved from http://ref.data.fao.org/map?entryId=e6ae47a9-2ee6-4fed-ba63-71780c967ec5&tab=metadata. Access date: 13 December 2014.

FAO. (2016). CODEX Alimentarius International Food Standards. Retrieved from http://www.fao.org/fao-who-codexalimentarius/about-codex/en/. Access date: 1 February 2016.

Feng, J., Fu, Z., Wang, Z., Xu, M., & Zhang, X. (2013). Development and evaluation on a RFID-based traceability system for cattle/beef quality safety in China. *Food Control, 31*(2), 314-325.

Fernandes, W. A. (2015). *The role of mining in economic development in Namibia post-2008 global economic crisis.* Doctoral Dissertation.

Fliess, B., Gonzales, F., & Schonfeld, R. (2008). Technical Barriers to Trade.

Food and Agricultural Organization. ((n.d.)). Livestock and Environment Toolbox: Mixed System: Communal Grazing. *Livestock, Environment and Development Initiative*

(LEAD). . Retrieved from http://www.fao.org/ag/againfo/programmes/en/lead/toolbox/Index.htm

Foster, C., & Heeks, R. (2013). Conceptualising inclusive innovation: Modifying systems of innovation frameworks to understand diffusion of new technology to low-income consumers. *The European Journal of Development Research, 25*(3), 333-355.

Fourie, M. (2013). *An interview conducted with Merwe Fourie, one of the developers of NamLITS, on 8 February 2013.*

Galloway, L., & Mochrie, R. (2005). The use of ICT in rural firms: a policy-orientated literature review. *info, 7*(3), 33-46.

Garnett, T., Appleby, M., Balmford, A., Bateman, I., Benton, T., Bloomer, P., Burlingame, B., Dawkins, M., Dolan, L. & Fraser, D. (2013). Sustainable intensification in agriculture: premises and policies. *Science, 341*(6141), 33-34.

Germain, C. (2003). Traceability implementation in developing countries, its possibilities and its constraints: A few case studies. FAO, Rome. Retrieved from ftp://ftp.fao.org/es/esn/food/traceability. pdf. Access date: 27 October 2015.

Gichamba, A., Wagacha, P. W., & Ochieng, D. O. (2017). An Assessment of e-Extension Platforms in Kenya. *International Journal of Innovative Studies in Sciences and Engineering Technology*, 3(7), 36-40.

Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008). Methods of data collection in qualitative research: interviews and focus groups. *British dental journal, 204*(6), 291-295.

Giovannucci, D., & Ponte, S. (2005). Standards as a new form of social contract? Sustainability initiatives in the coffee industry. *Food Policy, 30*(3), 284-301.

Glaser, B. G. (2002). Conceptualization: On theory and theorizing using grounded theory. *International Journal of Qualitative Methods, 1*(2), 23-38.

Goddard, W., & Melville, S. (2004). *Research methodology: An introduction*: Juta and Company Ltd.

Gollin, J. (1998). Deductive vs. inductive language learning. *ELT Journal, 52*(1), 88-89.

Greany, T., & Allen, T. (2014). School Improvement Networks and System Leadership in Coventry: Evaluating progress, areas for development and possible next steps: London: Institute of Education.

Greene, J. (2010). Animal identification and traceability: overview and issues. *Congressional Research Service, 29*.

Griffin, E. (2015). Hierarchy of needs of Abraham Maslow. *A First Look at Communicafion Theory*. . McGraw-Hill College.

GS1. (2010). *Traceability for Fresh Fruit and Vegetables. Implementation Guide*. retrieved from https://www.producetraceability.org/documents/Global_Traceability_Implementation_Fresh_Fruit_Veg.pdf. Access date: 12 May 2015.

Hansen, L. (2010). Ontologies, epistemologies, methodologies. *Gender matters in global politics: A feminist introduction to International Relations*, 17-28.

Harremoës, P., Gee, D., MacGarvin, M., Stirling, A., Keys, J., Wynne, B., & Vaz, S. G. (2001). *Late lessons from early warnings: the precautionary principle 1896-2000*: Citeseer.

Harris, R. W. (2015). How ICT4D research fails the poor. *Information Technology for Development*, 1-16.

Hedimbi, M., & Chinsembu, K. C. (2012). Ethnomedicinal study of plants used to manage HIV/AIDS-related disease conditions in the Ohangwena region, Namibia. *Int. J. Med. Plants Res, 1*(1), 004-011.

Heeks, R. (2002). Information systems and developing countries: Failure, success, and local improvisations. *The information society, 18*(2), 101-112.

Heeks, R. (2010). Do information and communication technologies (ICTs) contribute to development? *Journal of International Development, 22*(5), 625-640. doi:10.1002/jid.1716

Heeks, R., & Molla, A. (2009). Compendium on impact assessment of ICT-for-development projects. *Global Impact Study on Public Access to Information and Communication Technology.*

Heeks, R., Subramanian, L., & Jones, C. (2015). Understanding e-waste management in developing countries: Strategies, determinants, and policy implications in the Indian ICT sector. *Information Technology for Development, 21*(4), 653-667.

Herbert, R. K. (2007). Swaziland. *Countries and their cultures.* Retrieved from http://www.everyculture.com/Sa-Th/Swaziland.html. Access date: 7 June 2016.

Hilton, S., & Hunt, K. (2011). UK newspapers' representations of the 2009–10 outbreak of swine flu: one health scare not over-hyped by the media? *Journal of epidemiology and community Health, 65*(10), 941-946.

Hobbs, J. E. (2003). Consumer demand for traceability. Retrieved from https://ideas.repec.org/p/ags/iatrwp/14614.html. Access date: 4 July 2015.

Hobbs, J. E. (2003). *Traceability and country of origin labelling.* Paper presented at the Policy Dispute Information Consortium 9th Agricultural and Food Policy Information Workshop, Montreal.

Hobbs, J. E. (2014). *Public and Private Standards for Food Safety and Quality in Global Value Chains*. Retrieved from http://ageconsearch.umn.edu/bitstream/197191/2/Session%2014%20-%20Hobbs.pdf. Access date: 28 July 2016.

Hobbs, J. E., Bailey, D. V., Dickinson, D. L., & Haghiri, M. (2005). Traceability in the Canadian red meat sector: do consumers care? *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie, 53*(1), 47-65.

Hobbs, P. R. (2007). Conservation agriculture: what is it and why is it important for future sustainable food production? *Journal of Agricultural Science-Cambridge-, 145*(2), 127.

Hollow, D. (2015). ICT4D, Monitoring and Evaluation of. *The International Encyclopedia of Digital Communication and Society*.

Holzapfel, S., & Wollni, M. (2014). Is GlobalGAP certification of small-Scale farmers sustainable? Evidence from Thailand. *Journal of Development Studies, 50*(5), 731-747.

Hoque, M. R., & Ashraf, M. M. (2015). *An ICT4D project for promoting health awareness programmes in indigenous community.* Paper presented at the Proceedings of the Seventh International Conference on Information and Communication Technologies and Development.

Hoque, M. R., Saif, A. N. M., AlBar, A. M., & Bao, Y. (2015). Adoption of information and communication technology for development: A case study of small and medium enterprises in Bangladesh. *Information Development*, 0266666915578202.

Hoque, M. R., & Sorwar, G. (2015). ICT based e-government services for rural development: a study of union information and service center (UISC) in Bangladesh. *The Electronic Journal of Information Systems in Developing Countries, 71*.

Houston, S. (2001). Beyond social constructionism: Critical realism and social work. *British Journal of Social Work, 31*(6), 845-861.

Hubschle, O. (2005). *Presentation at OSRO/RAF/404/SAF workshop, Onderstepoort, South Africa, 3–4 May 2005; Agro-ecological zone Programme, Ministry of Agriculture & Rural Development, Namibia*.

Huitt, W. (2004). Maslow's hierarchy of needs. *Educational psychology interactive*. Retrieved from http://www.edpsycinteractive.org/. Access date: 23 October 2015.

Hussain, M. D., Bhuiyan, A. B., & Bakar, R. (2014). Entrepreneurship development and poverty alleviation: an empirical review. *Journal of Asian Scientific Research, 4*(10), 558.

Iglesias, A., Quiroga, S., Moneo, M., & Garrote, L. (2012). From climate change impacts to the development of adaptation strategies: challenges for agriculture in Europe. *Climatic Change, 112*(1), 143-168.

Ildikó, I., & Rădulescu, C. V. (2015). New Challenges for Agriculture within the Context of Climate Change. *Theoretical and Applied Economics, 22*(4 (605), Winter), 253-262.

Institute for Development Studies. (1996). Sustainable Rural Livelihoods. A Proposal to ESCOR. *IDS working Paper 72. Brighto*n.

International Institute for Sustainable Development. (2012). Sustainable Development Timeline. Retrieved from https://www.iisd.org/pdf/2012/sd_timeline_2012.pdf. Access date: 28 June 2016.

ISO 22000:2005. (2005). Food safety management systems-Requirements for any organization in the food chain. Geneva (Switzerland).Retrieved from https://www.iso.org/obp/ui/#iso:std:iso:22000:ed-1:v1:en. Access date: 16 February 2015.

ISO Standards, (2016).International Organization for Standardization. Retrieved from https://www.iso.org/home.html. Access date: 18 February 2016.

ISO/TS 22003:2007. (2007). Food safety management systems -- Requirements for bodies providing audit and certification of food safety management systems. Geneva (Switzerland).retrieved from https://www.iso.org/standard/39834.html. Access date: 18 February 2016.

Jacucci, E., Shaw, V., & Braa, J. (2006). Standardization of health information systems in South Africa: The challenge of local sustainability. *Information Technology for Development, 12*(3), 225-239.

Jayne, T., Chamberlin, J., & Headey, D. D. (2014). Land pressures, the evolution of farming systems, and development strategies in Africa: A synthesis. *Food Policy, 48*, 1-17.

Jin, H. J., Skripnitchenko, A., & Koo, W. W. (2004). *The effects of the BSE outbreak in the United States on the beef and cattle industry*: Center for Agricultural Policy and Trade Studies, Department of Agribusiness and Applied Economics, North Dakota State University.

Joffe, H., & Lee, N. L. (2004). Social representation of a food risk: The Hong Kong avian bird flu epidemic. *Journal of Health Psychology, 9*(4), 517-533.

Johnson, D. L., Pejovic, V., Belding, E. M., & van Stam, G. (2012). *VillageShare: Facilitating content generation and sharing in rural networks.* Paper presented at the Proceedings of the 2nd ACM Symposium on Computing for Development.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational researcher, 33*(7), 14-26.

Johnson, W. E. (1932). I.—Probability: The deductive and inductive problems. *Mind, 41*(164), 409-423.

Käferstein, F., & Abdussalam, M. (1999). Food safety in the 21st century. *Bulletin of the World Health Organization, 77*(4), 347.

Käferstein, F., Motarjemi, Y., & Bettcher, D. (1997). Foodborne disease control: a transnational challenge. *Emerging infectious diseases, 3*(4), 503.

Kahn, M. (1995). *Concepts, definitions, and key issues in sustainable development: the outlook for the future.* Paper presented at the Proceedings of the International Sustainable Development Research Conference, Manchester Conference Centre UK.

Kalfagianni, A., & Fuchs, D. (2012). The GlobalGAP. *Business, non-state regulation and development*, 160-172.

Kampragou, E., Assimacopoulos, D., Andreu, J., Bifulco, C., De Carli, A., Dias, S., Tánago, I.G., Monteagudo, D.H., Massarutto, A & Musolino, D. (2015). Systematic classification of drought vulnerability and relevant strategies - Case study scale.

Kaplan, B., & Duchon, D. (1988). Combining qualitative and quantitative methods in information systems research: a case study. *MIS Quarterly*, 571-586.

Kaplan, B., & Maxwell, J. A. (2005). Qualitative research methods for evaluating computer information systems *Evaluating the Organizational Impact of Healthcare Information Systems* (pp. 30-55): Springer.

Karanasios, S. (2014). Framing ICT4D research using activity theory: a match between the ICT4D field and theory? *Information Technologies & International Development, 10*(2), pp. 1-18.

Karesh, W. B., & Cook, R. A. (2005). The human-animal link. *Foreign Affairs, 84*(4), 38-50.

Kariuki, I. M., Loy, J. P., & Herzfeld, T. (2012). Farmgate private standards and price premium: evidence from the GlobalGAP scheme in Kenya's French beans marketing. *Agribusiness, 28*(1), 42-53.

Keating, B. A., Carberry, P. S., Bindraban, P. S., Asseng, S., Meinke, H., & Dixon, J. (2010). Eco-efficient agriculture: concepts, challenges, and opportunities. *Crop Science, 50*(Supplement_1), S-109-S-119.

Keen, P. G. (1980). MIS research: reference disciplines and a cumulative tradition.

Kelly, C. (2009). Origins of Sustainability. *Institute for Transport Studies, University of Leeds*.

Khalala, G., Botha, A., & Makitla, I. (2016). *Process as an element of UX in collecting Indigenous Knowledge: A case study in South Africa.* Paper presented at the IST-Africa Week Conference, 2016.

Ki-moon, B. (2013). BrainyQuote.com. Retrieved January 29, 2017, from BrainyQuote.com. Retrieved from https://www.brainyquote.com/quotes/quotes/b/bankimoon643741.html.

Knowles, T., Moody, R., & McEachern, M. G. (2007). European food scares and their impact on EU food policy. *British Food Journal, 109*(1), 43-67.

Köhler, J. (2014). Globalization and sustainable development: Case study on international transport and sustainable development. *The Journal of Environment & Development, 23*(1), 66-100.

Kössler, R. (2015). Two modes of amnesia: complexity in postcolonial Namibia. *Acta Academica, 47*(1), 138-160.

Kotir, J. H. (2011). Climate change and variability in Sub-Saharan Africa: a review of current and future trends and impacts on agriculture and food security. *Environment, Development and Sustainability, 13*(3), 587-605.

Kowalski, L. H., Monteiro, A. L. G., Hentz, F., Prado, O. R., Kulik, C. H., Fernandes, S. R., & Silva, C. J. A. d. (2014). Electronic and visual identification devices for adult goats reared in semi-intensive system. *Revista Brasileira de Zootecnia, 43*(2), 100-104.

Kumba, F. F. (2003). Farmer participation in agricultural research and extension service in Namibia. *Journal of International Agricultural and Extension Education, 10*(3), 47-55.

Kunstler, J.H. (n.d.). BrainyQuote.com. Retrieved January 29, 2017, from BrainyQuote.com. Retrieved from https://www.brainyquote.com/quotes/quotes/j/jameshowar694592.html.

Leitgeb, F., Funes-Monzote, F. R., Kummer, S., & Vogl, C. R. (2011). Contribution of farmers' experiments and innovations to Cuba's agricultural innovation system. *Renewable Agriculture and Food Systems, FirstView*, 1-14. doi:doi:10.1017/S1742170511000251

Leroy, J. L., Ruel, M., Frongillo, E. A., Harris, J., & Ballard, T. J. (2015). Measuring the Food Access Dimension of Food Security A Critical Review and Mapping of Indicators. *Food and nutrition bulletin, 36*(2), 167-195.

Lewandowski, I., & Faaij, A. P. (2006). Steps towards the development of a certification system for sustainable bio-energy trade. *Biomass and Bioenergy, 30*(2), 83-104.

Lin, A. C. (1998). Bridging positivist and interpretivist approaches to qualitative methods. *Policy studies journal, 26*(1), 162-180.

Loudon, M. (2016). A platform studies approach to the role of technology in the ICTD ecosystem: The SMS in m4d interventions. *Information Technology for Development, 22*(sup1), 7-25.

