An assessment of the opportunities and constraints to enhanced animal identification, traceability and quality verification in a beef marketing chain in Kenya

By

George Owuor Matete BVM, MSc. (University of Nairobi)

A thesis submitted in fulfilment of the requirements for the

Degree of

Doctor of Philosophy in Public Health

University of Nairobi

Faculty of Veterinary Medicine,

Department of Public Health, Pharmacology and Toxicology

DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

.... 16 . 02 / 2010

Dr. George O. Matete (BVM, M.Sc.) Date

This thesis has been submitted for examination with our approval as University supervisors:

.... 18/02/2010

1. Dr. G.M. Muchemi, BVM, MSc. (Guelph), PhD. (Liverpool) Date

.... 23/3/2010.

2. Prof. N. Maingi, BVM (UoN), MSc. (McGill), PhD. (UoN) Date

.... 23/3/2010

3. Prof. J.M. Gathuma, BVSc. MSc., PhD. (UoN) Date

.... 16.02.2010

4. Dr W. Ogara, DVM, MSc., PhD. (Moscow) Date

DEDICATION

To

Ruth Achieng

and

my parents Achieng and Adhiambo,

not forgetting my grandfather

Erasto Matete Oyoo who walked to Maseno in search of knowledge

ACKNOWLEDGEMENTS

My gratitude is to God Almighty, my Creator. For great is the LORD, and greatly to be praised: He also is to be feared above all gods, He lives forever, His dominion is an everlasting dominion, and His kingdom is from generation to generation. He alone has given me the ability, persistence and the energy to complete this thesis.

My supervisors; Dr. Gerald Muchemi, Professors Ndichu Maingi, Joseph Mwangi Gathuma and Dr. William Ogara, provided valuable insights and positive support. Their critical yet supportive attitude, while reading through this thesis was appreciated.

I am greatly indebted to the Somali traders cum ranchers Messrs Dirie Olow, Abdi Abdullahi, Bashow Muhamed and Yaro Aden who provided fervent cooperation. Without their great patience and willingness to chart the paths unknown, this thesis could not have been completed. Abdi Abdullahi, you opened up to me from day one and continued to provide the critical link to your fellow traders during the study.

The collection of required data was time-consuming and involved the participation of the Department of Veterinary Services. I thank the former and present Directors of Veterinary Services Drs. Joseph Musaa and Peter Ithondeka, for their foresight and cooperation.

The enduring friendship of Wahenya, Oyieke, my younger brother Odhiambo Ajowi, Carol, Godiah, and Joseph Gachanja provided the necessary push whenever I faltered. John Waibochi, Daniel Ndeti and the entire Virtual City team who helped with the design of the traceability database software and patiently examined the data with me during weekends.

Many veterinarians from the district offices and laboratories provided valuable assistance in terms of personal inputs and data gathering. These include my handyman friend, Dr. William Maritim, Drs. Mark Obonyo, Moenga, Kivuvo, Kabaka, Arithi Matembei, Nicholas Ayore, Sophie Njue, Wilson Kenga, Nkanata and James Audho. Doris Night Ngongo and Florence Ayall helped with the English editorial. Patrick Irungu and Lawrence Godiah critiqued the initial design of the benefit cost analysis. All the staff of Terra Nuova are acknowledged and thanked for their support. The late Jasper K'omollo and Phenny Ogutu sacrificed their lives in pursuit of this enterprise.

There are many other individuals who helped during the study, you all enriched my life and each encounter was indeed a worthwhile experience.

To my wife, Ruth Achieng Ayall, you are my best friend. For your unconditional love, affection, enduring devotion and commitment to everything I have asked, I am eternally indebted. To my daughters Rushmi Awour, Clara Aduda and Loice Akinyi, this effort is for you and that your vision may always be broad. I thank my sister, Mary and my brothers the late Jacktone, Robert, James, Paul and William. Most of all, I thank my two sets of parents, Philip Achieng Matete and Justo Ayall Okatch and Christine Adhiambo Achieng and Loice Odindo Ayall; without them I would not have been where I am now. Thank you all.

This study was done within the framework of the Improvement and Diversification of Somali Livestock Trade and Marketing Project that was implemented by Terra Nuova and funded by the European Union. The financial support for these organisations is appreciated.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABREVIATIONS

ACP	African Caribbean Pacific
AGOA	African Growth Opportunity Act
ARIS	Animal Resources Information System
ASALs	Arid and Semi Arid Lands
AU-IBAR	African Union-Inter-African Bureau of Animal Resources
BCA	Benefit-Cost Analysis
BCR	Benefit Cost Ratio
BMC	Botswana Meat Commission
CBPP	Contagious Bovine Pluropneumonia
CFT	Complement Fixation Test
COMESA	Common Market for Eastern and Southern Africa
EAC	East African Community
EC	European Community
EID	Electronic Identification Devices
FAO	Food and Agriculture Organisation
FMD	Foot and Mouth Disease
GAP	Good Agricultural Practices
ICAR	International Committee for Animal Recording
IDEA	Identification Electronique des Animaux
IGAD	Inter Governmental Authority on Development
IRR	Internal Rate of Return
ISO	International Standards Organisation

JRC	Joint Research Council
KRA	Kenya Revenue Authority
KLMC	Kenya Livestock Marketing Council
KMC	Kenya Meat Commission
LITS	Livestock Identification and Traceability System
LMD	Livestock Marketing Department
LSD	Lumpy Skin Disease
LTMS-K	Livestock Traders Marketing Society of Kenya
NEPAD	New Partnership for Africa's Development
NPV	Net Present Value
OIE	*Office international des epizooties*
PVB	Present Value of Benefits
PVC	Present Value of Costs
PVS	Performance, Vision and Strategy
RFID	Radio Frequency Identification Device
RVF	Rift Valley Fever
SDR	Social Discount Rate
SOP's	Standard Operating Procedures
SOUR	Statement of User Requirements
SPS	Sanitary and Phytosanitary Standards
SPSS	Statistical Package for Social Scientists
WHO	World Health Organisation
WTO	World Trade Organisation

ABSTRACT

The objective of this study was to assess the feasibility of implementation for an electronic Livestock Identification and Traceability System (LITS) in Kenya. It was envisaged that LITS would enable Kenya 1) ascertain origin and ownership of livestock and to discourage stock theft and thus livestock related insecurities; 2) support disease surveillance and minimise the spread of trans-boundary animal diseases (TADs); and 3) improve external market access through exports.

The study was implemented in six steps. First, stakeholder awareness, mobilisation and public private dialogue, second a LITS model suitable for pastoral production system was designed with the involvement of the key stakeholders. Third, a technical evaluation of the model was carried out at field level along the north-eastern Kenya and coastal marketing chain. Fourth, an economic evaluation of the model was undertaken using a Benefit Cost Analysis (BCA). Fifth, the existing constraints (such as institutional, organisational and in processes) towards up-scaling the model at a national level were analysed and finally, appropriate recommendations drawn up based on key findings from steps 1-5 (step six).

The study revealed that an electronic livestock identification and traceability system was technically feasible in pastoral areas in Kenya. Rumen boluses were found to be better identifiers compared to ear button tags, having a readability of 100% and no losses over the one-year duration. The cost, when calculated for the nearly three million beef cattle in arid and semi-arid lands (ASALs), was US$ 7.4/head for registration and US 7.3/head for annual maintenance. The ear button tags while exhibiting readability of 100% over the same duration had losses of nearly 6%, which fell short of The International Committee on Animal

Recording (ICAR) recommendations of minimum values >98% readability. The cost per head for ear button tags was estimated at US$ 5.15 for registration and US$ 5.04 for annual maintenance. The BCA revealed that the Net Present Value[1] (NPV) of LITS was approximately US$ 350 million at 2007 prices and the Benefit Cost Ratio[2] (BCR) was 4.73 – implying that the return on investment was computed at nearly five times the unit cost per dollar. Similarly, for the ear button tag NPV was US$ 386 million and the BCR 7.43. Sensitivity analysis conducted on the data showed that the underlying assumptions were valid and the project was economically and technically viable and beneficial to implement for pastoral beef cattle in Kenya.

The main challenges identified were limited competence of human resource, inadequate market support infrastructure and limited skills in the application of middle ware (equipment between the tag and computer such as reader and cables). Furthermore, prior to the study, the country did not have a clear institutional and organisational framework under which electronic LITS could be implemented. The study established that the cost incurred on establishing the system can be offset vide a modest increase in demand for beef in the domestic market or an increase in beef export demand equivalent. In conclusion, the study noted that with full participation of stakeholders the implementation of electronic traceability systems was both technically and economically feasible in pastoral production systems in Kenya despite it being a costly undertaking.

---

[1] When NPV is greater than zero it implies that the discounted value of future cash flows is greater than the initial investment and that there is an even higher return than desired.

[2] **Benefit Cost Ratio (BCR)** refers to the ratio of discounted benefits and discounted costs of a project or program. It is often used as an indicative ratio that attempts to summarize the overall value for money of a project or program. The project or program would be economically feasible if the BCR was greater than 1. Ideally, because a BCA is a social level analysis, benefits should be valued on the basis of beneficiaries' willingness to pay while costs are valued at opportunity cost of undertaking the project or program.

From the study it is recommended that: -

- The public sector driven mandatory traceability with a high degree of private sector participation be adopted in Kenya and the region as part of the regular activities of the Departments of Veterinary Services.
- Rumen boluses should be used as identifiers because in spite of their initial higher purchase and maintenance costs they are tamperproof, subject to minimal losses during use and can be recycled up to ten times and over 30 years.
- It is recommended that a policy of cost sharing at the rate of 40–50%: 60–50% (private public) be apply for early adopters of LITS.
- The application of the electronic identifiers should be supported by legislation and anchored in the Animal Diseases Control Act Chapter (CAP) 364 of the laws of Kenya in the short-term. In the long-term Branding Act CAP 357 should be repealed and replaced with a more inclusive animal identification and traceability act and provisions supporting its enforcement and monitoring made in other relevant Chapters of the Laws of Kenya such as the Stock Produce Theft CAP–355, Meat Control CAP 356, Cattle Cleansing CAP–358, Hides, Skin and Leather Trade CAP–359, Prevention of Cruelty to Animals CAP–360, Kenya Meat Commission Act CAP–363, Animal Diseases Act CAP–364 and Veterinary Surgeons Act CAP 366.
- Implementation of the LIT should be preceded by studies focusing on establishing a sustainable regional framework for implementing traceability systems with a well coordinated method of vertical and horizontal communication system, and

Given the nature of human and animal movement for grazing, water and trade in the region it is recommended that Kenya, with the support of regional African Union Organizations including East African Community (EAC), AU-IBAR and Inter Governmental Authority Development, adopts a LITS that is harmonised regionally in terms of legal and technical requirements.

CHAPTER 1: GENERAL INTRODUCTION

1.1 Introduction

Livestock and meat products have been among the fastest growing components of international trade. In 2008, the aggregate global value of live animal trade was estimated at US$ 8.5 billion, while that of meat was US$ 43 billion (FAOSTAT, 2008). However, cattle and meat exports from the Horn of Africa countries constitute less than 0.5 percent of global totals. Their trade has been substantially inured by the perceived risk or suspicions of presence of trans-boundary animal diseases (TADs) such as Rift Valley Fever (RVF) and Foot and Mouth Disease (FMD). The veterinary or competent authorities within the region do not have adequate Capacity to prove the absence of TADs (Morgan and Tallard, 2008; Agritrade, 2009). This situation can only be addressed through the introduction and rigorous application of modern Quality Assurance Programmes (QAPs) such as traceability systems (Füzesi *et al*., 2009).

Traceability has been defined as "*the ability to follow an animal or group of animals during all stages of its life*" (OIE, 2010[3]). Traceability systems consist of unique identifiers, a recording database and a sequentially recorded series of movement events related to the identifiers. Such systems are primarily meant for record-keeping and have been used to address information deficiencies within the marketing chain (Meuwissen *et al*., 2003; Beulens *et al*., 2005; Hisey, 2005). Traceability guarantees and facilitates safe trade by building consumer confidence and trust in the regulatory infrastructure (Liddell and Bailey, 2001).

---

[3] Available: http://www.oie.int/eng/normes/mcode/en_sommaire.htm

Traditionally, Kenya has used hot iron branding for livestock identification guided by the Branding of Stocks Act, CAP 357 of 1907. The Act, which may have been adequate when initially applied, is currently deemed as being restrictive as it does not provide for the inclusion, adoption and application of other means of contemporary techniques of livestock identification such as plastic ear tags, tattoos or oil paints currently being used for sheep, goats and pigs (Anon, 2009). In addition, none of these identifiers were ever meant for beef cattle which were branded according to the Branding of Stocks Act have been effective in tracing of beef cattle. The current animal identification system has not been effective in tracing beef cattle as Livestock Brand registry and field veterinary services have not been working in tandem especially given that the Brand Registrar ceased to exist in the 1980's. In addition records of animal movement permits have been poorly kept and in some instances circumvented through illegal movement of livestock.

The application of electronic identification and traceability has been recognised as a useful although expensive decision-support tool. Before recommendations for implementation of RFID-based Livestock Identification and Traceability Systems (LITS) at a country-wide scale in Kenya could be made, it was important that an evaluation of their technical and economic feasibility were conducted as recommended by the *Office International des Epizooties* (OIE).

Global trends of electronic animal identification have advocated for the use of Radio Frequency Identification Devices (RFID) as identifiers within traceability systems (Germain, 2005). RFID include rumen boluses, ear button tags and microchips that are useful in overcoming the problems associated with traditional recording systems (Golan *et al.*, 2005).

The benefits of RFID include reliable tag retention and readability, increased data integrity and future capabilities of full animal movement tracking (Germain, 2005).

1.2 Problem statement

Kenya has been unable to exploit global meat market due to her inability to control outbreaks of animal diseases caused mainly by uncontrolled movement of livestock across her borders (Morgan and Tallard, 2008). Non participation in international beef markets has also been made worse by reduced livestock production, arising from among other factors, livestock related insecurity (cattle rustling) in the main pastoral livestock producing areas (EAPCCO, 2008).

Compliance with the traceability requirements will not only be vital for the survival of from Kenya's beef export trade, but also for enhancement of security in pastoral production areas. While there may be clear organisational structures for cattle identification and traceability within the Branding of Stocks Act CAP–357 and the Hide, Skin and Leather Trade CAP–359, these regulations have been poorly implemented. Furthermore, being a recent international phenomenon, global standard-setting bodies such as OIE have recommended the establishment of guidelines for traceability systems in pastoral settings (OIE, 2009).

The study was therefore designed to evaluate the technical and economic feasibility for the implementation and adoption of electronic identification and traceability for beef cattle in pastoral production systems. This was undertaken through implementation of a pilot traceability system. The study was based on the premise that without implementing traceability systems, Kenya cannot access high value meat markets. This is because traceability systems contribute to the early detection of disease occurrence and management of risk along market value chains and contribute to an internationally recognized, credible, efficient and effective animal health inspection and certification system.

1.3 Objectives of the study

1.3.1 Overall objective:

The overall objective was to assess the opportunities and constraints to enhanced animal identification, traceability and quality verification in a pastoral beef cattle marketing chain in Kenya.

1.3.2 The specific objectives were:

1) To design a system for implementation of electronic livestock identification and traceability for the beef cattle marketing chain from North-Eastern Province to the Coastal ranches of Kenya;
2) To assess the technical applicability and suitability of the two types of identifiers, the ear buttons and rumen boluses RFID, for cattle identification in the pastoral beef cattle marketing chain from North-Eastern Province to the Coastal ranches of Kenya;
3) To undertake a benefit-cost analysis of the electronic identification and traceability system in Kenya;
4) To evaluate the institutional and organisational reforms needed for implementation of the electronic identification and traceability systems in Kenya.

5) To make recommendations on the requisite changes to the cattle identification and traceability policy and legislation in Kenya.

1.4 Hypothesis

This study investigated the most appropriate technical and economical solutions that can deliver LITS in pastoral beef production systems of Kenya. The following hypothesis was tested:

a. It is technically and economically feasible to design and implement an RFID based livestock identification and traceability system in the pastoral production systems in Kenya.

1.5 Study justification

Since 1977, Kenya has only managed to export one metric tonne (MT) of meat out of an expected annual exports quota of 142 MT to the European Union (FAOSTAT, 2008; Agritrade, 2009). Exports of live animals have been limited, barely exceeding 4000 head per year (FAOSTAT, 2008) and cannot sustain the Mauritius market (Abbas Mohammed, 2010, Personal Communication). In addition, the beef producing areas are also affected by livestock related insecurities such as the rustling of cattle, which not only serve to add to the constraints in productivity, but have also been incriminated in the spread of transboundary animal diseases and poverty.

Implementing traceability systems lay firm foundations for proving the presence of transparent and credible quality assurance system; determining and subsequently certifying the health status; animal welfare and the commercial characteristics of export commodities.

Kenya is expected to comply with traceability requirements in order for her meat exports to access high value beef markets such as the European Union's (EU). Moreover, the current livestock policy does not specify the use of RFID as identifiers for livestock traceability or for the use of. However, the technical and economic viability and policy and legal requirements have not been previously assessed. Adoption of RFID technology for identification shall: 1) help ascertain origin and ownership, and to deter livestock related insecurities such as cattle rustling and mis-representation[4] of animals and meat; 2) support disease surveillance in order to minimise the spread of trans-boundary animal diseases (TADs); and, 3) support to animal movement regulation, 4) improve external market access through exports. In the end, the implementation of a credible traceability and disease surveillance system, shall contribute towards the establishment of an internationally credible livestock inspection and certification system while contributing to the management of risks along the market value chain.

1.6 Assumptions

The underlying assumptions for the study were that no major livestock crises such as droughts, floods or inter-ethnic conflicts occur along the livestock trekking route during the trial and that the political climate in the country remains stable.

---

[4] A misrepresentation is a positive statement of fact, which is made or adopted by a party to a contract and is untrue."It may be made fraudulently, carelessly or innocently.

CHAPTER 2: LITERATURE REVIEW

2.1 Definition of traceability

A number of similar definitions for traceability exists. The European Commission (EC) traceability defined as "*the ability to trace and follow food, feed, food-producing animals or substances intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution*" (ECR Europe, 2004).