Loureiro, M. L., & Umberger, W. J. (2007). A choice experiment model for beef: What US consumer responses tell us about relative preferences for food safety, country-of-origin labeling and traceability. *Food Policy, 32*(4), 496-514. doi:http://dx.doi.org/10.1016/j.foodpol.2006.11.006

Mabila, J., Van Biljon, J., & Herselman, M. (2017). A sustainability framework for mobile technology integration in schools: The case of resource-constrained environments in South Africa. *The Journal of Community Informatics, 13*(2).

Malhotra, A., Melville, N. P., & Watson, R. T. (2010). Information systems and environmental sustainability. *MIS Quarterly, 24*(2), 429-430.

Maps-Africa. (2012). Southern Africa Map Pictures. Retrieved from http://maps-africa.blogspot.co.za/. Access date: 17 October 2016.

Marais, M. A. (2011). Analysis of the factors affecting the sustainability of ICT4D initiatives. *IDIA2011 Conference Proceedings, 100-120*

Marais, M. A. (2015). ICT4D and Sustainability. *The International Encyclopedia of Digital Communication and Society*. In book: The International Encyclopedia of Digital Communication and Society (IEDCS), Edition: 1st, Chapter: ICT4D and Sustainability, Publisher: John Wiley & Sons, Inc., Editors: Robin Mansell, Peng Hwa Ang

Marien, N. (2012). Lack of environment. 20 Years of unsustainable development. Retrieved from https://lackofenvironment.wordpress.com/2012/10/04/20-years-of-unsustainable-development/. Access date: 23 May 2015.

Martinez, M. G., & Poole, N. (2004). The development of private fresh produce safety standards: implications for developing Mediterranean exporting countries. *Food Policy, 29*(3), 229-255.

Marumo, D., & Monkhei, M. (2009). The effects of the European Union (EU)-Imposed livestock identification and traceback system on Botswana's beef exports, revenue and rural poverty. *Botswana Institute for Development Policy Analysis Gaborone, Botswana*.

Masiero, S. (2016). The Origins of Failure: Seeking the Causes of Design–Reality Gaps. *Information Technology for Development*, 1-16.

Maskus, K. E., & Wilson, J. S. (2001). *Quantifying the Impact of Technical Barriers to Trade: Can it be done?* : University of Michigan Press.

Maslow, A. H. (1943). Preface to motivation theory. *Psychosomatic medicine, 5*(1), 85-92.

Maslow, A. H. (1943). A theory of human motivation. *Psychological review, 50*(4), 370.

Maslow, A. H. (1987). Maslow's hierarchy of needs. *Salenger Incorporated*.

Mathibela, M. K., Egan, B. A., Du Plessis, H. J., & Potgieter, M. J. (2015). Socio-cultural profile of Bapedi traditional healers as indigenous knowledge custodians and conservation partners in the Blouberg area, Limpopo Province, South Africa. *Journal of ethnobiology and ethnomedicine, 11*(1), 49.

McFerron, W., Almeida, I., & Davison, W. (2016). FOOD CRISIS LOOMING IN ETHIOPIA AFTER WORST DROUGHT IN 50 YEARS. *The Nerve, Africa*. Retrieved from http://thenerveafrica.com/2584/food-crisis-looming-in-ethiopia-after-worst-drought-in-50-years/

McGuire, S. (2015). FAO, IFAD, and WFP. The State of Food Insecurity in the World 2015: Meeting the 2015 International Hunger Targets: Taking Stock of Uneven Progress. Rome: FAO, 2015. *Advances in Nutrition: An International Review Journal, 6*(5), 623-624.

McLeod, S. (2007). Maslow's hierarchy of needs. *Retrieved from: http://www. simplypsychology. org/maslow. html*. Access date: 23 October 2016.

McMichael, P. (2009). Banking on agriculture: a review of the World Development Report 2008. *Journal of Agrarian Change, 9*(2), 235-246.

McMichael, P., & Schneider, M. (2011). Food security politics and the Millennium Development Goals. *Third World Quarterly, 32*(1), 119-139.

Mdluli, S. (2012, 13 December 2012) *Discussing the use of SLITS/Interviewer: T. Prinsloo*.

Melber, H. (2003). *Re-examining liberation in Namibia: political culture since independence*: Nordic Africa Institute.

Melber, H. (2015). Post-liberation democratic authoritarianism: The case of Namibia. *Politikon, 42*(1), 45-66.

Meyer, I. A., & Marais, M. A. (2014). Decision support to enable sustainability in development projects. *Retrieved from http://www.monash.edu/it/our-research/research-centres-and-labs.* Access date: 25 March 2015.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*: Sage.

Mog, J. M. (2004). Struggling with sustainability—a comparative framework for evaluating sustainable development programs. *World Development, 32*(12), 2139-2160.

Mogensen, L., Nguyen, T., Madsen, N., Pontoppidan, O., Preda, T., & Hermansen, J. E. (2015). *Environmental impact of beef–the food chain from farm to fork.* Paper presented at the Annual Meeting of the European Association for Animal Production.

Monjardino de Souza Monteiro, D., & Caswell, J. (2004). The economics of implementing traceability in beef supply chains: Trends in major producing and trading countries. *University of Massachusetts, Amherst Working Paper* (2004-6).

Moreki, J. C., Ndubo, N. S., Ditshupo, T., & Ntesang, J. B. (2012). Cattle Identification and Traceability in Botswana. *Journal of Animal Science Advances, 2*(12), 925-933.

Mortimore, S., & Wallace, C. (1998). An introduction to HACCP *HACCP* (pp. 1-11): Springer.

Movileanu, P. (2011). Sustainable development of the agriculture and agricultural holdings - conceptual delimitations and methodology. *Scientific Papers Series - Management, Economic Engineering in Agriculture and Rural Development, 11*(1), 125-130.

Muhammed, M. (2007). Rural Development and Enterprise Development: Alexandria: Sustainable Development Association.

Musiyandaka, D., Ranga, G., & Kiwa, J. F. (2013). An analysis of factors influencing success of ICT4D projects: a case study of the Schools Computerisation Programme in Mashonaland West Province, Zimbabwe. *The Journal of Community Informatics, 9*(4).

Nakagawa, Y., & Shaw, R. (2004). Social capital: A missing link to disaster recovery. *International Journal of Mass Emergencies and Disasters, 22*(1), 5-34.

Nchuchuwe, F. F., & Adejuwon, K. D. (2012). The Challenges of Agriculture and Rural Development in Africa: The Case of Nigeria. *International Journal of Academic Research in Progressive Education and Development, 1*(3), 45-61.

Ndou, P. (2012). *The competitiveness of the South African citrus industry in the face of the changing global health and environmental standards.* Citeseer.

Norman, A. (2015). *Robert Mugabe and the betrayal of Zimbabwe*: McFarland.

O'Mahony, P. (2013). Finding horse meat in beef products—a global problem. *QJM, 106*(6), 595-597.

Oates, B. J. (2005). *Researching information systems and computing*: Sage.

Ohlsson, T. (2010). *Sustainability, food and the future.* Paper presented at the LCAFood 2010, VII international conference on life cycle assessment in the agri-food sector.

Oladele, O. (2011). Determinants of Constraints to Livestock Identification and Trace-back System Use for Disease Monitoring Among Cattle Farmers in Botswana. *International Journal of Applied Research Veterinary Medicine*, 9(2), 143-153.

Oladele, O., & Jood, M. (2010). Factors affecting adoption of livestock identification and trace-back system among cattle farmers in Kgalagadi district, Botswana. *Livestock Research for Rural Development, 22*(8), 2010.

Opara, L. U. (2002). Engineering and technological outlook on traceability of agricultural production and products. *Agricultural Engineering International: CIGR Journal of Scientific Research and Development.* Invited Overview Paper IV.

Opp, S. M., & Saunders, K. L. (2013). Pillar talk: local sustainability initiatives and policies in the United States—finding evidence of the “three E’s”: economic development, environmental protection, and social equity. *Urban Affairs Review*, 1078087412469344.

Pade-Khene, C., Mallinson, B., & Sewry, D. (2011). Sustainable rural ICT project management practice for developing countries: investigating the Dwesa and RUMEP projects. *Information Technology for Development, 17*(3), 187-212.

Pade, C., Mallinson, B., & Sewry, D. (2009). An exploration of the critical success factors for the sustainability of rural ICT projects–the Dwesa case study *Information Systems Development* (pp. 339-352): Springer.

Park, S. (2016). Digital inequalities in rural Australia: A double jeopardy of remoteness and social exclusion. *Journal of Rural Studies*, 54(2017), 399-407.

Paskin, R., Pauw, R., Mack, S., & Maki-Hokkonen, J. (2004). Livestock identification and recording: the Namibian experience. *ICAR Technical Series*(9), 85-91.

Pereira, P. M. d. C. C., & Vicente, A. F. d. R. B. (2013). Meat nutritional composition and nutritive role in the human diet. *Meat Science, 93*(3), 586-592. doi:http://dx.doi.org/10.1016/j.meatsci.2012.09.018

Perekwa, G. B., Prinsloo, T., & Van Deventer, J. P. (2016). The Impact of Mobile Technology on Micro and Small Enterprises in Zimbabwe in the Post-Hyperinflation Economic Era. *The African Journal of Information Systems, 8*(3), 3.

Peter, H. A. S. S. (2015). Communicating user experience:“Wicked” problems, patchwork personas, and the ICTD project lifecycle. *International Journal of Sociotechnology and Knowledge Development (IJSKD), 7*(2), 14-26.

Petter, S., DeLone, W., & McLean, E. R. (2013). Information systems success: The quest for the independent variables. *Journal of management information systems, 29*(4), 7-62.

Pinna, W., Sedda, P., Moniello, G., & Ribó, O. (2006). Electronic identification of Sarda goats under extensive conditions in the island of Sardinia. *Small Ruminant Research, 66*(1), 286-290.

Pinstrup-Andersen, P. (2009). Food security: definition and measurement. *Food Security, 1*(1), 5-7.

Pitula, K., Dysart-Gale, D., & Radhakrishnan, T. (2010). Expanding theories of HCI: A case study in requirements engineering for ICT4D. *Information Technologies & International Development, 6*(1), pp. 78-93.

Polonsky, M. J., & Waller, D. S. (2014). *Designing and managing a research project: A business student's guide*: Sage Publications.

Population Reference Bureau. (2015). *2015 World Population Data Sheet*. Retrieved from http://www.prb.org/pdf15/2015-world-population-data-sheet_eng.pdf. Access date: 30 April 2015.

Prinsloo, T, De Villiers, C & Van Niekerk, J. (2017). The role of the Namibian Livestock Traceability Systems in containing the recent foot-and-mouth disease outbreak: Case study from the Northern parts of Namibia. 2017. *NextComp IEEE Conference, 19 to 21 July 2017*.

Pye-Smith, C. (2014). *ICTs for agriculture: Making it happen*: CTA.

Qureshi, S. (2015). Are we making a Better World with Information and Communication Technology for Development (ICT4D) Research? Findings from the Field and Theory Building. *Information Technology for Development, 21*(4), 511-522.

Ramani, T., Zietsman, J., Gudmundsson, H., Hall, R., & Marsden, G. (2011). Framework for sustainability assessment by transportation agencies. *Transportation Research Record: Journal of the Transportation Research Board*(2242), 9-18.

Ramessar, K., Capell, T., Twyman, R. M., Quemada, H., & Christou, P. (2008). Trace and traceability—a call for regulatory harmony. *Nature biotechnology, 26*(9), 975-978.

Reason, P., & Bradbury, H. (2001). *Handbook of action research: Participative inquiry and practice*: Sage.

Regattieri, A., Gamberi, M., & Manzini, R. (2007). Traceability of food products: General framework and experimental evidence. *Journal of Food Engineering, 81*(2), 347-356.

Renken, J., & Heeks, R. (2013). *Conceptualising ICT4D project champions.* Paper presented at the Proceedings of the Sixth International Conference on Information and Communications Technologies and Development: Notes-Volume 2.

Rich, K. M., & Perry, B. D. (2011). Whither Commodity-based Trade? *Development policy review, 29*(3), 331-357.

Riely, F., Mock, N., Cogill, B., Bailey, L., & Kenefick, E. (1999). *Food security indicators and framework for use in the monitoring and evaluation of food aid programs*: Food Security and Nutrition Monitoring Project.

Ringius, L., Downing, T., Hulme, M., Waughray, D., & Selrod, R. (1996). Climate change in Africa: issues and challenges in agriculture and water for sustainable development. *Cicero report*.

Rockström, J., Barron, J., & Fox, P. (2003). Water productivity in rain-fed agriculture: challenges and opportunities for smallholder farmers in drought-prone tropical agroecosystems. *Water productivity in agriculture: Limits and opportunities for improvement, 85199*(669), 8.

Roosen, J., Lusk, J. L., & Fox, J. A. (2003). Consumer demand for and attitudes toward alternative beef labeling strategies in France, Germany, and the UK. *Agribusiness, 19*(1), 77-90.

Roy, R., Chan, N. W., & Rainis, R. (2013). Development of an empirical model of sustainable rice farming: A case study from three rice-growing ecosystems in Bangladesh. *American-Eurasian Journal of Agricultural & Environmental Sciences, 13*(4), 449-460.

Ruviaro, C. F., Barcellos, J. O. J., & Dewes, H. (2014). Market-oriented cattle traceability in the Brazilian Legal Amazon. *Land Use Policy, 38*, 104-110.

Rweyemamu, M., Roeder, P., MacKay, D., Sumption, K., Brownlie, J., & Leforban, Y. (2008). Planning for the Progressive Control of Foot-and-Mouth Disease Worldwide. *Transboundary and emerging diseases, 55*(1), 73-87.

Sadoulet, E., & De Janvry, A. (2009). Agriculture for development: lessons from the world development report 2008. *QA Rivista dell'Associazione Rossi-Doria*.

SAFA. (2003). South African feedlot industry and the economics of beef production. *Unpublished document. South African Feedlot Association, Pretor*ia.

Saghir, J. (2014). Global challenges in agriculture and the World Bank's response in Africa. *Food and Energy Security, 3*(2), 61-68.

Sahay, S., & Mukherjee, A. (2017). *Self-Reinforcing Linkages Between Value and Local Ownership: Rethinking Sustainability of ICT4D Project.* Paper presented at the International Conference on Social Implications of Computers in Developing Countries.

Salemink, K., Strijker, D., & Bosworth, G. (2017). Rural development in the digital age: A systematic literature review on unequal ICT availability, adoption, and use in rural areas. *Journal of Rural Studies, 54*, 360-371.

Salerno, J., Hinman, M., & Boulware, D. (2004). *Building a framework for situation awareness*. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.63.1633&rep=rep1&type=pdf. Access date: 12 November 2015.

Sasson, A. (2012). Food security for Africa: an urgent global challenge. *Agriculture & Food Security, 1*(1), 1.

Schmidt, R. H., & Rodrick, G. E. (2003). *Food safety handbook*: John Wiley & Sons.

Schmolke, T. (2008). *EU Private Standards (GLOBALGAP, EUREPGAP) as Substitutes for Missing Public Standards: The Case of Fresh Fruit and Vegetables.* Paper presented at the Marketing and Trade of Fresh Fruit and Vegetables Seminar, 30th May.

Schneirla, T. (1950). The relationship between observation and experimentation in the field study of behavior. *Annals of the New York Academy of Sciences, 51*(6), 1022-1044.

Schroeder, T. C., & Tonsor, G. T. (2012). International cattle ID and traceability: Competitive implications for the US. *Food Policy, 37*(1), 31-40.