According to the International Standards Organisation (ISO) traceability is defined as "*the ability to trace the history, application or location of an item or activity by means of recorded identification*" (Arisland and Kjærnsrød, 2005; Dessureault, 2006). While On Trace (2007), defined traceability as *"The ability to locate an animal, commodity, food product or ingredient and follow its history in the supply chain forward (from source to consumer) or backward (from consumer to source)."*

Generally, traceability systems have been defined based on their *breadth*, *depth* and *precision*. The '*breadth*' of a traceability system refers to the amount of information provided from its records, for example, country of origin. The '*depth*' refers to how far back or forwards the system can trace or track to, for example, an intermediate step in the supply chain ('farm to abattoir') or the entire chain ('farm to fork'). '*Precision*' relates to the degree of assurance or credibility with which the system can pinpoint the movement of a specific product (Souza-Monteiro and Caswell, 2004; Golan *et al.*, 2005).

Overall, traceability revolves around keeping records for the life history of animals. These records may include details of the animals' movement and disease management events such as vaccinations, quarantines or treatments either from birth to slaughter or from one place (step) to the next (OIE, 2010).

2.2 Technologies for animal identification

The identification of individual animals has been practiced in various forms for many years since the Branding of Stocks Act CAP 357 was passed in 1907. Hot and cryogenic brands have been the most widely used methods. While capable of permanently identifying animals, they have the possibility of hide damage, can easily be defaced or concealed. Therefore, electronic identification tags have been developed as an improvement over the visual tags. Electronic tags (or RFID) exist in three forms, namely microchips implants, boluses, and ear button tags (Weimers, 2000). They are however not currently in use in the identification of livestock in Kenya.

2.2.1 Radio frequency identification devices (RFID)

RFID has been defined as "a system that transmits the identity (unique serial number) of an object or person wirelessly, using radio waves" (RFID Journal, 2005; Kumar *et al.*, 2009). RFID consists of a tag and a transponder. The transponder incorporates a reading device to interpret the code and software that compiles the identification code and stores the data. The use of RFID tags has been constrained by cost and the requirement for an elaborate supportive communication infrastructure to be effective (Weimers, 2000; Smith *et al.*, 2005).

2.2.1.1 Boluses

The electronic bolus consists of a non-toxic ceramic capsule with high specific gravity (>3.3 g/cm3) encapsulating a 32-micrometre transponder (Korn, 2004). The bolus has a cylindrical shape with rounded extreme and features (external diameter, 21 mm; length, 70 mm; weight, 75 g). The shape has been designed for oral administration and to ensure permanent retention in the fore-stomach of ruminants. The two main advantages of the rumen bolus are provision of permanent and tamper proof identification and the fact that it can be recycled several times.

2.2.1.2 Ear tags

Ear tags have been identified as one of the best and cheapest means of livestock identification. Contemporary ear tags incorporate RFID for the electronic recording of data. However, due to their accessible location ear tags could be lost during animal movement or handling, which excludes tamper proof identification.

The tags mentioned above are used all over the world in established traceability systems. As mentioned earlier, these tags need to be supported by an elaborate communication infrastructure. The conceptual functioning of such an infrastructure is described next.

2.2.1.3 Use of identifiers and traceability systems

The implementation of livestock traceability systems requires a clear, easily readable, low-cost and relatively durable means of identification that can be transferred to a recording database with a minimum possibility of error (Pinna *et al.*, 2006). This is done through the use of a unique identifier attached to a product and a database for registration. Despite the high cost of start-up, electronic identifier systems have been more reliable when compared to visual systems. They cannot be lost, falsified or inter-changed, thus making it difficult to lose information (Carné *et al.*, 2009 $_{a, b}$). The database comprises of the unique identifier together with its corresponding series of true records of its history as it moves along the market value chain (Figure 2.1).

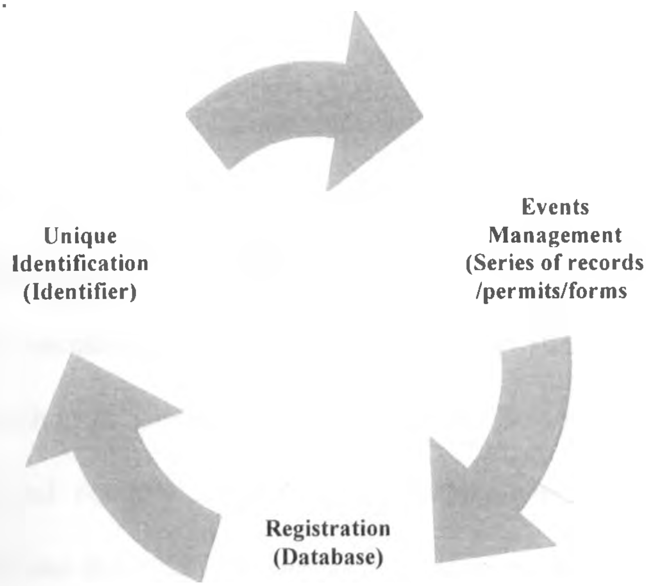


Figure 2.1: Diagrammatic illustration of the definition of Traceability

Such details enable one to trace every movement event, when it occurred, what was done during the movement, how it was done, and who did it and where the person can be found (ICAR, 2004; 2009). Effective traceability therefore depends upon the correct collection, recording and transmission of individual livestock data using either paper trail- or computer-based information systems. Thus, the functionality of traceability systems can be viewed as being based on three broad requirements: 1) overall administrative and organizational functions; 2) precise system of data capture and storage; and 3) use of data for investigations, reports and analysis.

Such traceability systems are implemented within specific areas, be they the whole country or only parts of the country. In countries where the veterinary service is challenged by limited human resources, finances as well as physical infrastructure, execution along the market value chain could be the most viable option.

From a technical point of view, full chain traceability is feasible in pastoral settings (Germain, 2005). The OIE further promotes national or regional programmes to provide new mechanisms and research for technologies and systems that can be used to achieve animal identification and traceability in countries and regions that have populations practising pastoral systems such as transhumance and nomadism. However, there is limited information on the technical and economic feasibility of implementing electronic LITS in pastoral production systems and this study was the first substantive attempt to address this gap.

The absence of specific studies on technical evaluation of traceability systems in pastoral areas not withstanding, implementation of such systems on a wide-scale requires to be preceded by an economic and/or business evaluation (Chryssochoidis *et al.*, 2009). Such an evaluation would be an effective means of ensuring that traceability has overall net benefits. Prior to its implementation in an area-wide scale, an economic and/or business evaluation would be an effective means of ensuring that traceability had an overall net benefit (Chryssochoidis *et al.*, 2009). Indeed, this requirement is part of the recommendation of the OIE, the body responsible for governing world animal health through the Animal Health Code, at its first conference of animal traceability held in Buenos Aires, Argentina (OIE, 2009) "- *continued to recommend animal identification and traceability programmes that are compatible within a specific country for each animal species; based on a scientific assessment* *of animal and public health risks; take account of consumer requests and needs and the results of* ***cost benefit assessment****; and are simple, affordable, outcomes based, transparent, auditable and commensurate with the size and nature of the farming sector in each country.*" Against this background, cost-benefit assessment must be at the heart of every traceability systems. This is discussed next.

2.3 Economics of implementing livestock identification and traceability systems

Despite the acknowledged importance of cost-benefit analysis of traceability systems, there is no literature specific for cost-benefit analysis on livestock traceability in pastoral production systems. However, a limited number of studies have been implemented in other production systems and sectors. Of these studies implemented, some have addressed the costs or benefit and costs of either animal identification alone or identification and traceability systems (Disney *et al.*, 2001; NAIS Benefit Cost Research Team, 2009).

Disney *et al.*, (2001) analyzed the economic impacts of improved animal identification systems for cattle and swine using a hypothetical Foot and Mouth Disease (FMD) outbreak in the United States. Improved animal identification systems in cattle could provide economic benefits with average benefit-cost ratios for cattle ranging from 1.24 to 3.15 depending upon the time planning horizon and the traceability situation.

Bailey (2006) examined the benefits and costs associated with an animal identification system for cattle in the United States; including reasons for implementing potential benefits and associated costs to an animal identification system. The main drivers and benefits include animal disease control, food safety and bio-security and market preservation and market development.

In the USA, the benefits and costs of National Animal Identification System (NAIS) was analysed across multiple species and at varying participation rates. The benefits and costs for producers with various herd sizes and also for markets, processors, consumers, and State and Federal governments based on the best data available and the most accurate modelling practices were also examined. The studies established that the implementation of NAIS would lead to significant savings in connection with the administration of animal disease control and eradication programs. The economic benefits in both the domestic and international marketplace resulting from enhanced traceability were found to be greater than the cost savings realized during animal disease control and eradication efforts. For industry, the effect of not implementing some aspects of NAIS (maintaining status quo) would result in significant losses as great as US$ 1.32 billion on average per year over a 10-year period due mostly to reduced export market access. The implementation of NAIS became more cost effective as participation levels increased.

Estimated tag and tagging costs varied among cattle producers with 50 head from US$ 3.30 to US$ 5.22 per cow, depending on the identification practices. A full traceability program added an estimated average of US$ 5.97 per head to the cost of cattle marketed. The total cost for implementing NAIS in the cattle sector was approximately US$ 200 million annually (at a 90 percent participation level). It was noted that within the cattle sector, producers' management practices had sizable impact on their cost of adopting an animal ID system and that smaller operations were likely to be slower to adopt identification systems because they incur higher per unit costs (NAIS Benefit Cost Research Team, 2009).

Trautman *et al.* (2008) provided an overview of the economic usefulness of improved animal identification and traceability systems in the United States. The benefit cost analysis of RFID traceability systems have been done for mineral water (Chryssochoidis *et al.*, 2009) and also in cattle of developed countries (Pouliot, 2008). While establishing traceability systems, costs have been categorised either as; start-up costs (hardware, software, systems engineering and training); or running costs that include tags, system upgrades, cost of record keeping, product differentiation and certification (Golan *et al.*, 2005; Trautman, *et al.*, 2008).

Even after traceability system has been found to be economically viable, it ought to operate under specific institutional and organisational environment. This involves a clear understanding of what this entails and the specific responsibilities ascribed to the competent authority as well as workable policies under which the implemented system would operate. These issues are reviewed next.

2.4 Institutional and organisational requirements for LITS

The words 'institution' and 'organization' have been used interchangeably in literature. However, new institutional economics describes institutions as "rules of the game" and organizations as "the players" (North, 1993).

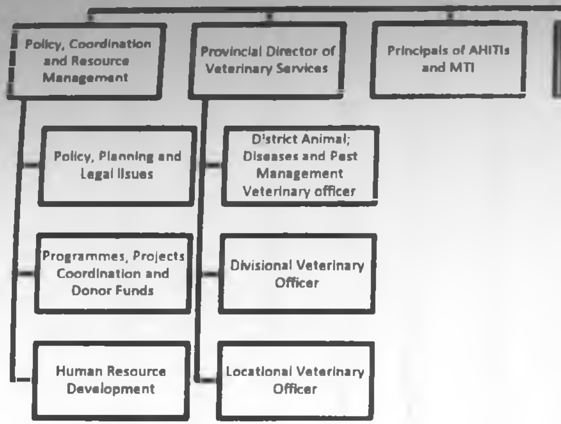
Institutions exhibit both a formal nature (constitutions, rules, regulations, laws, rights among other or among others?) and an informal nature (sanctions, customs, mores, traditions, among others.). North (1991) characterized them as determined by society and governing social, political, cultural and economic exchanges and interactions. They are used to define the range of choices, regulate risk and uncertainty, determine transaction and production costs, hence the feasibility and profitability of engaging in economic activity; they evolve incrementally, linking the past with the present and future; and provide the incentive structure of an economy and set the tone of societal development. Institutions also determine the growth path (social, economic, political, technological and cultural) of society as well as distribution of benefits, access to resources and power. An enabling institutional environment plays a central role in economic development by reducing transaction costs and risk, and thus promoting trade and specialization – the prerequisites for growth (North, 1990).

Organizations on the other hand, refer to a group or association, formal or informal, in which there are defined and accepted roles, positions and responsibilities structured in some relationship to each other in order to achieve a specific objective(s). They exist to secure and advance the interests of their members within the existing institutional framework, while constantly seeking to influence that framework so as to achieve greater advantages and benefits (North, 1993).

Institutions and organizations are closely interlinked. Institutions set the context and framework within which organizations operate. The quality and extent of outcomes or services that organizations can provide to their members or users/clients is greatly dependent upon the incentives, opportunities and resources that the institutional framework provides. Organizations, in turn, also influence policies and priorities of the government, either directly (lobbying, commissioning of studies, non-cooperation, publicity campaigns among others) or through their members/service use. What are the formal and informal institutional factors that affect the sectors the project cuts across and how do these in turn impact the project? To effect policy changes and arrive at desired outcomes, it is important to understand the institutional and organizational landscape in order to identify 'policy and organizational spaces', devise acceptable and effective ways of proceeding, access local resources, secure allies and ensure local commitment to change. The landscape consists of actors and their interests, networks and relationships, instruments and mechanisms of change and resistance, dominant cultural values, existing incentives and 'dampers' (North, 1990). Even if LITS is viable, it must operated under specific institutional and organisational environment. Furthermore, it requires workable policies under which the system would operate as well as a clear delineation of the specific responsibilities ascribed to the competent authority.

At the time of the study, the Branding of Stock Act CAP 357 was the primer law dealing with livestock identification. It was found to be restrictive and not responsive to the application of contemporary identifiers such as RFID. It was being implemented through the Department of Veterinary Services as the competent authority. The department comprised of nine (9) divisions with mandate over disease surveillance as well as certification for purpose of export; formulation, implementation and monitoring of veterinary service policies. In 2006, the Brand registry and office of the registrar were revived.

Figure 2.2 shows the organogram for the Department of Veterinary Services (GoK, 2008).



2.2: Organogram of the Department of Veterinary Services


Director of Veterinary Services
Animal Diseases and Pest Management
Hides, Skins and Leather development and Enviromental Management
Diagnostic Services, Quality Assurance and Bio-Safety
Extension services and Animal welfare
Livestock marketing, Quarantines and Holding Grounds
Slaughterhouses and Meat Processing
Quality assurance and Bio-safety
Extension Services and Research Liaison
Epidimio Services and Livestock Economics
Other Food Animals
National Food and Mouth Laboratory
Animal Breeding
Epizootic and Zoonotic Diseases
Central VIL Kabete
Animal Welfare and Nutrition
Vector Control
Veterinary Farms and Laboratory Animals Services
Veterinary Inspectorate
Diagnostics Services
Regional Veterinary Laboratories
Satellite Veterinary Laboratories

2.5 Global patterns and experiences with traceability systems in the world

Traceability systems have been successfully used in a number of places including the EU, USA, Japan, Australia, Brazil, Uruguay, Argentina and Canada. Four patterns of adoption have evolved. These include: 1). mandatory systems in response to consumer concerns such as EU and Japan; 2). mandatory traceability to maintain or enhance export market shares such as Australia, Brazil, and Argentina; 3). industry managed mandatory programs for animal identification (Canada); and, 4). voluntary systems in the USA (Souza-Monteiro and Caswell, 2004; Schwägele, 2005; Hobbs *et al.*, 2007).

African countries, while not being front runners in the global beef trade, have made substantial progress in establishing traceability systems. These countries provided the best examples while preparing a model for Kenya.

2.5.1 Livestock identification and traceability frameworks in Africa

Most support for Africa in the development of traceability protocols have been provided by the EU. The support has been meant to ensure compliance with preferential access and market entry requirements by Botswana, Namibia and Republic of South Africa (RSA). These countries are recognised as models of successful export-market-led livestock traceability systems in Africa to European markets[5] (Halderman and Nelson, 2005). Rudimentary traceability systems may exist in other countries.

2.5.1.1 Botswana

From 2000, Botswana Ministry of Agriculture (http://www.gov.bw) through the Department of Animal Health and Production has administrated a large-scale RFID based Livestock

[5] The region used to be a net exporter of livestock and livestock products to the European Unionmarket up to the 1980's but,has since lost accessibility notwithstanding the assured Lome II export quotas from the Africa Caribbean and Pacific (ACP) Nations.

Identification and Traceback System. This was done with support from Aleis International of Australia (www.aleis.com/aboutus.htm). The primary purpose has been compliance with the regulatory requirements for accessing the beef markets of the European Union. The system involves individual animal identification as well as whole life traceability using the rumen boluses. Livestock data is stored within a central database. In addition, the country has delineated several disease free zones with strict disease surveillance and livestock cordons as buffers.

The Botswana government has enacted supportive legislation that requires all cattle to be electronically identified before being slaughtered or sold to any other party (Stevens *et al.*, 2005). Boneless meat for export has been processed through the Botswana Meat Commission[6] (BMC) (http://www.alliedmeats.com/bmc1.htm). However, the investment and operating costs of this particular model are high. RFID tags similar to those used in Botswana are the ones whose applications were pilot tested in North-eastern Kenya.

2.5.1.2 Namibia and South Africa

Farm Assured Namibia (FAN) has been implementing an ear-tag based scheme for identifying and tracing cattle destined for export. The purpose has been to guarantee animal welfare and veterinary standards from producer level to export (Paskin, 2003; Bowles *et al.*, 2005). The scheme enforces the use of electronic movement permits linked into a central server (Meat Board of Namibia, 2003). Other enforcement tools included hot iron branding and a strict veterinary Cordon (red line) that separates the country into infected and uninfected parts. By implementing livestock traceability, the country has become the largest exporter of

[6] BMC established in 1965 has been responsible for the exportation of deboned meat to the EU. Around 2006, increase of prices paid to producers as well as an outbreak of Foot and Mouth Disease led to financial problems and significantly setback the meat export industry.

beef from Africa to the United Kingdom (UK) and an important supplier to the EU (Toto, 2009).

The South African traceability system closely mirrors that of Namibia in that they use RFID ear tags. The exception is that they use satellites to track the animals.

2.5.1 3 Tanzania

The Tanzanian government at the time of the study had established a division responsible for traceability and prepared a livestock traceability policy statements and law (LIRTRA No 12 of 2010) on LITS. This policy statement is in line with Article 7 of the OIE 2010 Terrestrial Animal Health Code Appendix 3.5.1 (OIE, 2010). Plans were for the implementation of a computerised registration and monitoring of livestock from birth to slaughter using plastic ear tags and bar coding of meat products. The purpose of traceability was to protect public health and safety and assist in disease control in animals and animal products, help small and medium enterprises that have invested extensively in livestock by-products to gain access to international markets.