Schultz, W. (2013, 8 February 2013) *Discussion on NamLITS and its uses./Interviewer: T. Prinsloo*.

Schwägele, F. (2005). Traceability from a European perspective. *Meat Science, 71*(1), 164-173.

Scoones, I., & Wolmer, W. (2003). Introduction: Livelihoods in Crisis: Challenges for Rural Development in Southern Africa. *IDS Bulletin, 34*(3), 1-14. doi:10.1111/j.1759-5436.2003.tb00073.x

Scoones, I., & Wolmer, W. (2006). Livestock, disease, trade and markets: policy choices for the livestock sector in Africa. *Working Paper 269.* Retrieved from http://hubrural.org/IMG/pdf/wp269.pdf. Access date: 23 May 2015.

Sein, M. K., & Harindranath, G. (2004). Conceptualizing the ICT Artifact: Toward Understanding the Role of ICT in National Development. *The information society, 20*(1), 15-24. doi:10.1080/01972240490269942

Shin, D.-H. (2009). Ubiquitous city: Urban technologies, urban infrastructure and urban informatics. *Journal of Information Science, 35*(5), 515-526.

Shortall, R., Davidsdottir, B., & Axelsson, G. (2015). Geothermal energy for sustainable development: A review of sustainability impacts and assessment frameworks. *Renewable and Sustainable Energy Reviews, 44*, 391-406.

Siena, A., Maiden, N., Lockerbie, J., Karlsen, K., Perini, A., & Susi, A. (2008). *Exploring the effectiveness of normative i* modelling: Results from a case study on food chain traceability.* Paper presented at the Advanced Information Systems Engineering.

Simons, J. A., Irwin, D. B., & Drinnien, B. A. (1987). Maslow's hierarchy of needs. *Retrieved October, 9*, 2009.

Smith, G., Pendell, D., Tatum, J., Belk, K., & Sofos, J. (2008). Post-slaughter traceability. *Meat Science, 80*(1), 66-74.

Smith, H. K., & Harper, P. R. (2015). Can you model growth of trust? A study of the sustainability of a rural community health centre in North India. *Journal of Simulation, 9*(2), 170-181.

Smith, R. D. (2006). Responding to global infectious disease outbreaks: lessons from SARS on the role of risk perception, communication and management. *Social science & medicine, 63*(12), 3113-3123.

Sodano, V., & Verneau, F. (2004). Traceability and food safety: public choice and private incentives. *Quality Assurance, Risk Management and Environmental Control in Agriculture and Food Supply Networks, Universitat Bonn-ILB, Germany*.

Stephen, V. (1996). Sustainability‘s Five Capitals and Three Pillars. *Dennis C. Pirages. Building Sustainable Societies. A Blueprint for Post-Industrial World. Armonk, NY: ME Sharpe*.

Storøy, J., Thakur, M., & Olsen, P. (2013). The TraceFood Framework – Principles and guidelines for implementing traceability in food value chains. *Journal of Food Engineering, 115*(1), 41-48. doi:http://dx.doi.org/10.1016/j.jfoodeng.2012.09.018

Strachan, D. L., Källander, K., Nakirunda, M., Ndima, S., Muiambo, A., & Hill, Z. (2015). Using theory and formative research to design interventions to improve community health worker motivation, retention and performance in Mozambique and Uganda. *Human resources for health, 13*(1), 25.

Strauss, A., & Corbin, J. (1994). Grounded theory methodology. *Handbook of qualitative research*, 273-285.

Szent-Gyorgyi, A. (n.d.). BrainyQuote.com. Retrieved January 29, 2017, from BrainyQuote.com. Retrieved from https://www.brainyquote.com/quotes/quotes/a/albertszen389956.htm

Tacastacas, R. C. (2011). *Value chain integration, cluster cooperation, and sustainable livelihoods.* University of Missouri.

Tetteh, K. A. (2014). *The Role of Communication in Achieving the Millennium Development Goals: A Case Study of the National Development Planning Commission (NDPC) and the United Nations Development Programme (UNDP) In Ghana.* University of Ghana.

The Beef Site. (2015). Namibia's First Foot and Mouth Case For Six Years. Retrieved from http://www.thebeefsite.com/news/47368/namibias-first-foot-and-mouth-case-for-six-years/

The Government of the Kingdom of Swaziland. (2012). Veterinary Services: The Swaziland Livestock Information and Traceability System. *Ministry of Agriculture.* Retrieved from http://www.gov.sz/index.php?option=com_content&view=article&catid=80%3Aagriculture&id=865%3Aslits&Itemid=594

The International Fund for Agricultural Development. (2013). *Enabling the rural poor to overcome poverty in Swaziland*. Retrieved from https://www.ifad.org/documents/10180/66b37ddb-be5b-4824-a23c-47cb102c5cc7. Access date: 30 June 2015.

The Namibian. (2015). Foot-and-mouth disease breaks out in northern regions [Press release]. Retrieved from http://www.namibian.com.na/index.php?id=136996&page=archive-read

Thomson, G., & Penrith, M.-L. (2011). *Animal health policy, legislation and trade in beef in the five participating states of the Kavango-Zambezi transfrontier conservation area (KAZA TFCA)*. Technical Report to the Wildlife Conservation Society's AHEAD Program. 132 pp. http://www. wcs-ahead. org/workinggrps_kaza. html.

Thomson, G., Penrith, M. L., Atkinson, M., Atkinson, S., Cassidy, D., & Osofsky, S. (2013). Balancing livestock production and wildlife conservation in and around southern Africa's transfrontier conservation areas. *Transboundary and emerging diseases, 60*(6), 492-506.

Thornton, P. K., Jones, P. G., Ericksen, P. J., & Challinor, A. J. (2011). Agriculture and food systems in sub-Saharan Africa in a 4 C+ world. *Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences, 369*(1934), 117-136.

Toldrá, F., & Reig, M. (2006). Methods for rapid detection of chemical and veterinary drug residues in animal foods. *Trends in Food Science & Technology, 17*(9), 482-489.

Toman, M. A. (2006). The difficulty in defining sustainability. *The RFF Reader in Environmental and Resource Policy, 2*.

Turk, Ž. (2006). Construction informatics: Definition and ontology. *Advanced Engineering Informatics, 20*(2), 187-199.

Turner, M. (2012). World heritage and sustainable development. *World Heritage, 65*, 6-13.

Uimonen, P. (2015). Beyond Failure: Rethinking Research and evaluation in ICT4D. *Digital Divides: The New Challenges and Opportunities of e-Inclusion, 195*, 247.

UNESCO. (2015). *UNESCO and Sustainable Development Goals*. Retrieved from http://www.un.org/sustainabledevelopment/. Access date: 12 January 2015.

United Nations. (2015). *The Millennium Development Goals report 2015*. Retrieved from http://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf. Access date: 13 April 2015.

United Nations. (n.d.). *We can end poverty. Millenium Development Goals and Beyond 2015*. Retrieved from http://www.un.org/millenniumgoals/. Access date: 16 April 2015.

United States Central Intelligence Agency. (2016a). 2016 World Fact Book of the United States Central Intelligence Agency: Namibia Government 2016. Retrieved from https://www.cia.gov/library/publications/the-world-factbook/geos/wa.html. Access date: 13 May 2016.

United States Central Intelligence Agency. (2016b). 2016 World Fact Book of the United States Central Intelligence Agency: Swaziland Government 2016. Retrieved from http://www.theodora.com/wfbcurrent/swaziland/swaziland_government.html. Access date: 20 May 2016.

Urquhart, C., Lehmann, H., & Myers, M. D. (2010). Putting the 'theory'back into grounded theory: guidelines for grounded theory studies in information systems. *Information Systems Journal, 20*(4), 357-381.

Van de Brug, F. J., Lucas Luijckx, N. B., Cnossen, H. J., & Houben, G. F. (2014). Early signals for emerging food safety risks: From past cases to future identification. *Food Control, 39*(0), 75-86. doi:http://dx.doi.org/10.1016/j.foodcont.2013.10.038

Van der Meulen, B., & Van der Velde, M. (2004). Food safety law in the European Union. *W ageningen Academia Publishers, The Netherlands*.

Van Vark, C., Humphrey, J., Sampathkumar, R., Nicolaides, L., Robinson, P., Ducharme, H., & Longfield, J. (2013). What do food traceability crises in the North mean for people working in food chains in the global South? *Food Chain, 3*(1), 5-17.

Van Zyl, E., McCrindle, C. & Grace, D. (2008). Participatory risk assessment for food safety in informal markets. *54th International Congress of Meat Science and Technology,* 2008, 10-15.

Vandome, C., Vines, A., & Weimer, M. (2013). *Swaziland: Southern Africa's Forgotten Crisis*: Chatham House London.

Venkatesh, V., Brown, S. A., & Bala, H. (2013). Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. *MIS Quarterly, 37*(1), 21-54.

Venkatesh, V., Brown, S. A., & Sullivan, Y. W. (2016). Guidelines for Conducting Mixed-methods Research: An Extension and Illustration. *Journal of the Association for Information Systems, 17*(7), 2.

Verbeke, W. (2001). The emerging role of traceability and information in demand-oriented livestock production. *Outlook on Agriculture, 30*(4), 249-255. doi:10.5367/000000001101293733

Vos, R. O. (2007). Defining sustainability: a conceptual orientation. *Journal of Chemical Technology and Biotechnology, 82*(4), 334-339.

Vosloo, W., Bastos, A., Sangare, O., Hargreaves, S., & Thomson, G. (2002). Review of the status and control of foot and mouth disease in sub-Saharan Africa. *Revue Scientifique et Technique-Office International des Epizooties, 21*(3), 437-445.

Vosloo, W., Knowles, N., & Thomson, G. (1992). Genetic relationships between southern African SAT-2 isolates of foot-and-mouth-disease virus. *Epidemiology and infection, 109*(03), 547-558.

Weiss, B. (2012). Configuring the authentic value of real food: Farm-to-fork, snout-to-tail, and local food movements. *American Ethnologist, 39*(3), 614-626.

Wik, M., Pingali, P., & Broca, S. (2008). Global agricultural performance: past trends and future prospects. *Background paper for the WDR*.

Winter-Nelson, A., & Rich, K. M. (2008). Mad cows and sick birds: financing international responses to animal disease in developing countries. *Development policy review, 26*(2), 211-226.

World Bank. (1987). *World Development Report 1987: Environment, Growth and Development*. New York: Oxford University Press.

World Bank. (1992). *World Development Report 1992: Development and the environment*. New York: Oxford University Press.

World Bank. (2007). *World Development Report 2008: Agriculture for Development*. New York: Oxford University Press.

World Bank. (2015). List of Countries by Population Density. Retrieved from http://statisticstimes.com/population/countries-by-population-density.php. Access date: 14 March 2015.

World Food Summit. (1996). The Rome Declaration on World Food Security. *Population and Development Review, 22*(4), 807 - 809. http://www.jstor.org/stable/2137827 Retrieved from http://www.jstor.org/stable/2137827

World Trade Organisation. (2015). *Annex 5 - Kingdom of Swaziland*. Retrieved from https://www.wto.org/english/tratop_e/tpr_e/s324-04_e.pdf

Worldomotors. (2017). Swaziland Population. Retrieved from http://www.worldometers.info/world-population/swaziland-population/. Access date: 12 July 2017.

Wynekoop, J. L., & Russo, N. L. (1997). Studying system development methodologies: an examination of research methods. *Information Systems Journal, 7*(1), 47-65.

Xinhau. (2016). Namibia free of foot and mouth disease: minister. Retrieved from http://news.xinhuanet.com/english/2016-01/23/c_135038635.htm. Access date: 23 January 2017.

Yam, P. (2003). Mad cow's human toll. *The Pathological Protein: Mad Cow, Chronic Wasting, and Other Deadly Prion Diseases*, 137-152.

Yeung, R. M., & Morris, J. (2001). Food safety risk: Consumer perception and purchase behaviour. *British Food Journal, 103*(3), 170-187.

Yilmaz, Ş. (2014). *An Assessment on The Link Between Sustainability And Urban Form: The Case Of Gaziantep.* Middle East Technical University.

Yin, R. K. (1994). *Case study research: Design and methods*: Beverley Hills: Sage publishing.

Yin, R. K. (2013). *Case study research: Design and methods*: Sage publications.

Zumthor, P. (n.d.). BrainyQuote.com. Retrieved January 29, 2017, from BrainyQuote.com. Retrieved from https://www.brainyquote.com/quotes/quotes/p/peterzumth542972.html

Appendix 1. Interview questions

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Economic and Management Sciences

Letter of Introduction and Informed Consent

Dept. of Informatics

Title of the study

The impact of livestock traceability systems on the communal farmer: Cases from Swaziland and Namibia

Research conducted by:
Mrs Tania Prinsloo
Student number: 20235722
Cell: 083 415 7913
E-mail address: tania.prinsloo@up.ac.za

Dear Participant

You are invited to participate in an academic research study conducted by Tania Prinsloo, doctoral student from the Department of Informatics at the University of Pretoria.

The purpose of the study is to explain the impact of the communal after the traceability system was introduced in the region. The aim is to create an overall framework explaining the impact in detail.

Please note the following:
This is not an anonymous interview and your name will be used as a reference. The answers you give will be treated with respect and you will not be quoted out of context. You also consent to the interview being voice-recorded.

- Your participation in this study is very important to us. You may, however, choose not to participate and you may also stop participating at any time without any negative consequences.
- Please answer the questions in the interview as completely and honestly as possible. The interview will be kept as short as possible.
- The results of the study will be used for academic purposes only and may be published in an academic journal. We will provide you with a summary of our findings on request.
- Please contact my study leader, Prof. Carina de Villiers, cellular phone number 083 289 1989, e-mail address carina.devilliers@up.ac.za if you have any questions or comments regarding the study.

Please sign the form to indicate that:

- You have read and understood the information provided above.
- You give your consent to participate in the study on a voluntary basis.

______________________________ ______________________

Participant's signature **Date**

Interview 1: Interview with the Swaziland Director of Veterinary Services and other key staff on the new traceability system.

1. What do you expect from Swaziland Livestock Information and Traceability System (SLITS)?
2. What are the differences between the traceability systems used by commercial and communal farmers?
3. What technology is typically being used at the dipping events?
4. What are the main purposes of SLITS?
5. When was SLITS rolled-out throughout Swaziland?
6. How and when did the process of creating SLITS start?
7. When did the ear-tagging of the communal farmers' cattle start?
8. What is the procedure to get an ear-tag?
9. How much does ear-tags cost?
10. How often did you ear-tag?
11. How often do dipping events take place?
12. Was there any resistance with implementing SLITS?
13. What are the main benefits of SLITS?
14. Is SLITS part of an overall e-government drive?
15. Where do you mainly export the beef products to?

Interview 2: Interview with the developers of the Namibian Livestock Identification and Traceability System (NamLITS).

1. What are the main differences between SLITS and NamLITS?
2. How often do dipping events take place?
3. What regions are there in Namibia and how do the cattle's ear-tags differ?
4. When did NamLITS start?
5. What are the different phases of NamLITS?
6. How do NamLITS ear-tags differ from SLITS?
7. How many cattle are there in Namibia?
8. Is the branding process documented? Where can I find that information?
9. What is a Toughbook?
10. What happens if you cannot trace the origin of a specific animal?
11. What cattle diseases are prominent in Namibia?
12. Who sponsored NamLITS?

Interview 3: Interview with key role-players of the Namibian Meat Board.

1. What is your beef export quota annually?
2. Do you export your full quota?
3. What do you do in terms of disease control?
4. When last did you have an outbreak of foot-and-mouth disease?
5. How do you quarantine areas where diseases break out?
6. How do the RFID ear-tags work?
7. How does branding of animals work?
8. What are your agricultural policies and laws?
9. How many of Namibia's cattle are found above the red line?

Interview 4: Interview with the Directorate of Veterinary Services (DVS) in Namibia.

1. What is your main responsibility at DVS?
2. What is the procedure when animals are sent for slaughter?
3. How many animal health technicians are in Namibia?
4. What is the impact on the Namibian communal farmer?
5. How often does a livestock auction take place?
6. Do these auctions take place country-wide?
7. How is the auction administered?
8. How do stock permits work?
9. If there is an outbreak of foot-and-mouth disease, what are the procedures you have in place to minimise the effects?
10. Is there specific quarantine legislation in cases of disease outbreaks?
11. What are your contingency plans?

Interview 5: Interview with commercial farmers in Swaziland.

1. Do you use SLITS? In what capacity?
2. When are new-born calves registered on SLITS?
3. How do you dip the animals?
4. What diseases do you struggle with in Swaziland?
5. How often do you vaccinate?
6. How often is data from the dipping event captured on SLITS?
7. Are your feelings towards SLITS positive?
8. Do you have to buy your own tags? How much do they cost?
9. Do you sell cattle for export?
10. Do farmers know when the optimal time is to sell their cattle?

11. Does government attempt to educate communal farmers?
12. How much do you pay for young calves?
13. Do you perhaps see, in future, that there might be a shift in culture where you rather see your cattle as money in the bank rather than keeping them for lobola?

Interview 6: Interview with Swaziland's veterinary assistants at the Siteki offices.

1. Are the veterinary assistants happy with SLITS?
2. Do you educate communal farmers on the best times to sell their cattle?
3. How often do communal farmers sell their animals?
4. When, typically, do they sell? What months?
5. In terms of grazing areas, are the areas badly over-grazed?
6. Is SLITS easy to use?
7. Does it lead to a decrease in your work load?
8. Do you benefit from using SLITS?
9. Do you have sufficient computer equipment?
10. Did you receive any official training before using SLITS? Please elaborate.

Interview 7 and 8: Interview with a representative of the Meat Industries of Swaziland and the project manager of SLITS.

1. I believe SLITS became compulsory for all farmers to use at the beginning of 2014 and now the number of cattle bought for slaughter has decreased significantly compared to last year. Why do you think this is the case?
2. What were some of the major obstacles?
3. What other factors also played a role in the numbers being significantly lower compared to 2013?
4. How many animals that were bought for slaughter came from the communal farmers compared to those offered by the commercial farmers?
5. What happens if a farmer's animals have not yet been captured on the database? How do you assist the farmer?
6. Why do you think SLITS is used optimally / not used optimally?
7. What do you think can be improved in terms of the SLITS usage?
8. In your opinion, will SLITS, in the long run, promote the livestock traceability in such a way that it will be easy for all farmers to be able to export their meat?
9. Is there anything else that you would like to add to ensure that I have the necessary information regarding the use of SLITS?

Appendix 2. Questionnaire completed by the animal technicians in Namibia

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Economic and Management Sciences

Letter of Introduction and Informed Consent

Dept. of Informatics

Title of the study:
The impact of livestock traceability systems on the communal farmer: Cases from Swaziland and Namibia

Research conducted by:
Mrs Tania Prinsloo
Student number: 20235722
Cell: 083 415 7913
E-mail address: tania.prinsloo@up.ac.za

Dear Participant

You are invited to participate in an academic research study conducted by Tania Prinsloo, doctoral student from the Department of Informatics at the University of Pretoria.

The purpose of the study is to explain the impact of the communal after the traceability system was introduced in the region. The aim is to create an overall framework explaining the impact in detail.

Please note the following:

This is an *anonymous* questionnaire as your name will not appear on the questionnaire. The answers you give will be treated as strictly *confidential* as you cannot be identified in person based on the answers you give.

- Your participation in this study is very important to us. You may, however, choose not to participate and you may also stop participating at any time without any negative consequences.
- Please answer the questions in the questionnaire as completely and honestly as possible. This should not take more than thirty minutes of your time.
- The results of the study will be used for academic purposes only and may be published in an academic journal. We will provide you with a summary of our findings on request.
- Please contact my study leader, Prof. Carina de Villiers, cellular phone number 083 289 1989, e-mail address carina.devilliers@up.ac.za if you have any questions or comments regarding the study.

Please sign the form to indicate that:

- You have read and understood the information provided above.
- You give your consent to participate in the study on a voluntary basis.

____________________________ ____________________

Participant's signature **Date**

NamLITS Questionnaire – August 2015

Section A: Biographical information

1. What is your gender? Please tick the appropriate option:

Male		Female	

2. How old are you? …….….… years

3. How long have you been working as an animal technician in Namibia? ……….years ……….months

Section B: Information on dip tank area

4. What is the nearest town to your crush pen area?

....

5a. How many farmers are in your crush pen area? ………..

5b. How many of the farmers are male and how many are female?

Male ……….	Female ……..

6. What type of farming do the farmers in your crush pen do?

Mainly livestock	
Mainly crop production	
Livestock and crop production	
Other	

If "Other", please explain:

7. How many farmers in your crush pen area live on the following? Give the total of each:

Communal land	
Commercial land	

8. How often do you ***normally*** see the cattle in the crush pen area?

More than once a week	
Once a week	
Once every two weeks	
Once a month	
Once every six months	
Once a year	

Section C: Information on NamLITS

9a. Have all the cattle in your crush pen area been ear-tagged?

Yes		No	

9b. If you answered "No", what percentage, more or less, of cattle have not yet been ear-tagged?

………………%

10. Please answer each one of the following statements:

		Yes	No	Uncertain
10a.	The general health of the communal farmer's herd has improved since NamLITS was introduced.			
10b.	The incidence of highly contagious diseases, such as foot-and-mouth disease has declined since NamLITS was introduced.			
10c.	Since NamLITS was introduced, the communal farmers receive a more commercial market-related price for cattle sold.			

If you answered "No" to question 10c, please respond to the following statements:

	Yes	No	Uncertain
10c1. The general health of animals sold is still not satisfactory.			
10c2. Animals are not sold at an optimal age.			

10c3. Other. Please explain.

11. Please answer each one of the following statements:

		Yes	No	Uncertain
11a.	Cattle vaccinations are accurately documented with NamLITS.			
11b.	NamLITS simplifies the process of accurately tracking vaccinations of communal farmers' cattle.			
11c.	NamLITS improves Veterinary Service's ability to contain/manage disease outbreak.			
11d.	NamLITS assists in disease outbreak investigation.			
11e.	NamLITS assists in recovering stolen cattle.			
11f.	NamLITS assists in identifying stray animals.			

Other. Please explain.

11g.

Section D: Your interaction with NamLITS

12. What is your overall attitude towards NamLITS?

Positive		Negative	

Please justify your answer.

13. Please add any other comments you might have regarding NamLITS.

Thank you very much for your time!

Appendix 3. Questionnaire completed by the veterinary assistants in Swaziland

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Economic and Management Sciences

Letter of Introduction and Informed Consent

Dept. of Informatics

Title of the study:
The impact of livestock traceability systems on the communal farmer: Cases from Swaziland and Namibia

Research conducted by:
Mrs Tania Prinsloo
Student number: 20235722
Cell: 083 415 7913
E-mail address: tania.prinsloo@up.ac.za

Dear Participant

You are invited to participate in an academic research study conducted by Tania Prinsloo, doctoral student from the Department of Informatics at the University of Pretoria.

The purpose of the study is to explain the impact of the communal after the traceability system was introduced in the region. The aim is to create an overall framework explaining the impact in detail.

Please note the following:

This is an *anonymous* questionnaire as your name will not appear on the questionnaire. The answers you give will be treated as strictly *confidential* as you cannot be identified in person based on the answers you give.

- Your participation in this study is very important to us. You may, however, choose not to participate and you may also stop participating at any time without any negative consequences.
- Please answer the questions in the questionnaire as completely and honestly as possible. This should not take more than thirty minutes of your time.
- The results of the study will be used for academic purposes only and may be published in an academic journal. We will provide you with a summary of our findings on request.
- Please contact my study leader, Prof Carina de Villiers, cellular phone number 083 289 1989, e-mail address carina.devilliers@up.ac.za if you have any questions or comments regarding the study.

Please sign the form to indicate that:

- You have read and understood the information provided above.
- You give your consent to participate in the study on a voluntary basis.

____________________________ ____________________

Participant's signature **Date**

SLITS Questionnaire – October 2015

Section A: Biographical information

1. What is your gender? Please tick the appropriate option:

Male		Female	

2. How old are you? ………… years

3. How long have you been working as a veterinary assistant in Swaziland? ……….years ……….months

Section B: Information on dip tank area

4. What is the nearest town to your dip tank area?

....

5a. How many farmers are in your dip tank area? ………..

5b. How many of the farmers are male and how many are female?

Male ……….	Female ……..

6. What type of farming do the farmers in your dip tank do?

Mainly livestock	
Mainly crop production	
Livestock and crop production	
Other	

If "Other", please explain:

7. How many farmers in your dip tank area live on the following? Give the total of each:

Communal land	
Commercial land	

8. How often do you ***normally*** see the cattle in the dip tank area?

More than once a week	
Once a week	
Once every two weeks	
Once a month	
Once every six months	
Once a year	

Section C: Information on SLITS

9a. Have all the cattle in your dip tank area been ear-tagged?

Yes		No	

9b. If you answered “No”, what percentage, more or less, of cattle have not yet been ear-tagged?
………………%

10. Please answer each one of the following statements:

		Yes	**No**	**Uncertain**
10a.	The general health of the communal farmer’s herd has improved since SLITS was introduced.			
10b.	The incidence of diseases, such as tick-borne diseases, has declined since SLITS was introduced.			
10c.	Since SLITS was introduced, the communal farmers receive a more commercial market-related price for cattle sold.			

If you answered “No” in question 10c, please respond to the following statements:

	Yes	**No**	**Uncertain**
10c1. The general health of animals sold is still not satisfactory.			
10c2. Animals are not sold at an optimal age.			

10c3. Other. Please explain.

11. Please answer each one of the following statements:

		Yes	No	Uncertain
11a.	Cattle vaccinations are accurately documented with SLITS.			
11b.	SLITS simplifies the process of accurately tracking vaccinations of communal farmers' cattle.			
11c.	SLITS improves Veterinary Service's ability to contain/manage disease outbreak.			
11d.	SLITS assists in disease outbreak investigation.			
11e.	SLITS assists in recovering stolen cattle.			
11f.	SLITS assists in identifying stray animals.			

Other. Please explain.

11g.

Section D: Your interaction with SLITS

12. What is your overall attitude towards SLITS?

Positive			Negative	

Please justify your answer.

13. Please add any other comments you might have regarding SLITS.

Thank you very much for your time!

Appendix 4. Proof of language editing by Prof. Tinus Kühn

I
HATE
MISTEAKS

TK Language Service
Editing and Proofreading
Cell: 082 303 5415
Tel: 012 343 8412
Email: tinus.kuhn@gmail.com
Address: 180 Smith Street, Muckleneuk, Pretoria, 0002

21 January 2017

TO WHOM IT MAY CONCERN

I, the undersigned, hereby declare that the doctoral thesis titled **Livestock Traceability Systems in Swaziland and Namibia: Towards an Impact-for-Sustainable-Agriculture Framework** by **Tania Prinsloo** has been edited for grammar errors. It remains the responsibility of the candidate to effect the recommended changes.

Prof. Tinus Kühn

Appendix 5. SPSS Results from the Swaziland questionnaire data

The results below show the results from the SPSS calculations, with the initial figure directly below illustrating how the data types were defined:

*Swziland.sav [DataSet1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Direct Marketing Graphs Utilities Extensions Window Help

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	Gender	Numeric	8	0	Gender	None	None	7	Right	Ordinal	Input
2	Age	String	8	0	Age	None	None	8	Left	Nominal	Input
3	Years_Worked	String	8	0	Years_Worked	None	None	8	Left	Nominal	Input
4	Closest_Town	String	20	0	Closest_Town	None	None	8	Left	Nominal	Input
5	Number_of_Farmers	Numeric	8	0	Number_of_Farmers	None	None	8	Right	Ordinal	Input
6	Male_Farmers	Numeric	8	0	Male_Farmers	None	None	8	Right	Ordinal	Input
7	Female_Farmers	Numeric	8	0	Female_Farmers	None	None	8	Right	Ordinal	Input
8	Type_of_farming	String	40	0	Type_of_farming	None	None	8	Left	Nominal	Input
9	Live_on_Communal_Land	Numeric	8	0	Live_on_Communal_Land	None	None	8	Right	Ordinal	Input
10	Live_on_Commercial_Land	Numeric	8	0	Live_on_Commercial_Land	None	None	8	Right	Ordinal	Input
11	See_Farmers	Numeric	40	0	See_Farmers	None	None	8	Right	Ordinal	Input
12	Cattle_ear_tagged	Numeric	8	0	Cattle_ear_tagged	None	None	8	Right	Nominal	Input
13	Cattle_Health_Improved	Numeric	8	0	Cattle_Health_Improved	None	None	8	Right	Nominal	Input
14	Disease_Declined	Numeric	8	0	Disease_Declined	None	None	8	Right	Nominal	Input
15	Higher_Price	Numeric	8	0	Higher_Price	None	None	8	Right	Nominal	Input
16	Accurate_Cattle_Vaccinations	Numeric	8	0	Accurate_Cattle_Vaccinations	None	None	8	Right	Nominal	Input
17	Simplief_Tracking_Vccinations	Numeric	8	0	Simplief_Tracking_Vccinations	None	None	8	Right	Nominal	Input
18	Contain_Disease_Outbreaks	Numeric	8	0	Contain_Disease_Outbreaks	None	None	8	Right	Nominal	Input
19	Assist_Disease_Outbreaks	Numeric	8	0	Assist_Disease_Outbreaks	None	None	8	Right	Nominal	Input
20	Recover_Stolen_Animal	Numeric	8	0	Recover_Stolen_Animal	None	None	8	Right	Nominal	Input
21	Identify_Stray_Animals	Numeric	8	0	Identify_Stray_Animals	None	None	8	Right	Nominal	Input
22											

The data below are the results obtained through cross-tabulations in the same order as they were given in the thesis. Below is the first cross-tabulation in terms of gender and overall health improvement of animals:

1.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Gender * Cattle_Health_Improved	44	95.7%	2	4.3%	46	100.0%

Gender * Cattle_Health_Improved Crosstabulation

			Cattle_Health_Improved			Total
			1	2	3	
Gender	1	Count	19	9	4	32
		% within Gender	59.4%	28.1%	12.5%	100.0%
		% within Cattle_Health_Improved	67.9%	90.0%	66.7%	72.7%
		% of Total	43.2%	20.5%	9.1%	72.7%
	2	Count	9	1	2	12
		% within Gender	75.0%	8.3%	16.7%	100.0%

		% within Cattle_Health_Improved	32.1%	10.0%	33.3%	27.3%
		% of Total	20.5%	2.3%	4.5%	27.3%
Total		Count	28	10	6	44
		% within Gender	63.6%	22.7%	13.6%	100.0%
		% within Cattle_Health_Improved	100.0%	100.0%	100.0%	100.0%
		% of Total	63.6%	22.7%	13.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.950[a]	2	.377	.427	
Likelihood Ratio	2.259	2	.323	.385	
Fisher's Exact Test	1.944			.427	
Linear-by-Linear Association	.214[b]	1	.643	.819	.420
N of Valid Cases	44				

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.211	.377	.427
	Cramer's V	.211	.377	.427
N of Valid Cases		44		