2.5.1.4 Kenya

In Kenya, the identification of livestock, registration of stock and brands has been done under the Branding of Stocks Act– CAP 357. This law enacted on 12th December 1907, established the office of Registrar of Brands in the Department of Veterinary Services. It prescribes the manner, in which both the registrar and inspectors of brands were gazetted, procedures for application of and transfer of or brands and cattle. In addition to the national brand, individuals or a group of persons such as auctioneers, local authorities, butcheries were capable of brand registration. An example of the livestock brand in use within the country included three components, thus Country mark- (K) for Kenya, District brand marks (H) and Location mark (a number like 12).

Kenya has had no systematic way of tracing livestock. Keeping records of livestock movement was hitherto on paper a largely ineffective means of record keeping. In pastoral production systems that produce 67% of the beef marketed in Kenya. The hot iron brand remains the main form of identification for livestock. Between the 1970's and 2007, branding has not been properly enforced, with less than 4% coverage.

Branding of stocks has been constrained by the credibility of the certification process since it has not been possible to trace the movement of individual cattle backwards, nor track them forward (AU-IBAR and NEPDP, 2006). This study was meant to address the limitations of record keeping and recommend both institutional and organisational framework that would support the process of implementation.

Most of the cattle sold in Garissa were directly trucked for slaughter within the major towns of Mombasa and Nairobi. However, about one third were trekked to the coastal ranches for fattening, domestic sales and export. This group could most likely help in the spread of trans-boundary diseases or subject of rustling/theft during movement and since they have been the source of export cattle were of interest to this study.

2.6 Other issues pertinent to implementation of LITS

2.6.1 The coastal livestock marketing chain

In 2007, the national cattle herd was estimated at about 12,900,300 of which nearly 9 million were reared for beef (FAOSTAT, 2008). The largest beef livestock marketing chain originates from North-Eastern Kenya and provides cattle that enter ranches located within the coastal areas. North-Eastern Kenya has an estimated 67% of the national beef herd either exported or slaughtered within the export standard abattoirs (Wanyoike and Rich, 2008; AU-IBAR and NEPDP, 2006). Figure 2.3 describes the marketing chain originating from Southern Somalia North-eastern Kenya and the subsequent movement of beef cattle to either the slaughterhouse or export port (Wanyoike and Rich, 2008).

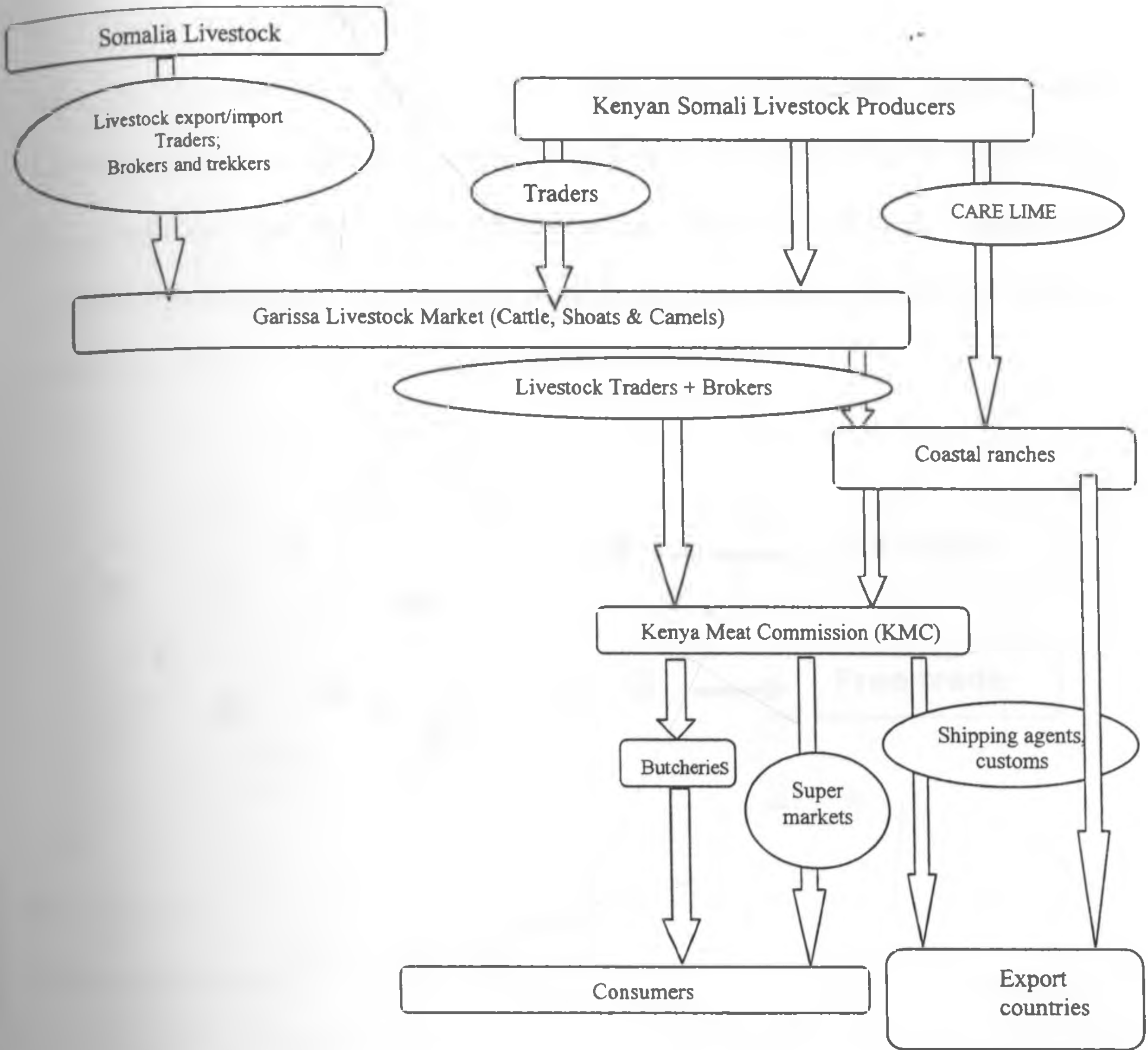
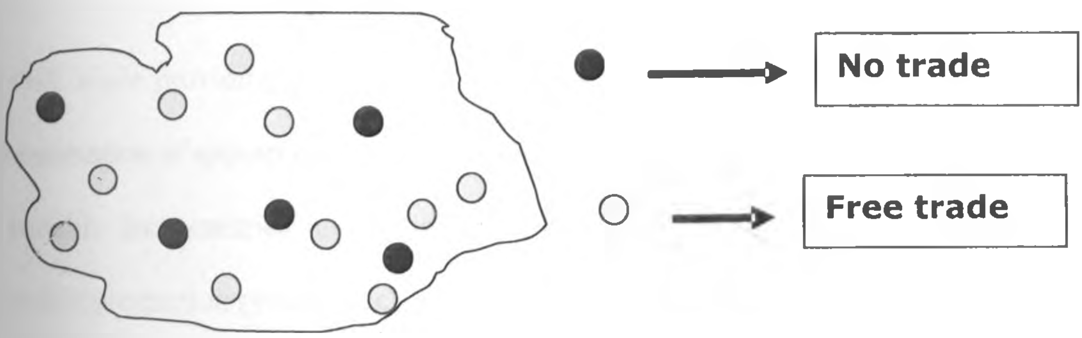


Figure 2.3: The livestock value chain Garissa – coastal ranches (Wanyoike and Rich, 2008)

In Kenya large swathes are prone to endemic diseases. For developing economies like Kenya, the concept of compartmentalisation was first established as a viable option for export in 2006 and as an alternative to zonation by the OIE. The concept of compartmentalisation implies animals are subject to specific bio-security measures by the private sector. However, compartments must be operated under close supervision and accreditation of the official veterinary service.

2.7 Use of compartments

Along the Garissa-Coastal trekking route, cattle were moved under specific mobile compartments that recognised animal populations could have different health status, based on management and bio-security (Scotts *et al.*, 2006). The basic principle of compartmentalisation has been that exports would be possible if the risk is below a certain level (Figure 2.4).



Key

● Infected herd

○ Non-infected herd

Figure 2.4: Diagram illustrating export from a compartment

CHAPTER 3: DESIGN OF AN ELECTRONIC IDENTIFICATION AND TRACEABILITY SYSTEM

3.1 Introduction

Global concerns on the spread of animal diseases, protection of human health and consumer preference has necessitated development of livestock identification and traceability systems for beef markets (Souza-Monteiro and Caswell, 2004). The purpose of such systems is to offer quality assurance and facilitate access to premium meat markets (Smith *et al.*, 2005).

The OIE while providing guidelines of key factors to be considered in the identification and implementation of appropriate traceability models, it is yet to indicate the formal requirements for suitable for countries and regions that have populations practicing various forms of pastoralist production systems such as transhumance and nomadism (OIE, 2009[7]; 2010).

The OIE stipulates that the design of such traceability systems must take an integrated approach not only tracing livestock products from the plate back to the animal of origin, but to cover all the related processes, as well as analyse all the information required to meet specific objectives, such as the prevention of disease, the acquisition of health certificates amongst others (Barcos, 2001). Overall, such systems should conform to international standards, define the objectives, scope of the system and organizational arrangements (consistent with geographical, environmental and cultural considerations), and specify choice of technologies used for registration. The system should also delineate the obligations of the parties; guarantee confidentiality and offer procedures for access and exchange of information (OIE, 2010).