2.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Gender * Disease_Declined	45	97.8%	1	2.2%	46	100.0%

Gender * Disease_Declined Crosstabulation

			Disease_Declined			
			1	2	3	Total
Gender	1	Count	10	18	5	33
		% within Gender	30.3%	54.5%	15.2%	100.0%
		% within Disease_Declined	71.4%	81.8%	55.6%	73.3%
		% of Total	22.2%	40.0%	11.1%	73.3%
	2	Count	4	4	4	12

	% within Gender	33.3%	33.3%	33.3%	100.0%
	% within Disease_Declined	28.6%	18.2%	44.4%	26.7%
	% of Total	8.9%	8.9%	8.9%	26.7%
Total	Count	14	22	9	45
	% within Gender	31.1%	48.9%	20.0%	100.0%
	% within Disease_Declined	100.0%	100.0%	100.0%	100.0%
	% of Total	31.1%	48.9%	20.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.290[a]	2	.318	.340	
Likelihood Ratio	2.213	2	.331	.376	
Fisher's Exact Test	2.346			.303	
Linear-by-Linear Association	.396[b]	1	.529	.639	.346
N of Valid Cases	45				

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.226	.318	.340
	Cramer's V	.226	.318	.340
N of Valid Cases		45		

3.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Gender * Higher_Price	44	95.7%	2	4.3%	46	100.0%

Gender * Higher_Price Crosstabulation

			Higher_Price			
			1	2	3	Total
Gender	1	Count	15	12	5	32
		% within Gender	46.9%	37.5%	15.6%	100.0%
		% within Higher_Price	75.0%	80.0%	55.6%	72.7%
		% of Total	34.1%	27.3%	11.4%	72.7%
	2	Count	5	3	4	12

	% within Gender	41.7%	25.0%	33.3%	100.0%
	% within Higher_Price	25.0%	20.0%	44.4%	27.3%
	% of Total	11.4%	6.8%	9.1%	27.3%
Total	Count	20	15	9	44
	% within Gender	45.5%	34.1%	20.5%	100.0%
	% within Higher_Price	100.0%	100.0%	100.0%	100.0%
	% of Total	45.5%	34.1%	20.5%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.790[a]	2	.409	.508	
Likelihood Ratio	1.693	2	.429	.558	
Fisher's Exact Test	1.776			.463	
Linear-by-Linear Association	.751[b]	1	.386	.518	.257
N of Valid Cases	44				

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.202	.409	.508
	Cramer's V	.202	.409	.508
N of Valid Cases		44		

4.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Age * Cattle_Health_Improved	45	97.8%	1	2.2%	46	100.0%

Age * Cattle_Health_Improved Crosstabulation

		Cattle_Health_Improved			
		1	2	3	Total
Age	Count	1	0	0	1
	% within Age	100.0%	0.0%	0.0%	100.0%
	% within Cattle_Health_Improved	3.4%	0.0%	0.0%	2.2%

		% of Total	2.2%	0.0%	0.0%	2.2%
	0-35	Count	8	4	4	16
		% within Age	50.0%	25.0%	25.0%	100.0%
		% within Cattle_Health_Improved	27.6%	40.0%	66.7%	35.6%
		% of Total	17.8%	8.9%	8.9%	35.6%
	36-45	Count	15	2	2	19
		% within Age	78.9%	10.5%	10.5%	100.0%
		% within Cattle_Health_Improved	51.7%	20.0%	33.3%	42.2%
		% of Total	33.3%	4.4%	4.4%	42.2%
	46+	Count	5	4	0	9
		% within Age	55.6%	44.4%	0.0%	100.0%
		% within Cattle_Health_Improved	17.2%	40.0%	0.0%	20.0%
		% of Total	11.1%	8.9%	0.0%	20.0%
Total		Count	29	10	6	45
		% within Age	64.4%	22.2%	13.3%	100.0%
		% within Cattle_Health_Improved	100.0%	100.0%	100.0%	100.0%
		% of Total	64.4%	22.2%	13.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	7.971[a]	6	.240	.283
Likelihood Ratio	9.005	6	.173	.208
Fisher's Exact Test	7.796			.221
N of Valid Cases	45			

a. 9 cells (75,0%) have expected count less than 5. The minimum expected count is ,13.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.421	.240	.283
	Cramer's V	.298	.240	.283
N of Valid Cases		45		

6.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Age * Disease_Declined	46	100.0%	0	0.0%	46	100.0%

Age * Disease_Declined Crosstabulation

			Disease_Declined			Total
			1	2	3	
Age		Count	1	0	0	1
		% within Age	100.0%	0.0%	0.0%	100.0%
		% within Disease_Declined	6.7%	0.0%	0.0%	2.2%
		% of Total	2.2%	0.0%	0.0%	2.2%
	0-35	Count	4	10	3	17
		% within Age	23.5%	58.8%	17.6%	100.0%
		% within Disease_Declined	26.7%	45.5%	33.3%	37.0%
		% of Total	8.7%	21.7%	6.5%	37.0%
	36-45	Count	8	6	5	19
		% within Age	42.1%	31.6%	26.3%	100.0%
		% within Disease_Declined	53.3%	27.3%	55.6%	41.3%
		% of Total	17.4%	13.0%	10.9%	41.3%
	46+	Count	2	6	1	9
		% within Age	22.2%	66.7%	11.1%	100.0%
		% within Disease_Declined	13.3%	27.3%	11.1%	19.6%
		% of Total	4.3%	13.0%	2.2%	19.6%
22,2Total		Count	15	22	9	46
		% within Age	32.6%	47.8%	19.6%	100.0%
		% within Disease_Declined	100.0%	100.0%	100.0%	100.0%
		% of Total	32.6%	47.8%	19.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	6.269[a]	6	.394	.423
Likelihood Ratio	6.544	6	.365	.420
Fisher's Exact Test	6.052			.417
N of Valid Cases	46			

a. 8 cells (66,7%) have expected count less than 5. The minimum expected count is ,20.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.369	.394	.423
	Cramer's V	.261	.394	.423
N of Valid Cases		46		

7.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Age * Higher_Price	45	97.8%	1	2.2%	46	100.0%

Age * Higher_Price Crosstabulation

			Higher_Price			Total
			1	2	3	
Age		Count	1	0	0	1
		% within Age	100.0%	0.0%	0.0%	100.0%
		% within Higher_Price	4.8%	0.0%	0.0%	2.2%
		% of Total	2.2%	0.0%	0.0%	2.2%
	0-35	Count	7	5	5	17
		% within Age	41.2%	29.4%	29.4%	100.0%
		% within Higher_Price	33.3%	33.3%	55.6%	37.8%
		% of Total	15.6%	11.1%	11.1%	37.8%
	36-45	Count	10	6	2	18
		% within Age	55.6%	33.3%	11.1%	100.0%
		% within Higher_Price	47.6%	40.0%	22.2%	40.0%
		% of Total	22.2%	13.3%	4.4%	40.0%
	46+	Count	3	4	2	9
		% within Age	33.3%	44.4%	22.2%	100.0%
		% within Higher_Price	14.3%	26.7%	22.2%	20.0%
		% of Total	6.7%	8.9%	4.4%	20.0%
Total		Count	21	15	9	45
		% within Age	46.7%	33.3%	20.0%	100.0%
		% within Higher_Price	100.0%	100.0%	100.0%	100.0%
		% of Total	46.7%	33.3%	20.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	3.798[a]	6	.704	.768
Likelihood Ratio	4.217	6	.647	.758
Fisher's Exact Test	4.116			.734
N of Valid Cases	45			

a. 8 cells (66,7%) have expected count less than 5. The minimum expected count is ,20.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.291	.704	.768
	Cramer's V	.205	.704	.768
N of Valid Cases		45		

8.

Years_Worked * Cattle_Health_Improved Crosstabulation

			Cattle_Health_Improved			
			1	2	3	Total
Years_Worked		Count	1	0	0	1
		% within Years_Worked	100.0%	0.0%	0.0%	100.0%
		% within Cattle_Health_Improved	3.4%	0.0%	0.0%	2.2%
		% of Total	2.2%	0.0%	0.0%	2.2%
	00-04	Count	3	2	1	6
		% within Years_Worked	50.0%	33.3%	16.7%	100.0%
		% within Cattle_Health_Improved	10.3%	20.0%	16.7%	13.3%
		% of Total	6.7%	4.4%	2.2%	13.3%
	05-09	Count	12	1	3	16
		% within Years_Worked	75.0%	6.3%	18.8%	100.0%
		% within Cattle_Health_Improved	41.4%	10.0%	50.0%	35.6%
		% of Total	26.7%	2.2%	6.7%	35.6%
	10-14	Count	7	3	2	12
		% within Years_Worked	58.3%	25.0%	16.7%	100.0%

		% within Cattle_Health_Improved	24.1%	30.0%	33.3%	26.7%
		% of Total	15.6%	6.7%	4.4%	26.7%
	15+	Count	6	4	0	10
		% within Years_Worked	60.0%	40.0%	0.0%	100.0%
		% within Cattle_Health_Improved	20.7%	40.0%	0.0%	22.2%
		% of Total	13.3%	8.9%	0.0%	22.2%
Total		Count	29	10	6	45
		% within Years_Worked	64.4%	22.2%	13.3%	100.0%
		% within Cattle_Health_Improved	100.0%	100.0%	100.0%	100.0%
		% of Total	64.4%	22.2%	13.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	6.592[a]	8	.581	.610
Likelihood Ratio	8.622	8	.375	.489
Fisher's Exact Test	7.784			.468
N of Valid Cases	45			

a. 12 cells (80,0%) have expected count less than 5. The minimum expected count is ,13.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.383	.581	.610
	Cramer's V	.271	.581	.610
N of Valid Cases		45		

9.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Years_Worked * Disease_Declined	46	100.0%	0	0.0%	46	100.0%

Years_Worked * Disease_Declined Crosstabulation

			Disease_Declined 1	2	3	Total
Years_Worked		Count	1	0	0	1
		% within Years_Worked	100.0%	0.0%	0.0%	100.0%
		% within Disease_Declined	6.7%	0.0%	0.0%	2.2%
		% of Total	2.2%	0.0%	0.0%	2.2%
	00-04	Count	3	2	1	6
		% within Years_Worked	50.0%	33.3%	16.7%	100.0%
		% within Disease_Declined	20.0%	9.1%	11.1%	13.0%
		% of Total	6.5%	4.3%	2.2%	13.0%
	05-09	Count	6	6	5	17
		% within Years_Worked	35.3%	35.3%	29.4%	100.0%
		% within Disease_Declined	40.0%	27.3%	55.6%	37.0%
		% of Total	13.0%	13.0%	10.9%	37.0%
	10-14	Count	3	7	2	12
		% within Years_Worked	25.0%	58.3%	16.7%	100.0%
		% within Disease_Declined	20.0%	31.8%	22.2%	26.1%
		% of Total	6.5%	15.2%	4.3%	26.1%
	15+	Count	2	7	1	10
		% within Years_Worked	20.0%	70.0%	10.0%	100.0%
		% within Disease_Declined	13.3%	31.8%	11.1%	21.7%
		% of Total	4.3%	15.2%	2.2%	21.7%
Total		Count	15	22	9	46
		% within Years_Worked	32.6%	47.8%	19.6%	100.0%
		% within Disease_Declined	100.0%	100.0%	100.0%	100.0%
		% of Total	32.6%	47.8%	19.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	6.876[a]	8	.550	.599
Likelihood Ratio	7.001	8	.537	.653
Fisher's Exact Test	6.615			.620
N of Valid Cases	46			

a. 12 cells (80,0%) have expected count less than 5. The minimum expected count is ,20.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.387	.550	.599
	Cramer's V	.273	.550	.599
N of Valid Cases		46		

10.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Years_Worked * Higher_Price	45	97.8%	1	2.2%	46	100.0%

Years_Worked * Higher_Price Crosstabulation

			Higher_Price			Total
			1	2	3	
Years_Worked		Count	1	0	0	1
		% within Years_Worked	100.0%	0.0%	0.0%	100.0%
		% within Higher_Price	4.8%	0.0%	0.0%	2.2%
		% of Total	2.2%	0.0%	0.0%	2.2%
	00-04	Count	4	1	0	5
		% within Years_Worked	80.0%	20.0%	0.0%	100.0%
		% within Higher_Price	19.0%	6.7%	0.0%	11.1%
		% of Total	8.9%	2.2%	0.0%	11.1%
	05-09	Count	8	3	6	17
		% within Years_Worked	47.1%	17.6%	35.3%	100.0%
		% within Higher_Price	38.1%	20.0%	66.7%	37.8%
		% of Total	17.8%	6.7%	13.3%	37.8%
	10-14	Count	5	6	1	12
		% within Years_Worked	41.7%	50.0%	8.3%	100.0%
		% within Higher_Price	23.8%	40.0%	11.1%	26.7%
		% of Total	11.1%	13.3%	2.2%	26.7%
	15+	Count	3	5	2	10
		% within Years_Worked	30.0%	50.0%	20.0%	100.0%
		% within Higher_Price	14.3%	33.3%	22.2%	22.2%
		% of Total	6.7%	11.1%	4.4%	22.2%
Total		Count	21	15	9	45
		% within Years_Worked	46.7%	33.3%	20.0%	100.0%
		% within Higher_Price	100.0%	100.0%	100.0%	100.0%

% of Total	46.7%	33.3%	20.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	10.153[a]	8	.254	.251
Likelihood Ratio	11.333	8	.184	.248
Fisher's Exact Test	9.233			.283
N of Valid Cases	45			

a. 12 cells (80,0%) have expected count less than 5. The minimum expected count is ,20.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.475	.254	.251
	Cramer's V	.336	.254	.251
N of Valid Cases		45		

11.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Gender * Accurate_Cattle_Vaccinations	43	93.5%	3	6.5%	46	100.0%

Gender * Accurate_Cattle_Vaccinations Crosstabulation

			Accurate_Cattle_Vaccinations			Total
			1	2	3	
Gender	1	Count	25	7	0	32
		% within Gender	78.1%	21.9%	0.0%	100.0%
		% within Accurate_Cattle_Vaccinations	78.1%	70.0%	0.0%	74.4%
		% of Total	58.1%	16.3%	0.0%	74.4%
	2	Count	7	3	1	11

	% within Gender	63.6%	27.3%	9.1%	100.0%
	% within Accurate_Cattle_Vaccinations	21.9%	30.0%	100.0%	25.6%
	% of Total	16.3%	7.0%	2.3%	25.6%
Total	Count	32	10	1	43
	% within Gender	74.4%	23.3%	2.3%	100.0%
	% within Accurate_Cattle_Vaccinations	100.0%	100.0%	100.0%	100.0%
	% of Total	74.4%	23.3%	2.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.243[a]	2	.198	.244	
Likelihood Ratio	3.065	2	.216	.244	
Fisher's Exact Test	2.947			.244	
Linear-by-Linear Association	1.795[b]	1	.180	.296	.161
N of Valid Cases	43				

Chi-Square Tests

	Point Probability
Pearson Chi-Square	
Likelihood Ratio	
Fisher's Exact Test	
Linear-by-Linear Association	.110
N of Valid Cases	

a. 3 cells (50,0%) have expected count less than 5. The minimum expected count is ,26.

b. The standardized statistic is 1,340.