[7] Available : http://www.oie.int/eng/traceability-2009/documents.html

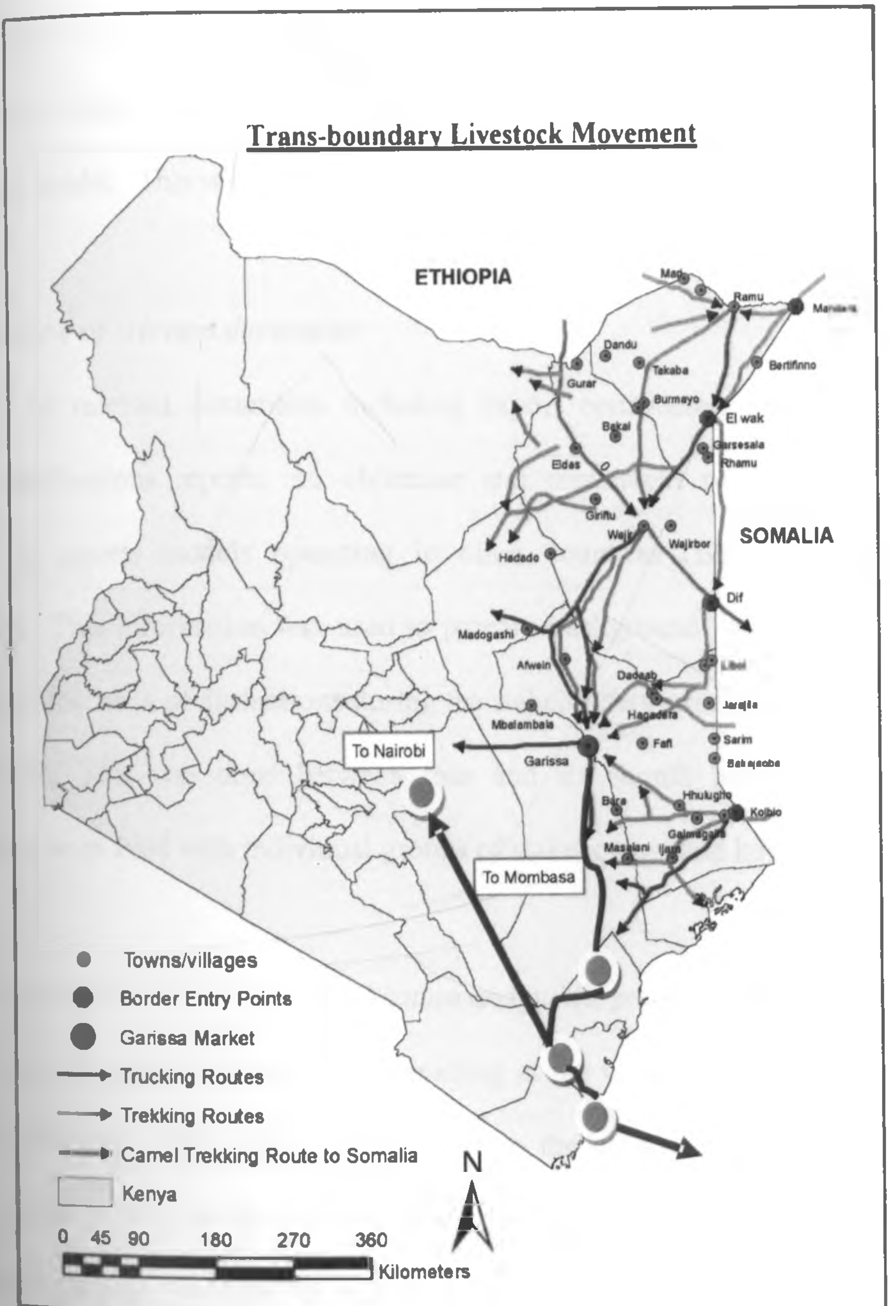
In addition, traceability systems developed for third world countries ought to be of low cost, simple and phased in implementation. The models should also be guided by the outcomes of disease risk assessments, the animal and public health situation and related programmes, population parameters (species, breed, numbers, distribution types of production and animal movement patterns), benefit-cost analysis and other economic considerations (OIE, 2010).

This chapter describes the preliminary steps that led to the design and choice of the traceability system used in identifying and tracing beef cattle in pastoral production systems of Kenya.

3.2 Materials and methods

3.2.1 Selection of study sites

The study was implemented along the cattle marketing chain from North-Eastern to the Coast in Kenya comprising of Garissa livestock market, Chakama Ranch in Malindi District, Taru Ranch in Taita District, Mombasa export terminus and Kenya Meat Commission (KMC) in Athi River (Figure 3.1). The area, which was predetermined by the funding agent, was the tail-end of the marketing chain with pastoral livestock originating from North-Eastern Kenya and Central and Southern Somalia, coalescing in the Garissa Market. On average 1,000 heads of cattle were sold in the market and trekked to the Coast during the weekly formal auction.



Source: Adapted from Provincial Director of Veterinary Services, North Eastern Province Livestock Movement Map.
By: Improvement and Diversification of Somali Livestock Trade and Marketing (Terra Nuova/ILRI)

Figure 3.1: Selected study sites in Kenya as part of the Trans-boundary livestock movement route.

3.2.2 Study design

Since the site was already predetermined by the funding agent, it was important to harness the knowledge of relevant stakeholders (Public and private) in designing a suitable RFID based traceability model. This was accomplished through the following steps:

3 2.2.1 Review of relevant documents

A review of relevant documents including export certificates, livestock surveillance and disease notifications reports, no objection and movement permits, laboratory and OIE notification reports models operating in other countries (Botswana and Namibia) was conducted. This information was used to prepare background papers and guiding principles that formed the basis of discussions during the stakeholders' workshop and during community mobilization This was done between four and six month period. During same period, discussions were hold with individual groups of stakeholders and key informants.

3.2.2.2 Stakeholder awareness, mobilisation and public private dialogue

The unique circumstances that were prevailing at the time of the study were an outbreak of RVF in November 2006 /early 2007 that led to the closure of the Garissa market for over three months as well as the a study tour organised by AU-IBAR to apprise and acquaint export traders with livestock identification and traceability in Botswana, implied that the trader associations were already sensitized on the need for such a system.

Over a duration of four months, the stakeholders were systematically mobilised by creating awareness of the proposed study, encourage participation, assess Capacity (ability to act) and capability (the knowledge of how to act) and to consult on the process of integrating LITS into the local market economy. Specific actors such as the provincial administration, Minister, assistant Minister and Permanent Secretary of Livestock Development, Director of Veterinary Services. AU-IBAR staff, municipality and county council officials, KLMC and LTMSK officials and community opinion leaders were contacted and stakeholder dialogue initiated.

3.2.2.3 Stakeholder workshop

Garissa, which was the main entry-point for developing a model for LITS to stakeholders including the veterinary and animal production departments, provincial administration, political leaders, the traders' association and their officials, was the site selected for participatory stakeholders' workshop. During the two-day workshop, the background, justification, importance and the process of implementing a livestock traceability system was carefully laid out to enable the participants to make informed decisions. The participants were introduced to the available RFID technologies and different approaches that could be used to model a system for the selected livestock marketing chain. The investigator thus presented in more detail the proposed steps in implementing the study thus, the need for traceability requirements analysis, the strategy workshops, systems design, testing and deployment.

During the workshop, the participants undertook the following activities: first, leaders of the two trader associations who had visited Botswana and practically experienced the success with RFID were able to guide the stakeholders in selecting the RFID tools to be tested in the Kenyan traceability model; second, identify key stakeholders to be involved in the traceability system; third, assign roles and identify key responsibilities for implementing the system; and fourth, assist in developing a study implementation plan. Afterwards the stakeholders who participated in the development of the traceability model were identified. Finally, the traceable information requirements of each stakeholder were established through a comprehensive needs analysis.

3.2.2.4 Analysis of stakeholders traceability requirements

A combination of key informant interviews, focus group discussions and expert opinions were used to determine the needs of the stakeholders starting from the headquarters (centre) and ending up at the peripheral district level (Appendix I). This process was implemented over a two month period. One spent on data gathering and a second on analysis and interpretation of the information collected. The information gathered during stakeholder needs analysis was consolidated into a Statement of User Requirements (SOUR). The traceability requirements (needs analysis) for each stakeholder were used to show the critical data required for the identification of individual cattle (Appendix II).

The stakeholders consulted during the needs analysis included the Ministry of Livestock Development (Veterinary and Animal Production Departments); African Union Inter-African Bureau of Animal Resources (AU-IBAR); Trader Associations (Kenya Livestock Marketing Council (KLMC) and Livestock Traders Marketing Society of Kenya (LTMS-K); Kenya Meat Commission (KMC); and Aridlands Information Network (ALIN). This process took a total of one month.

3.2.2.5 Strategy meeting

A strategy planning meeting was subsequently held over a two day period with senior technical experts (Subject Matter Specialists) at the Department of Veterinary Services headquarters in Kabete, after the completion of the needs assessment. The purpose of the meeting was to refine the outputs of the needs analysis and develop an implementation plan or the operational blueprint upon which the design and implementation of LITS was to be based. The business/organizational processes in LITS were also benchmarked (aligned) against international best-practices.