12.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.275	.198	.244
	Cramer's V	.275	.198	.244

N of Valid Cases	43		

Gender * Simplief_Tracking_Vccinations Crosstabulation

			Simplief_Tracking_Vccinations			Total
			1	2	3	
Gender	1	Count	28	5	0	33
		% within Gender	84.8%	15.2%	0.0%	100.0%
		% within Simplief_Tracking_Vccinations	75.7%	83.3%	0.0%	73.3%
		% of Total	62.2%	11.1%	0.0%	73.3%
	2	Count	9	1	2	12
		% within Gender	75.0%	8.3%	16.7%	100.0%
		% within Simplief_Tracking_Vccinations	24.3%	16.7%	100.0%	26.7%
		% of Total	20.0%	2.2%	4.4%	26.7%
Total		Count	37	6	2	45
		% within Gender	82.2%	13.3%	4.4%	100.0%
		% within Simplief_Tracking_Vccinations	100.0%	100.0%	100.0%	100.0%
		% of Total	82.2%	13.3%	4.4%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.911[a]	2	.052	.101	
Likelihood Ratio	5.731	2	.057	.101	
Fisher's Exact Test	4.602			.101	
Linear-by-Linear Association	2.311[b]	1	.128	.187	.122
N of Valid Cases	45				

Chi-Square Tests

	Point Probability
Pearson Chi-Square	
Likelihood Ratio	
Fisher's Exact Test	

Linear-by-Linear Association	.082
N of Valid Cases	

a. 4 cells (66,7%) have expected count less than 5. The minimum expected count is ,53.

b. The standardized statistic is 1,520.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.362	.052	.101
	Cramer's V	.362	.052	.101
N of Valid Cases		45		

13.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Gender * Contain_Disease_Outbreaks	44	95.7%	2	4.3%	46	100.0%

Gender * Contain_Disease_Outbreaks Crosstabulation

			Contain_Disease_Outbreaks			Total
			1	2	3	
Gender	1	Count	32	1	0	33
		% within Gender	97.0%	3.0%	0.0%	100.0%
		% within Contain_Disease_Outbreaks	76.2%	100.0%	0.0%	75.0%
		% of Total	72.7%	2.3%	0.0%	75.0%
	2	Count	10	0	1	11
		% within Gender	90.9%	0.0%	9.1%	100.0%
		% within Contain_Disease_Outbreaks	23.8%	0.0%	100.0%	25.0%
		% of Total	22.7%	0.0%	2.3%	25.0%
Total		Count	42	1	1	44
		% within Gender	95.5%	2.3%	2.3%	100.0%
		% within Contain_Disease_Outbreaks	100.0%	100.0%	100.0%	100.0%
		% of Total	95.5%	2.3%	2.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.365[a]	2	.186	.442	
Likelihood Ratio	3.380	2	.185	.442	
Fisher's Exact Test	3.021			.442	
Linear-by-Linear Association	1.698[b]	1	.193	.250	.250
N of Valid Cases	44				

Chi-Square Tests

	Point Probability
Pearson Chi-Square	
Likelihood Ratio	
Fisher's Exact Test	
Linear-by-Linear Association	.192
N of Valid Cases	

a. 4 cells (66,7%) have expected count less than 5. The minimum expected count is ,25.

b. The standardized statistic is 1,303.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.277	.186	.442
	Cramer's V	.277	.186	.442
N of Valid Cases		44		

14.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Age * Accurate_Cattle_Vaccinations	44	95.7%	2	4.3%	46	100.0%

Age * Accurate_Cattle_Vaccinations Crosstabulation

			Accurate_Cattle_Vaccinations			
			1	2	3	Total
Age		Count	1	0	0	1
		% within Age	100.0%	0.0%	0.0%	100.0%
		% within Accurate_Cattle_Vaccinations	3.0%	0.0%	0.0%	2.3%
		% of Total	2.3%	0.0%	0.0%	2.3%
	0-35	Count	12	5	0	17
		% within Age	70.6%	29.4%	0.0%	100.0%
		% within Accurate_Cattle_Vaccinations	36.4%	50.0%	0.0%	38.6%
		% of Total	27.3%	11.4%	0.0%	38.6%
	36-45	Count	14	2	1	17
		% within Age	82.4%	11.8%	5.9%	100.0%
		% within Accurate_Cattle_Vaccinations	42.4%	20.0%	100.0%	38.6%
		% of Total	31.8%	4.5%	2.3%	38.6%
	46+	Count	6	3	0	9
		% within Age	66.7%	33.3%	0.0%	100.0%
		% within Accurate_Cattle_Vaccinations	18.2%	30.0%	0.0%	20.5%
		% of Total	13.6%	6.8%	0.0%	20.5%
Total		Count	33	10	1	44
		% within Age	75.0%	22.7%	2.3%	100.0%
		% within Accurate_Cattle_Vaccinations	100.0%	100.0%	100.0%	100.0%
		% of Total	75.0%	22.7%	2.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	3.827[a]	6	.700	.678
Likelihood Ratio	4.470	6	.613	.661
Fisher's Exact Test	6.227			.661
N of Valid Cases	44			

a. 9 cells (75,0%) have expected count less than 5. The minimum expected count is ,02.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.295	.700	.678
	Cramer's V	.209	.700	.678
N of Valid Cases		44		

15.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Age * Simplief_Tracking_Vccinations	46	100.0%	0	0.0%	46	100.0%

Age * Simplief_Tracking_Vccinations Crosstabulation

			Simplief_Tracking_Vccinations			Total
			1	2	3	
Age		Count	1	0	0	1
		% within Age	100.0%	0.0%	0.0%	100.0%
		% within Simplief_Tracking_Vccinations	2.6%	0.0%	0.0%	2.2%
		% of Total	2.2%	0.0%	0.0%	2.2%
	0-35	Count	14	2	1	17
		% within Age	82.4%	11.8%	5.9%	100.0%
		% within Simplief_Tracking_Vccinations	36.8%	33.3%	50.0%	37.0%
		% of Total	30.4%	4.3%	2.2%	37.0%
	36-45	Count	15	3	1	19
		% within Age	78.9%	15.8%	5.3%	100.0%
		% within Simplief_Tracking_Vccinations	39.5%	50.0%	50.0%	41.3%
		% of Total	32.6%	6.5%	2.2%	41.3%
	46+	Count	8	1	0	9
		% within Age	88.9%	11.1%	0.0%	100.0%

	% within Simplief_Tracking_Vccinations	21.1%	16.7%	0.0%	19.6%
	% of Total	17.4%	2.2%	0.0%	19.6%
Total	Count	38	6	2	46
	% within Age	82.6%	13.0%	4.3%	100.0%
	% within Simplief_Tracking_Vccinations	100.0%	100.0%	100.0%	100.0%
	% of Total	82.6%	13.0%	4.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	.961[a]	6	.987	1.000
Likelihood Ratio	1.507	6	.959	1.000
Fisher's Exact Test	3.261			1.000
N of Valid Cases	46			

a. 9 cells (75,0%) have expected count less than 5. The minimum expected count is ,04.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.145	.987	1.000
	Cramer's V	.102	.987	1.000
N of Valid Cases		46		

16.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Age * Contain_Disease_Outbreaks	45	97.8%	1	2.2%	46	100.0%

Age * Contain_Disease_Outbreaks Crosstabulation

		Contain_Disease_Outbreaks			Total
		1	2	3	

Age		Count	1	0	0	1
		% within Age	100.0%	0.0%	0.0%	100.0%
		% within Contain_Disease_Outbreaks	2.3%	0.0%	0.0%	2.2%
		% of Total	2.2%	0.0%	0.0%	2.2%
	0-35	Count	16	0	1	17
		% within Age	94.1%	0.0%	5.9%	100.0%
		% within Contain_Disease_Outbreaks	37.2%	0.0%	100.0%	37.8%
		% of Total	35.6%	0.0%	2.2%	37.8%
	36-45	Count	17	1	0	18
		% within Age	94.4%	5.6%	0.0%	100.0%
		% within Contain_Disease_Outbreaks	39.5%	100.0%	0.0%	40.0%
		% of Total	37.8%	2.2%	0.0%	40.0%
	46+	Count	9	0	0	9
		% within Age	100.0%	0.0%	0.0%	100.0%
		% within Contain_Disease_Outbreaks	20.9%	0.0%	0.0%	20.0%
		% of Total	20.0%	0.0%	0.0%	20.0%
Total		Count	43	1	1	45
		% within Age	95.6%	2.2%	2.2%	100.0%
		% within Contain_Disease_Outbreaks	100.0%	100.0%	100.0%	100.0%
		% of Total	95.6%	2.2%	2.2%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	3.174[a]	6	.787	.845
Likelihood Ratio	3.806	6	.703	1.000
Fisher's Exact Test	7.455			1.000
N of Valid Cases	45			

a. 9 cells (75,0%) have expected count less than 5. The minimum expected count is ,02.

Symmetric Measures

	Value	Approximate Significance	Exact Significance

Nominal by Nominal	Phi	.266	.787	.845
	Cramer's V	.188	.787	.845
N of Valid Cases		45		

17.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Years_Worked * Accurate_Cattle_Vaccinations	44	95.7%	2	4.3%	46	100.0%

Years_Worked * Accurate_Cattle_Vaccinations Crosstabulation

			Accurate_Cattle_Vaccinations			Total
			1	2	3	
Years_Worked		Count	1	0	0	1
		% within Years_Worked	100.0%	0.0%	0.0%	100.0%
		% within Accurate_Cattle_Vaccinations	3.0%	0.0%	0.0%	2.3%
		% of Total	2.3%	0.0%	0.0%	2.3%
	00-04	Count	4	1	1	6
		% within Years_Worked	66.7%	16.7%	16.7%	100.0%
		% within Accurate_Cattle_Vaccinations	12.1%	10.0%	100.0%	13.6%
		% of Total	9.1%	2.3%	2.3%	13.6%
	05-09	Count	14	3	0	17
		% within Years_Worked	82.4%	17.6%	0.0%	100.0%
		% within Accurate_Cattle_Vaccinations	42.4%	30.0%	0.0%	38.6%
		% of Total	31.8%	6.8%	0.0%	38.6%
	10-14	Count	8	3	0	11
		% within Years_Worked	72.7%	27.3%	0.0%	100.0%
		% within Accurate_Cattle_Vaccinations	24.2%	30.0%	0.0%	25.0%
		% of Total	18.2%	6.8%	0.0%	25.0%
	15+	Count	6	3	0	9
		% within Years_Worked	66.7%	33.3%	0.0%	100.0%

	% within Accurate_Cattle_Vaccinations	18.2%	30.0%	0.0%	20.5%
	% of Total	13.6%	6.8%	0.0%	20.5%
Total	Count	33	10	1	44
	% within Years_Worked	75.0%	22.7%	2.3%	100.0%
	% within Accurate_Cattle_Vaccinations	100.0%	100.0%	100.0%	100.0%
	% of Total	75.0%	22.7%	2.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	7.748[a]	8	.458	.411
Likelihood Ratio	5.585	8	.694	.675
Fisher's Exact Test	8.036			.644
N of Valid Cases	44			

a. 12 cells (80,0%) have expected count less than 5. The minimum expected count is ,02.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.420	.458	.411
	Cramer's V	.297	.458	.411
N of Valid Cases		44		

18.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Years_Worked * Simplief_Tracking_Vccinations	46	100.0%	0	0.0%	46	100.0%

Years_Worked * Simplief_Tracking_Vccinations Crosstabulation

			Simplief_Tracking_Vccinations			Total
			1	2	3	
Years_Worked		Count	1	0	0	1
		% within Years_Worked	100.0%	0.0%	0.0%	100.0%
		% within Simplief_Tracking_Vccinations	2.6%	0.0%	0.0%	2.2%
		% of Total	2.2%	0.0%	0.0%	2.2%
	00-04	Count	5	1	0	6
		% within Years_Worked	83.3%	16.7%	0.0%	100.0%
		% within Simplief_Tracking_Vccinations	13.2%	16.7%	0.0%	13.0%
		% of Total	10.9%	2.2%	0.0%	13.0%
	05-09	Count	15	1	1	17
		% within Years_Worked	88.2%	5.9%	5.9%	100.0%
		% within Simplief_Tracking_Vccinations	39.5%	16.7%	50.0%	37.0%
		% of Total	32.6%	2.2%	2.2%	37.0%
	10-14	Count	8	3	1	12
		% within Years_Worked	66.7%	25.0%	8.3%	100.0%
		% within Simplief_Tracking_Vccinations	21.1%	50.0%	50.0%	26.1%
		% of Total	17.4%	6.5%	2.2%	26.1%
	15+	Count	9	1	0	10
		% within Years_Worked	90.0%	10.0%	0.0%	100.0%
		% within Simplief_Tracking_Vccinations	23.7%	16.7%	0.0%	21.7%
		% of Total	19.6%	2.2%	0.0%	21.7%
Total		Count	38	6	2	46
		% within Years_Worked	82.6%	13.0%	4.3%	100.0%
		% within Simplief_Tracking_Vccinations	100.0%	100.0%	100.0%	100.0%
		% of Total	82.6%	13.0%	4.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	4.052[a]	8	.852	.835
Likelihood Ratio	4.734	8	.786	.863
Fisher's Exact Test	6.425			.755
N of Valid Cases	46			

a. 12 cells (80,0%) have expected count less than 5. The minimum expected count is ,04.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.297	.852	.835
	Cramer's V	.210	.852	.835
N of Valid Cases		46		

19.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Years_Worked * Contain_Disease_Outbreaks	45	97.8%	1	2.2%	46	100.0%

Years_Worked * Contain_Disease_Outbreaks Crosstabulation

			Contain_Disease_Outbreaks			Total
			1	2	3	
Years_Worked		Count	1	0	0	1
		% within Years_Worked	100.0%	0.0%	0.0%	100.0%
		% within Contain_Disease_Outbreaks	2.3%	0.0%	0.0%	2.2%
		% of Total	2.2%	0.0%	0.0%	2.2%
	00-04	Count	5	0	0	5
		% within Years_Worked	100.0%	0.0%	0.0%	100.0%
		% within Contain_Disease_Outbreaks	11.6%	0.0%	0.0%	11.1%
		% of Total	11.1%	0.0%	0.0%	11.1%
	05-09	Count	16	0	1	17
		% within Years_Worked	94.1%	0.0%	5.9%	100.0%

		% within Contain_Disease_Outbreaks	37.2%	0.0%	100.0%	37.8%
		% of Total	35.6%	0.0%	2.2%	37.8%
	10-14	Count	11	1	0	12
		% within Years_Worked	91.7%	8.3%	0.0%	100.0%
		% within Contain_Disease_Outbreaks	25.6%	100.0%	0.0%	26.7%
		% of Total	24.4%	2.2%	0.0%	26.7%
	15+	Count	10	0	0	10
		% within Years_Worked	100.0%	0.0%	0.0%	100.0%
		% within Contain_Disease_Outbreaks	23.3%	0.0%	0.0%	22.2%
		% of Total	22.2%	0.0%	0.0%	22.2%
Total		Count	43	1	1	45
		% within Years_Worked	95.6%	2.2%	2.2%	100.0%
		% within Contain_Disease_Outbreaks	100.0%	100.0%	100.0%	100.0%
		% of Total	95.6%	2.2%	2.2%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	4.453[a]	8	.814	.863
Likelihood Ratio	4.646	8	.795	.863
Fisher's Exact Test	9.631			.863
N of Valid Cases	45			

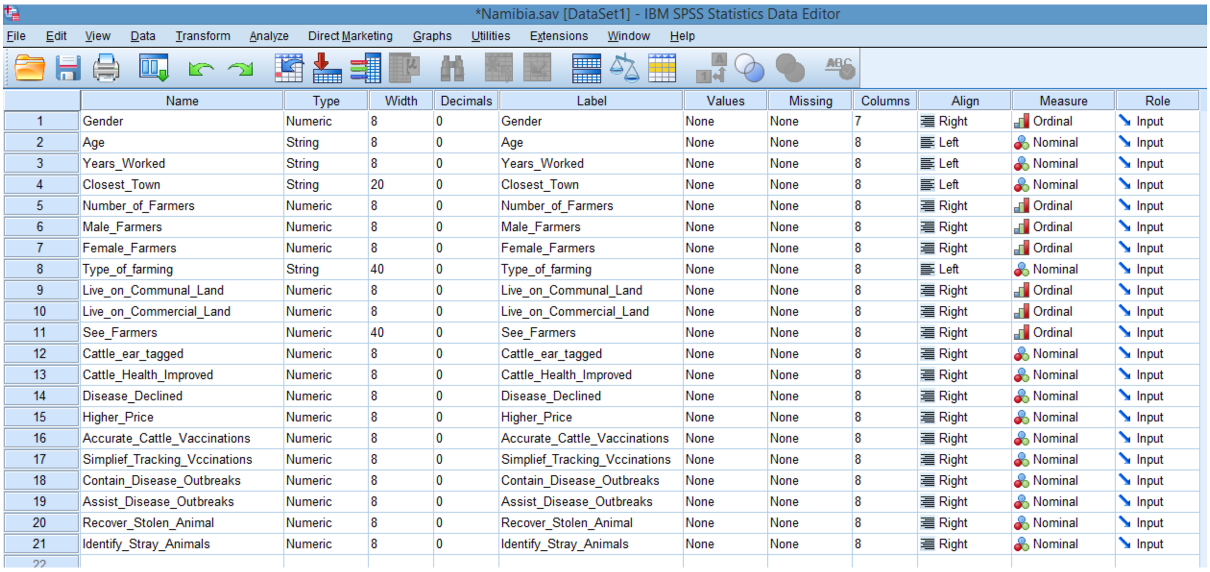
a. 12 cells (80,0%) have expected count less than 5. The minimum expected count is ,02.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.315	.814	.863
	Cramer's V	.222	.814	.863
N of Valid Cases		45		

Appendix 6. SPSS Results from the Namibian questionnaire data

The results below show once again, as in Appendix 5, the results from the SPSS calculations, with the initial figure directly below illustrating how the data types were defined:


*Namibia.sav [DataSet1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Direct Marketing Graphs Utilities Extensions Window Help

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	Gender	Numeric	8	0	Gender	None	None	7	Right	Ordinal	Input
2	Age	String	8	0	Age	None	None	8	Left	Nominal	Input
3	Years_Worked	String	8	0	Years_Worked	None	None	8	Left	Nominal	Input
4	Closest_Town	String	20	0	Closest_Town	None	None	8	Left	Nominal	Input
5	Number_of_Farmers	Numeric	8	0	Number_of_Farmers	None	None	8	Right	Ordinal	Input
6	Male_Farmers	Numeric	8	0	Male_Farmers	None	None	8	Right	Ordinal	Input
7	Female_Farmers	Numeric	8	0	Female_Farmers	None	None	8	Right	Ordinal	Input
8	Type_of_farming	String	40	0	Type_of_farming	None	None	8	Left	Nominal	Input
9	Live_on_Communal_Land	Numeric	8	0	Live_on_Communal_Land	None	None	8	Right	Ordinal	Input
10	Live_on_Commercial_Land	Numeric	8	0	Live_on_Commercial_Land	None	None	8	Right	Ordinal	Input
11	See_Farmers	Numeric	40	0	See_Farmers	None	None	8	Right	Ordinal	Input
12	Cattle_ear_tagged	Numeric	8	0	Cattle_ear_tagged	None	None	8	Right	Nominal	Input
13	Cattle_Health_Improved	Numeric	8	0	Cattle_Health_Improved	None	None	8	Right	Nominal	Input
14	Disease_Declined	Numeric	8	0	Disease_Declined	None	None	8	Right	Nominal	Input
15	Higher_Price	Numeric	8	0	Higher_Price	None	None	8	Right	Nominal	Input
16	Accurate_Cattle_Vaccinations	Numeric	8	0	Accurate_Cattle_Vaccinations	None	None	8	Right	Nominal	Input
17	Simplief_Tracking_Vccinations	Numeric	8	0	Simplief_Tracking_Vccinations	None	None	8	Right	Nominal	Input
18	Contain_Disease_Outbreaks	Numeric	8	0	Contain_Disease_Outbreaks	None	None	8	Right	Nominal	Input
19	Assist_Disease_Outbreaks	Numeric	8	0	Assist_Disease_Outbreaks	None	None	8	Right	Nominal	Input
20	Recover_Stolen_Animal	Numeric	8	0	Recover_Stolen_Animal	None	None	8	Right	Nominal	Input
21	Identify_Stray_Animals	Numeric	8	0	Identify_Stray_Animals	None	None	8	Right	Nominal	Input

The data below are the results obtained through cross-tabulations in the same order as they were given in the thesis, only now as it applies to Namibia:

1.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Gender * Cattle_Health_Improved	44	95.7%	2	4.3%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.950[a]	2	.377	.427	
Likelihood Ratio	2.259	2	.323	.385	
Fisher's Exact Test	1.944			.427	
Linear-by-Linear Association	.214[b]	1	.643	.819	.420
N of Valid Cases	44				

Chi-Square Tests

	Point Probability
Pearson Chi-Square	
Likelihood Ratio	
Fisher's Exact Test	
Linear-by-Linear Association	.169
N of Valid Cases	

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is 1.64.

b. The standardized statistic is -.463.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.211	.377	.427
	Cramer's V	.211	.377	.427
N of Valid Cases		44		

2.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Gender * Disease_Declined	45	97.8%	1	2.2%	46	100.0%

Gender * Disease_Declined Crosstabulation

			Disease_Declined			
			1	2	3	Total
Gender	1	Count	10	18	5	33
		% within Gender	30.3%	54.5%	15.2%	100.0%
		% within Disease_Declined	71.4%	81.8%	55.6%	73.3%
		% of Total	22.2%	40.0%	11.1%	73.3%
	2	Count	4	4	4	12
		% within Gender	33.3%	33.3%	33.3%	100.0%
		% within Disease_Declined	28.6%	18.2%	44.4%	26.7%
		% of Total	8.9%	8.9%	8.9%	26.7%
Total		Count	14	22	9	45
		% within Gender	31.1%	48.9%	20.0%	100.0%
		% within Disease_Declined	100.0%	100.0%	100.0%	100.0%
		% of Total	31.1%	48.9%	20.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.290[a]	2	.318	.340	
Likelihood Ratio	2.213	2	.331	.376	
Fisher's Exact Test	2.346			.303	
Linear-by-Linear Association	.396[b]	1	.529	.639	.346
N of Valid Cases	45				

Chi-Square Tests

	Point Probability
Pearson Chi-Square	
Likelihood Ratio	
Fisher's Exact Test	
Linear-by-Linear Association	.153
N of Valid Cases	

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.40.

b. The standardized statistic is .629.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.226	.318	.340
	Cramer's V	.226	.318	.340
N of Valid Cases		45		

3.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Gender * Higher_Price	37	94.9%	2	5.1%	39	100.0%

Gender * Higher_Price Crosstabulation

	Higher_Price	Total

			1	2	3	
Gender	1	Count	5	19	3	27
		% within Gender	18.5%	70.4%	11.1%	100.0%
		% within Higher_Price	83.3%	73.1%	60.0%	73.0%
		% of Total	13.5%	51.4%	8.1%	73.0%
	2	Count	1	7	2	10
		% within Gender	10.0%	70.0%	20.0%	100.0%
		% within Higher_Price	16.7%	26.9%	40.0%	27.0%
		% of Total	2.7%	18.9%	5.4%	27.0%
Total		Count	6	26	5	37
		% within Gender	16.2%	70.3%	13.5%	100.0%
		% within Higher_Price	100.0%	100.0%	100.0%	100.0%
		% of Total	16.2%	70.3%	13.5%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.753[a]	2	.686	.724	
Likelihood Ratio	.755	2	.686	.625	
Fisher's Exact Test	.878			.724	
Linear-by-Linear Association	.725[b]	1	.394	.508	.303
N of Valid Cases	37				

Chi-Square Tests

	Point Probability
Pearson Chi-Square	
Likelihood Ratio	
Fisher's Exact Test	
Linear-by-Linear Association	.187
N of Valid Cases	

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is 1.35.

b. The standardized statistic is .852.

Symmetric Measures

	Value	Approximate Significance	Exact Significance

Nominal by Nominal	Phi	.143	.686	.724
	Cramer's V	.143	.686	.724
N of Valid Cases		37		

4.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Age * Cattle_Health_Improved	37	94.9%	2	5.1%	39	100.0%

Age * Cattle_Health_Improved Crosstabulation

			Cattle_Health_Improved			
			1	2	3	Total
Age	0-35	Count	8	3	4	15
		% within Age	53.3%	20.0%	26.7%	100.0%
		% within Cattle_Health_Improved	40.0%	60.0%	33.3%	40.5%
		% of Total	21.6%	8.1%	10.8%	40.5%
	36-45	Count	7	2	4	13
		% within Age	53.8%	15.4%	30.8%	100.0%
		% within Cattle_Health_Improved	35.0%	40.0%	33.3%	35.1%
		% of Total	18.9%	5.4%	10.8%	35.1%
	46+	Count	5	0	4	9
		% within Age	55.6%	0.0%	44.4%	100.0%
		% within Cattle_Health_Improved	25.0%	0.0%	33.3%	24.3%
		% of Total	13.5%	0.0%	10.8%	24.3%
Total		Count	20	5	12	37
		% within Age	54.1%	13.5%	32.4%	100.0%
		% within Cattle_Health_Improved	100.0%	100.0%	100.0%	100.0%
		% of Total	54.1%	13.5%	32.4%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	2.287[a]	4	.683	.738

Likelihood Ratio	3.410	4	.492	.584
Fisher's Exact Test	2.222			.773
N of Valid Cases	37			

a. 7 cells (77.8%) have expected count less than 5. The minimum expected count is 1.22.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.249	.683	.738
	Cramer's V	.176	.683	.738
N of Valid Cases		37		

5.

Age * Disease_Decline Crosstabulation

			Disease_Decline			
			1	2	3	Total
Age	0-35	Count	5	3	7	15
		% within Age	33.3%	20.0%	46.7%	100.0%
		% within Disease_Decline	38.5%	33.3%	46.7%	40.5%
		% of Total	13.5%	8.1%	18.9%	40.5%
	36-45	Count	3	5	5	13
		% within Age	23.1%	38.5%	38.5%	100.0%
		% within Disease_Decline	23.1%	55.6%	33.3%	35.1%
		% of Total	8.1%	13.5%	13.5%	35.1%
	46+	Count	5	1	3	9
		% within Age	55.6%	11.1%	33.3%	100.0%
		% within Disease_Decline	38.5%	11.1%	20.0%	24.3%
		% of Total	13.5%	2.7%	8.1%	24.3%
Total		Count	13	9	15	37
		% within Age	35.1%	24.3%	40.5%	100.0%
		% within Disease_Decline	100.0%	100.0%	100.0%	100.0%
		% of Total	35.1%	24.3%	40.5%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	3.717[a]	4	.446	.475

Likelihood Ratio	3.643	4	.457	.515
Fisher's Exact Test	3.404			.523
N of Valid Cases	37			

a. 6 cells (66.7%) have expected count less than 5. The minimum expected count is 2.19.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.317	.446	.475
	Cramer's V	.224	.446	.475
N of Valid Cases		37		

6.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Age * Higher_Price	37	94.9%	2	5.1%	39	100.0%

Age * Higher_Price Crosstabulation

			Higher_Price			Total
			1	2	3	
Age	0-35	Count	1	11	3	15
		% within Age	6.7%	73.3%	20.0%	100.0%
		% within Higher_Price	16.7%	42.3%	60.0%	40.5%
		% of Total	2.7%	29.7%	8.1%	40.5%
	36-45	Count	2	9	1	12
		% within Age	16.7%	75.0%	8.3%	100.0%
		% within Higher_Price	33.3%	34.6%	20.0%	32.4%
		% of Total	5.4%	24.3%	2.7%	32.4%
	46+	Count	3	6	1	10
		% within Age	30.0%	60.0%	10.0%	100.0%
		% within Higher_Price	50.0%	23.1%	20.0%	27.0%
		% of Total	8.1%	16.2%	2.7%	27.0%
Total		Count	6	26	5	37
		% within Age	16.2%	70.3%	13.5%	100.0%
		% within Higher_Price	100.0%	100.0%	100.0%	100.0%

% of Total	16.2%	70.3%	13.5%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	3.022[a]	4	.554	.621
Likelihood Ratio	3.021	4	.554	.638
Fisher's Exact Test	2.969			.628
N of Valid Cases	37			

a. 6 cells (66.7%) have expected count less than 5. The minimum expected count is 1.35.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.286	.554	.621
	Cramer's V	.202	.554	.621
N of Valid Cases		37		

7.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Years_Worked * Cattle_Health_Improved	37	94.9%	2	5.1%	39	100.0%

Years_Worked * Cattle_Health_Improved Crosstabulation

			Cattle_Health_Improved			
			1	2	3	Total
Years_Worked	00-04	Count	2	2	3	7
		% within Years_Worked	28.6%	28.6%	42.9%	100.0%
		% within Cattle_Health_Improved	10.0%	40.0%	25.0%	18.9%
		% of Total	5.4%	5.4%	8.1%	18.9%
	05-09	Count	6	2	2	10
		% within Years_Worked	60.0%	20.0%	20.0%	100.0%

		% within Cattle_Health_Improved	30.0%	40.0%	16.7%	27.0%
		% of Total	16.2%	5.4%	5.4%	27.0%
	10-14	Count	5	1	2	8
		% within Years_Worked	62.5%	12.5%	25.0%	100.0%
		% within Cattle_Health_Improved	25.0%	20.0%	16.7%	21.6%
		% of Total	13.5%	2.7%	5.4%	21.6%
	15+	Count	7	0	5	12
		% within Years_Worked	58.3%	0.0%	41.7%	100.0%
		% within Cattle_Health_Improved	35.0%	0.0%	41.7%	32.4%
		% of Total	18.9%	0.0%	13.5%	32.4%
Total		Count	20	5	12	37
		% within Years_Worked	54.1%	13.5%	32.4%	100.0%
		% within Cattle_Health_Improved	100.0%	100.0%	100.0%	100.0%
		% of Total	54.1%	13.5%	32.4%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	5.329[a]	6	.502	.531
Likelihood Ratio	6.830	6	.337	.463
Fisher's Exact Test	5.668			.459
N of Valid Cases	37			

a. 10 cells (83.3%) have expected count less than 5. The minimum expected count is .95.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.380	.502	.531
	Cramer's V	.268	.502	.531
N of Valid Cases		37		

8.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Years_Worked * Disease_Decline	37	94.9%	2	5.1%	39	100.0%

Years_Worked * Disease_Decline Crosstabulation

			Disease_Decline			Total
			1	2	3	
Years_Worked	00-04	Count	1	3	3	7
		% within Years_Worked	14.3%	42.9%	42.9%	100.0%
		% within Disease_Decline	7.7%	33.3%	20.0%	18.9%
		% of Total	2.7%	8.1%	8.1%	18.9%
	05-09	Count	5	0	5	10
		% within Years_Worked	50.0%	0.0%	50.0%	100.0%
		% within Disease_Decline	38.5%	0.0%	33.3%	27.0%
		% of Total	13.5%	0.0%	13.5%	27.0%
	10-14	Count	2	3	3	8
		% within Years_Worked	25.0%	37.5%	37.5%	100.0%
		% within Disease_Decline	15.4%	33.3%	20.0%	21.6%
		% of Total	5.4%	8.1%	8.1%	21.6%
	15+	Count	5	3	4	12
		% within Years_Worked	41.7%	25.0%	33.3%	100.0%
		% within Disease_Decline	38.5%	33.3%	26.7%	32.4%
		% of Total	13.5%	8.1%	10.8%	32.4%
Total		Count	13	9	15	37
		% within Years_Worked	35.1%	24.3%	40.5%	100.0%
		% within Disease_Decline	100.0%	100.0%	100.0%	100.0%
		% of Total	35.1%	24.3%	40.5%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	6.271[a]	6	.394	.426
Likelihood Ratio	8.629	6	.196	.294
Fisher's Exact Test	6.753			.348
N of Valid Cases	37			

a. 12 cells (100.0%) have expected count less than 5. The minimum expected count is 1.70.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.412	.394	.426
	Cramer's V	.291	.394	.426
N of Valid Cases		37		