Taking cognisance of sustainability; the socio-economic status and expected level of user involvement, the functional objectives, scope (species of animals, the *depth* and detail of data), the part of the country selected for the trial of LITS, performance criteria, desired outcomes, type of identifiers and the characteristics of the proposed system were defined. In addition, choice was made as to whether or not it was possible or beneficial to integrate LITS into exiting databases. The procedures for audit and how to develop and enforce SOP's were also defined.

3.2.2.6 Procurement of goods and services

(a) Identification and selection of vendors

After the needs analysis and design of the model, a list of suitable RFID vendors was obtained and a suitable vendor selected to supply the equipment (Appendix II).

(b) System design and development

This was aimed at procuring a system that was standardized and tested in order to ensure its recognition by external markets. Briefly, system design entailed a detailed architectural set-up, configuration and customization of content management software into relevant modules. Over a period of four months, a comprehensive listing of data items and types used in the transfer of data between parties involved in the project was carried out using software engineering tool. This data model comprised a listing of all relevant entities (animals, people and equipment), defined and codified the attributes of each entity (breed, vet, traders and mode of transport) and defined the relationships between all of the entities. For each entity, the list of attributes and a description of each attribute was included.

Subsequently, data dictionary containing all necessary data to be recorded and registered in the database with codification and format (numeric, alphanumeric, length, address and ISO codification) was constructed. Wherever possible the existing data dictionaries were adopted.

With assistance of a software development company, the data was transformed into prototype LITS user modules thus registration, health, receive, dispatch, sales, slaughter and export. Mini-field-tests interspaced by user acceptance test sessions were used to guide the process of design.

3.3 Results

This consultative meeting with stakeholders provided a mechanism for closing the between service providers and the other stakeholders as well as provide opportunity for constructive dialogue and the establishment of a working relationship amongst the actors.

3.3.1 Results of the stakeholders workshop

3.3.1.1 RFID technologies selected

The stakeholders opted that both RFID ear button tags and rumen boluses be tried in Kenya. Need for comparison of the two technologies warranted technical evaluation at field level.

3.3.1.2 Organisational mapping (stakeholders and their role at implementation)

The roles of the key stakeholders during implementation of the study were established (Table 3.1).

Table 3.1 Roles of the key stakeholders in the implementation of LITS

Stakeholder	Role in LITS
Department of Veterinary Services Headquarters	– Control/custodian of the central data base; – Validation and verification of market data; – Engineering policy change to the branding of Stock Act; – Provision of access to market infrastructure; – Provision of required human resource; – Explore opportunities to expand traceability to the rest of Kenya; – Provision of livestock IDs (registrar of brands); – Ensuring compliance with veterinary procedures; – Sensitisation and awareness to the community; – Recovery and recycling of rumen bolus from slaughterhouse.

Department of Veterinary Services District level	– Recruitment and registration of traders; – Compliance with market related veterinary procedures; ▪ Movement permit. ▪ Physical mouthing of animals for FMD. ▪ Serological testing for CBPP (P-1). ▪ Hot iron branding. – Application of ear tags and RFID devices to consigned cattle; and – Collection, entry, validation and verification of market data; – Uploading of file and transferring of the information to the local database and subsequently to the central data base.
Livestock Production Department	– Promote policy change – Sensitisation and awareness
AU-IBAR	– Cross-border policy harmonisation, dialogue and information exchange – Audit of the traceability system – Explore possibility of up-scaling the system regionally (IGAD, COMESA)

3.3.2 Results of stakeholder traceability requirements

The information gathered during stakeholder needs analysis was transformed into SOUR. This included information such as: Unique electronic identification number or code for individual cattle; Individual animal details (breed, age, sex and coat colour); Herd-of-origin identification (the market/ranch/province where the animal originated); Owners Legally Registered Brand Mark or code, if any; Lot identification (when animals are in separate groups normally by trader identification); Transaction identification (showing the date of identification and country + district + location, brand marks or codes and their locality on the skin); Identification of establishments thus, by zone or compartment or district + division + locality and registration number and code of owner's residential premises and Identification of all areas in which the animal transits from sale to slaughter or export.

Stakeholders were also required to provide market supply chain information such as; Livestock trade data (price, owners name, provenance); Owner details (name, identity card number, address and telephone as well as legally Registered Brand Mark or code, if any); Trade market activity (change of ownership and date when this occurred); Route which the trekked animals followed; and above all, trader information data such as name, telephone, identity card number and membership of trader association.

Other requirements were in regard to change of animal ownership by: First ownership mark [as letter F], First transferred ownership mark [as letters FT], Second transferred ownership mark [ST] and Date of transfer.

Stakeholders had to also provide animal health information such as; Animal production/ husbandry, systems (nomadism, pastoralist and agro-pastoralist systems); OIE designated status (such as disease free with vaccination zone and regime, no vaccination zone); Certification procedures showing early response and disease notification mechanisms; animal movement controls, such as. permits, origin, route, destination, purpose; animals inspection procedures and results such as tests for microbial load, residues, growth hormones and other prohibited substances, heavy metal contaminants); Fair practices in trade and Utilization of inputs (such as veterinary drugs, feeds and pesticides) at farm level. Other animal health information was in regard to disease incidence/prevalence reporting (surveillance for specified disease and regime, such as. FMD, Rinderpest, RVF, CBPP and BSE); Disease control measures (vaccination, isolation and quarantine reports) and finally Consolidated trend reports.

The LITS designed was to be public sector driven and mandatory in application for all beef cattle in Kenya and with strong private sector involvement.

3.3.3 The traceability blueprint

The strategy meeting with Subject Matter Specialists was able to refine the proposed blue print to reflect the following: a mandatory and electronic LITS system as the design of choice. This system was to be operated at two levels thus; a comprehensive central level as well as distributed database with datasets enabling more efficient Capacity for uploading, management, storage, retrieval and access to key data of interest such as surveillance and trend monitoring to those involved in the livestock industry in user-friendly interfaces (drop down menu) to the system and processes that minimised the administrative burden placed on end-users. Concurrently, SOPs were to be availed that clearly defined the data to be collected and implement quality standards and business rules that support in-built processes for validation of data for accuracy, for completeness and precision to enable easier and more efficient data management.

Since the Department of Veterinary Services has a requirement to report to the OIE, it was imperative credible data sources and information pertinent to these reports were incorporated and effectively protected in the event of system failures. Moreover, the privacy and confidentiality of individual information needed to be protected, while simultaneously availing the information to be used for defined purposes. Ultimately, the implementation of LITS was meant to facilitate rather than constrain the movement, processing or sale of animals, provide appropriate archival facility to enable historical searches; flexibility to cover individual animals and/or groups of animals (dependent on risks for individual livestock species); and, allow for the incorporation of additional functionality. The following elements of the trial were also established;

Definition for traceability chosen for Kenya

From the list of definitions the On-trace (2007) definition was preferred and adopted by the Department of Veterinary Services.[8]

Scope

The initial species selected for consideration was cattle at individual animal level; however, the framework designed was flexible enough to encompass other livestock species. It suggested 1) mandatory use of radio-frequency microchips (bolus and ear buttons) tags to track traded cattle on the basis of user acceptance and cost-effectiveness; 2) monitoring of cattle from the secondary markets in pastoral areas each time they are sold or moved through various inspections and manipulations to the abattoir or exit port if being exported; and 3) area of choice was selected as North-Eastern Kenya and the Coast through which cattle for export were grazed.

[8] On Trace (2007) defines traceability as "the ability to locate an animal, commodity, food product or ingredient and follow its history in the supply chain forward (from source to consumer) or backward (from consumer to source)."

Drivers for implementation of animal identification and traceability systems

Identification and traceability of animals was designed to provide data to meet any agreed requirements such as; 1) To ascertain origin and ownership, and to deter livestock related insecurities such as cattle rustling and misrepresentation of animals and meat; 2) Use in disease surveillance in order to minimise the spread of trans-boundary animal diseases and; 3) Improve external market access through exports.

For the traceability to work effectively, the LITS system ought to accept the unique identifying number (RFID tag) that is applied to each individual cattle. Subsequently, the unique number was correctly linked to the individual animal's details like age, weight, breed, sex, commercial grades, vaccination status, treatments, location for secondary market and ownership. The localized databases in participating districts were to be synchronised remotely to enable transfer and sharing of data and reports with the central server located at the headquarters of the Department of Veterinary Services- Kabete via Global System for Mobile Communications (GSM) "Virtual Private Network" data connectivity.

Limited data was disseminated locally; however, comprehensive and consolidated data and reports were to be available at the headquarters. The information within the central database was to be shared through summary tables or reports formats with key stakeholders such as OIE, AU-IBAR, KLMC and LTMS-K as appropriate. Through an E-Delivery system (Web Wireless Application Protocol (WAP), Short Message Service (SMS), Email, Really Simple Syndication (RSS) Feeds), the central database/website was to be accessible to all relevant stakeholders.

3.3.4 System design and development

The system design process took approximately ten (10) working days for the software solution, database, screens and reports. It involved applying a clearly defined and phased approach to implementation. System development (LITS HQ and LITS district modules) was done by Virtual City according to specifications provided by the investigator, over a period of one-month. During the entire process of development, the modules underwent rigorous quality assurance testing in order to ensure their functionality was perfected and adhered to standards of software development.