9.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Years_Worked * Higher_Price	37	94.9%	2	5.1%	39	100.0%

Years_Worked * Higher_Price Crosstabulation

			Higher_Price			
			1	2	3	Total
Years_Worked	00-04	Count	0	5	2	7
		% within Years_Worked	0.0%	71.4%	28.6%	100.0%
		% within Higher_Price	0.0%	19.2%	40.0%	18.9%
		% of Total	0.0%	13.5%	5.4%	18.9%
	05-09	Count	1	8	1	10
		% within Years_Worked	10.0%	80.0%	10.0%	100.0%
		% within Higher_Price	16.7%	30.8%	20.0%	27.0%
		% of Total	2.7%	21.6%	2.7%	27.0%
	10-14	Count	2	5	1	8
		% within Years_Worked	25.0%	62.5%	12.5%	100.0%
		% within Higher_Price	33.3%	19.2%	20.0%	21.6%
		% of Total	5.4%	13.5%	2.7%	21.6%
	15+	Count	3	8	1	12
		% within Years_Worked	25.0%	66.7%	8.3%	100.0%
		% within Higher_Price	50.0%	30.8%	20.0%	32.4%
		% of Total	8.1%	21.6%	2.7%	32.4%
Total		Count	6	26	5	37
		% within Years_Worked	16.2%	70.3%	13.5%	100.0%
		% within Higher_Price	100.0%	100.0%	100.0%	100.0%
		% of Total	16.2%	70.3%	13.5%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	4.062[a]	6	.668	.725
Likelihood Ratio	4.856	6	.562	.743
Fisher's Exact Test	3.975			.747
N of Valid Cases	37			

a. 9 cells (75.0%) have expected count less than 5. The minimum expected count is .95.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.331	.668	.725
	Cramer's V	.234	.668	.725
N of Valid Cases		37		

10.

Gender * Accurate_Cattle_Vaccinations Crosstabulation

			Accurate_Cattle_Vaccinations		
			1	2	Total
Gender	1	Count	27	1	28
		% within Gender	96.4%	3.6%	100.0%
		% within Accurate_Cattle_Vaccinations	71.1%	100.0%	71.8%
		% of Total	69.2%	2.6%	71.8%
	2	Count	11	0	11
		% within Gender	100.0%	0.0%	100.0%
		% within Accurate_Cattle_Vaccinations	28.9%	0.0%	28.2%
		% of Total	28.2%	0.0%	28.2%
Total		Count	38	1	39
		% within Gender	97.4%	2.6%	100.0%
		% within Accurate_Cattle_Vaccinations	100.0%	100.0%	100.0%
		% of Total	97.4%	2.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.403[a]	1	.525	1.000	.718
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.673	1	.412	1.000	.718
Fisher's Exact Test				1.000	.718
Linear-by-Linear Association	.393[c]	1	.531	1.000	.718
N of Valid Cases	39				

Chi-Square Tests

	Point Probability
Pearson Chi-Square	
Continuity Correction[b]	
Likelihood Ratio	
Fisher's Exact Test	
Linear-by-Linear Association	.718
N of Valid Cases	

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .28.

b. Computed only for a 2x2 table

c. The standardized statistic is -.627.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	-.102	.525	1.000
	Cramer's V	.102	.525	1.000
N of Valid Cases		39		

11.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent

Gender * Simplified_Tracking_Vaccinations	35	89.7%	4	10.3%	39	100.0%

Gender * Simplified_Tracking_Vaccinations Crosstabulation

			Simplified_Tracking_Vaccinations 1	Total
Gender	1	Count	25	25
		% within Gender	100.0%	100.0%
		% within Simplified_Tracking_Vaccinations	71.4%	71.4%
		% of Total	71.4%	71.4%
	2	Count	10	10
		% within Gender	100.0%	100.0%
		% within Simplified_Tracking_Vaccinations	28.6%	28.6%
		% of Total	28.6%	28.6%
Total		Count	35	35
		% within Gender	100.0%	100.0%
		% within Simplified_Tracking_Vaccinations	100.0%	100.0%
		% of Total	100.0%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	35

a. No statistics are computed because Simplified_Tracking_Vaccinations is a constant.

Symmetric Measures

		Value
Nominal by Nominal	Phi	.[a]
N of Valid Cases		35

a. No statistics are computed because Simplified_Tracking_Vaccinations is a constant.

12.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Gender * Contain_Disease_Outbreks	39	100.0%	0	0.0%	39	100.0%

Gender * Contain_Disease_Outbreks Crosstabulation

			Contain_Disease_Outbreks		
			1	3	Total
Gender	1	Count	28	0	28
		% within Gender	100.0%	0.0%	100.0%
		% within Contain_Disease_Outbreks	73.7%	0.0%	71.8%
		% of Total	71.8%	0.0%	71.8%
	2	Count	10	1	11
		% within Gender	90.9%	9.1%	100.0%
		% within Contain_Disease_Outbreks	26.3%	100.0%	28.2%
		% of Total	25.6%	2.6%	28.2%
Total		Count	38	1	39
		% within Gender	97.4%	2.6%	100.0%
		% within Contain_Disease_Outbreks	100.0%	100.0%	100.0%
		% of Total	97.4%	2.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.612[a]	1	.106	.282	.282
Continuity Correction[b]	.241	1	.624		
Likelihood Ratio	2.599	1	.107	.282	.282
Fisher's Exact Test				.282	.282
Linear-by-Linear Association	2.545[c]	1	.111	.282	.282
N of Valid Cases	39				

Chi-Square Tests

	Point Probability
Pearson Chi-Square	
Continuity Correction[b]	
Likelihood Ratio	
Fisher's Exact Test	
Linear-by-Linear Association	.282
N of Valid Cases	

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .28.

b. Computed only for a 2x2 table

c. The standardized statistic is 1.595.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.259	.106	.282
	Cramer's V	.259	.106	.282
N of Valid Cases		39		

13.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Age * Accurate_Cattle_Vaccinations	39	100.0%	0	0.0%	39	100.0%

Age * Accurate_Cattle_Vaccinations Crosstabulation

			Accurate_Cattle_Vaccinations		Total
			1	2	
Age	0-35	Count	15	0	15
		% within Age	100.0%	0.0%	100.0%
		% within Accurate_Cattle_Vaccinations	39.5%	0.0%	38.5%
		% of Total	38.5%	0.0%	38.5%
	36-45	Count	12	1	13
		% within Age	92.3%	7.7%	100.0%

		% within Accurate_Cattle_Vaccinations	31.6%	100.0%	33.3%
		% of Total	30.8%	2.6%	33.3%
	46+	Count	11	0	11
		% within Age	100.0%	0.0%	100.0%
		% within Accurate_Cattle_Vaccinations	28.9%	0.0%	28.2%
		% of Total	28.2%	0.0%	28.2%
Total		Count	38	1	39
		% within Age	97.4%	2.6%	100.0%
		% within Accurate_Cattle_Vaccinations	100.0%	100.0%	100.0%
		% of Total	97.4%	2.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	2.053[a]	2	.358	.615
Likelihood Ratio	2.250	2	.325	.615
Fisher's Exact Test	1.893			.615
N of Valid Cases	39			

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .28.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.229	.358	.615
	Cramer's V	.229	.358	.615
N of Valid Cases		39		

14.

Case Processing Summary

Cases					
Valid		Missing		Total	
N	Percent	N	Percent	N	Percent

Age * Simplified_Tracking_Vaccinations	35	89.7%	4	10.3%	39	100.0%

Age * Simplified_Tracking_Vaccinations Crosstabulation

			Simplified_Tracking_Vaccinations 1	Total
Age	0-35	Count	15	15
		% within Age	100.0%	100.0%
		% within Simplified_Tracking_Vaccinations	42.9%	42.9%
		% of Total	42.9%	42.9%
	36-45	Count	13	13
		% within Age	100.0%	100.0%
		% within Simplified_Tracking_Vaccinations	37.1%	37.1%
		% of Total	37.1%	37.1%
	46+	Count	7	7
		% within Age	100.0%	100.0%
		% within Simplified_Tracking_Vaccinations	20.0%	20.0%
		% of Total	20.0%	20.0%
Total		Count	35	35
		% within Age	100.0%	100.0%
		% within Simplified_Tracking_Vaccinations	100.0%	100.0%
		% of Total	100.0%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	35

a. No statistics are computed because Simplified_Tracking_Vaccinations is a constant.

Symmetric Measures

		Value
Nominal by Nominal	Phi	.[a]
N of Valid Cases		35

a. No statistics are computed because Simplified_Tracking_Vaccinations is a constant.

15.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Age * Contain_Disease_Outbreks	39	100.0%	0	0.0%	39	100.0%

Age * Contain_Disease_Outbreks Crosstabulation

			Contain_Disease_Outbreks		
			1	3	Total
Age	0-35	Count	14	1	15
		% within Age	93.3%	6.7%	100.0%
		% within Contain_Disease_Outbreks	36.8%	100.0%	38.5%
		% of Total	35.9%	2.6%	38.5%
	36-45	Count	13	0	13
		% within Age	100.0%	0.0%	100.0%
		% within Contain_Disease_Outbreks	34.2%	0.0%	33.3%
		% of Total	33.3%	0.0%	33.3%
	46+	Count	11	0	11
		% within Age	100.0%	0.0%	100.0%
		% within Contain_Disease_Outbreks	28.9%	0.0%	28.2%
		% of Total	28.2%	0.0%	28.2%
Total		Count	38	1	39
		% within Age	97.4%	2.6%	100.0%

% within Contain_Disease_Outbreks	100.0%	100.0%	100.0%
% of Total	97.4%	2.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	1.642[a]	2	.440	1.000
Likelihood Ratio	1.953	2	.377	1.000
Fisher's Exact Test	1.607			1.000
N of Valid Cases	39			

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .28.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.205	.440	1.000
	Cramer's V	.205	.440	1.000
N of Valid Cases		39		

16.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Years_Worked * Accurate_Cattle_Vaccinations	39	100.0%	0	0.0%	39	100.0%

Years_Worked * Accurate_Cattle_Vaccinations Crosstabulation

			Accurate_Cattle_Vaccinations		
			1	2	Total
Years_Worked	00-04	Count	7	0	7
		% within Years_Worked	100.0%	0.0%	100.0%
		% within Accurate_Cattle_Vaccinations	18.4%	0.0%	17.9%
		% of Total	17.9%	0.0%	17.9%

	05-09	Count	9	1	10
		% within Years_Worked	90.0%	10.0%	100.0%
		% within Accurate_Cattle_Vaccinations	23.7%	100.0%	25.6%
		% of Total	23.1%	2.6%	25.6%
	10-14	Count	8	0	8
		% within Years_Worked	100.0%	0.0%	100.0%
		% within Accurate_Cattle_Vaccinations	21.1%	0.0%	20.5%
		% of Total	20.5%	0.0%	20.5%
	15+	Count	14	0	14
		% within Years_Worked	100.0%	0.0%	100.0%
		% within Accurate_Cattle_Vaccinations	36.8%	0.0%	35.9%
		% of Total	35.9%	0.0%	35.9%
Total		Count	38	1	39
		% within Years_Worked	97.4%	2.6%	100.0%
		% within Accurate_Cattle_Vaccinations	100.0%	100.0%	100.0%
		% of Total	97.4%	2.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	2.976[a]	3	.395	.641
Likelihood Ratio	2.800	3	.424	.641
Fisher's Exact Test	2.974			.641
N of Valid Cases	39			

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is .18.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.276	.395	.641

	Cramer's V	.276	.395	.641
N of Valid Cases		39		

17.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Years_Worked * Simplified_Tracking_Vaccinations	35	89.7%	4	10.3%	39	100.0%

Years_Worked * Simplified_Tracking_Vaccinations Crosstabulation

			Simplified_Tracking_Vaccinations	
			1	Total
Years_Worked	00-04	Count	7	7
		% within Years_Worked	100.0%	100.0%
		% within Simplified_Tracking_Vaccinations	20.0%	20.0%
		% of Total	20.0%	20.0%
	05-09	Count	9	9
		% within Years_Worked	100.0%	100.0%
		% within Simplified_Tracking_Vaccinations	25.7%	25.7%
		% of Total	25.7%	25.7%
	10-14	Count	8	8
		% within Years_Worked	100.0%	100.0%
		% within Simplified_Tracking_Vaccinations	22.9%	22.9%
		% of Total	22.9%	22.9%
	15+	Count	11	11
		% within Years_Worked	100.0%	100.0%
		% within Simplified_Tracking_Vaccinations	31.4%	31.4%
		% of Total	31.4%	31.4%
Total		Count	35	35

	% within Years_Worked	100.0%	100.0%
	% within Simplified_Tracking_Vaccinations	100.0%	100.0%
	% of Total	100.0%	100.0%

Chi-Square Tests

	Value
Pearson Chi-Square	.[a]
N of Valid Cases	35

a. No statistics are computed because Simplified_Tracking_Vaccinations is a constant.

Symmetric Measures

		Value
Nominal by Nominal	Phi	.[a]
N of Valid Cases		35

a. No statistics are computed because Simplified_Tracking_Vaccinations is a constant.

18.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Years_Worked * Contain_Disease_Outbreks	39	100.0%	0	0.0%	39	100.0%

Years_Worked * Contain_Disease_Outbreks Crosstabulation

			Contain_Disease_Outbreks		
			1	3	Total
Years_Worked	00-04	Count	6	1	7
		% within Years_Worked	85.7%	14.3%	100.0%
		% within Contain_Disease_Outbreks	15.8%	100.0%	17.9%
		% of Total	15.4%	2.6%	17.9%
	05-09	Count	10	0	10

		% within Years_Worked	100.0%	0.0%	100.0%
		% within Contain_Disease_Outbreks	26.3%	0.0%	25.6%
		% of Total	25.6%	0.0%	25.6%
	10-14	Count	8	0	8
		% within Years_Worked	100.0%	0.0%	100.0%
		% within Contain_Disease_Outbreks	21.1%	0.0%	20.5%
		% of Total	20.5%	0.0%	20.5%
	15+	Count	14	0	14
		% within Years_Worked	100.0%	0.0%	100.0%
		% within Contain_Disease_Outbreks	36.8%	0.0%	35.9%
		% of Total	35.9%	0.0%	35.9%
Total		Count	38	1	39
		% within Years_Worked	97.4%	2.6%	100.0%
		% within Contain_Disease_Outbreks	100.0%	100.0%	100.0%
		% of Total	97.4%	2.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	4.692[a]	3	.196	.179
Likelihood Ratio	3.560	3	.313	.179
Fisher's Exact Test	3.687			.179
N of Valid Cases	39			

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is .18.

Symmetric Measures

		Value	Approximate Significance	Exact Significance
Nominal by Nominal	Phi	.347	.196	.179
	Cramer's V	.347	.196	.179
N of Valid Cases		39		