The pilot system was established to operate on a 'mainframe-software-architecture' hosted on the web; thus users interact with the host through the Internet. The system was developed with the backend database thus the server operating on SQL server 2005 SP2, for the head office, while the clients' remote databases operated on Sybase 10 version 3722. The front-end applications were established on Microsoft.Net 2.0 platform with the headquarters application on ASP.Net 2.0, while the client application on Windows.net 2.0. The programming language used was C#2. Crystal software was used for simple cross tabulations and queries.

Transfer of remote data was done on a General Packet Radio Service (GPRS) modem from both Safaricom Company Limited and Zain Company Limited as Internet Service Providers (ISP). A system user manual was developed to assist the end users address minor errors whereas the major issues were referred to the software development company for assistance. The investigator supported the process of software design by a software specialist knowledgeable in the development of software infrastructure and architecture.

3.3.4.2 Features of the LITS system

The information collected during LITS application was consolidated into easy to use drop down menus in the windows application. Clicking upon each icon would enable the user to access detailed information regarding the particular module and enter the corresponding data regarding the particular subject matter within the system.

Each window had administrative features through which information entered at field level could have been verified or edited by the super user (administrator) at the headquarters.

3.3.4.3 Features of the district module

The district module has seven functional modules. These include the animal registration, animal health, dispatch, receipt, sales, slaughterhouses and export modules. These modules are accessed through the log-in page. After entry of the corresponding data, the information was uploaded to the central database by synchronisation. Figure 3.2 shows the animal health module. This window allows the user to report on the procedures (health tests, examinations, manipulation, vaccinations and treatment) carried out by the veterinary officers.

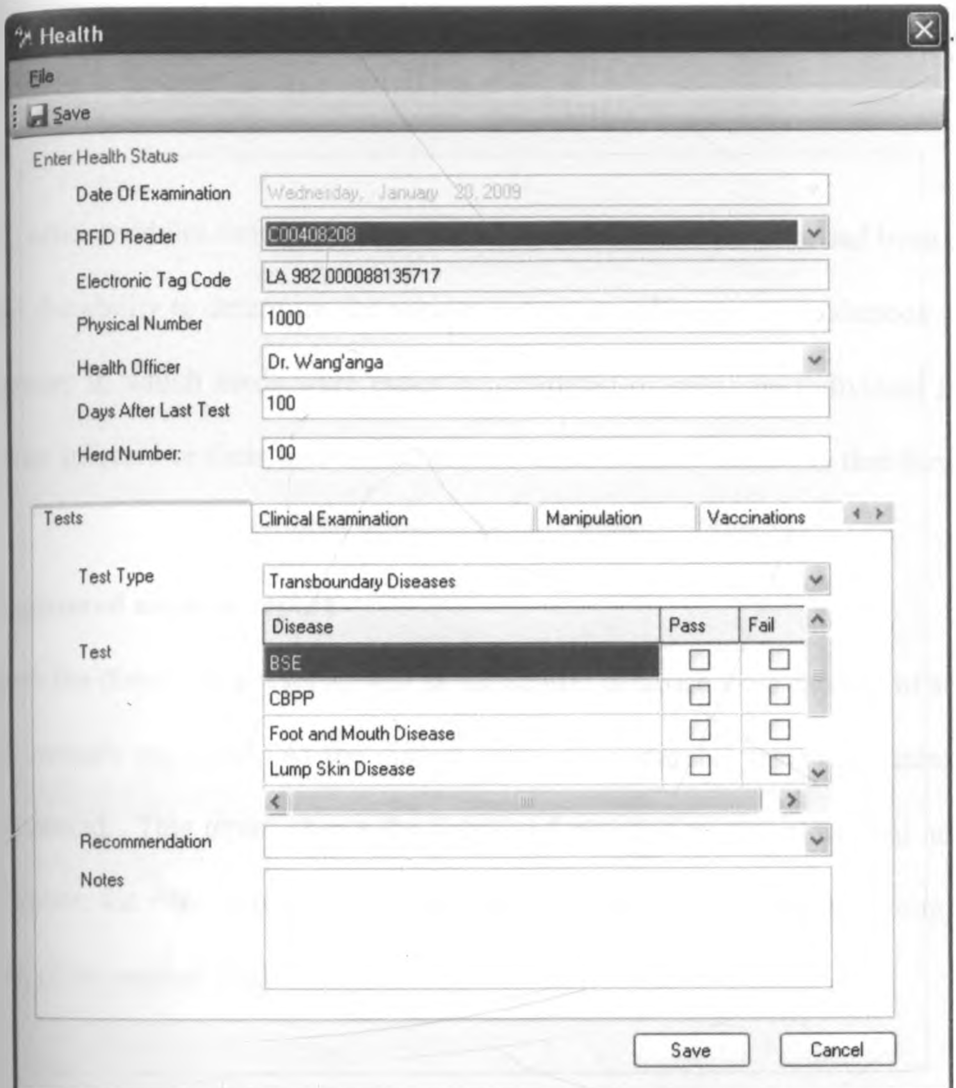


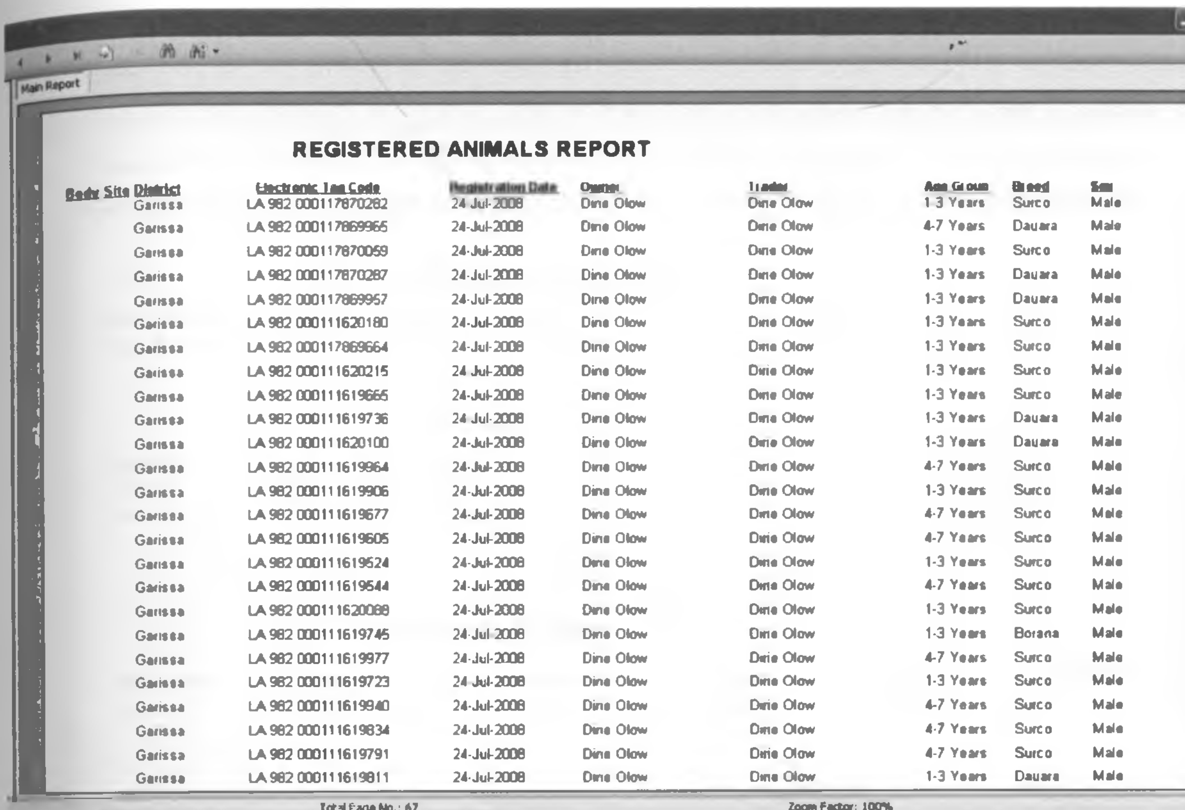
Figure 3.2: Animal health window

Simple drop down menus opened to the various categories of health tests that were to be performed. Under each specific category, the health officer was able to mark (checked) the specific system of the animal examined such as integumentary system. The health module also reported on the manipulations performed on each individual animal such as hot iron branding. Based on the results of the actual test, the health officer then checked (ticked) in the appropriate box his judgement on whether the animal passed or failed. The animal was then treated using drugs or vaccines, condemned (for immediate slaughter or destruction) or released to proceed into the coastal zone.

All other modules functioned in a similar manner. Once the data had been collected the LITS had the ability to determine the various veterinary officers who undertook particular tests, the manner in which herds were either consolidated or split, the individual number of animals either infected or clean and the durations and individual treatments that they had received.

Registered animals report

Both the district databases as well as the central database were capable of summarising the list of animals registered. At the district level, a comparable registered animal report could be generated. This report shows the district of registration, the individual animal identification number, the date of registration, the owner of the animals, the age group, the breed and the sex of the animal (Figure 3.3).



REGISTERED ANIMALS REPORT

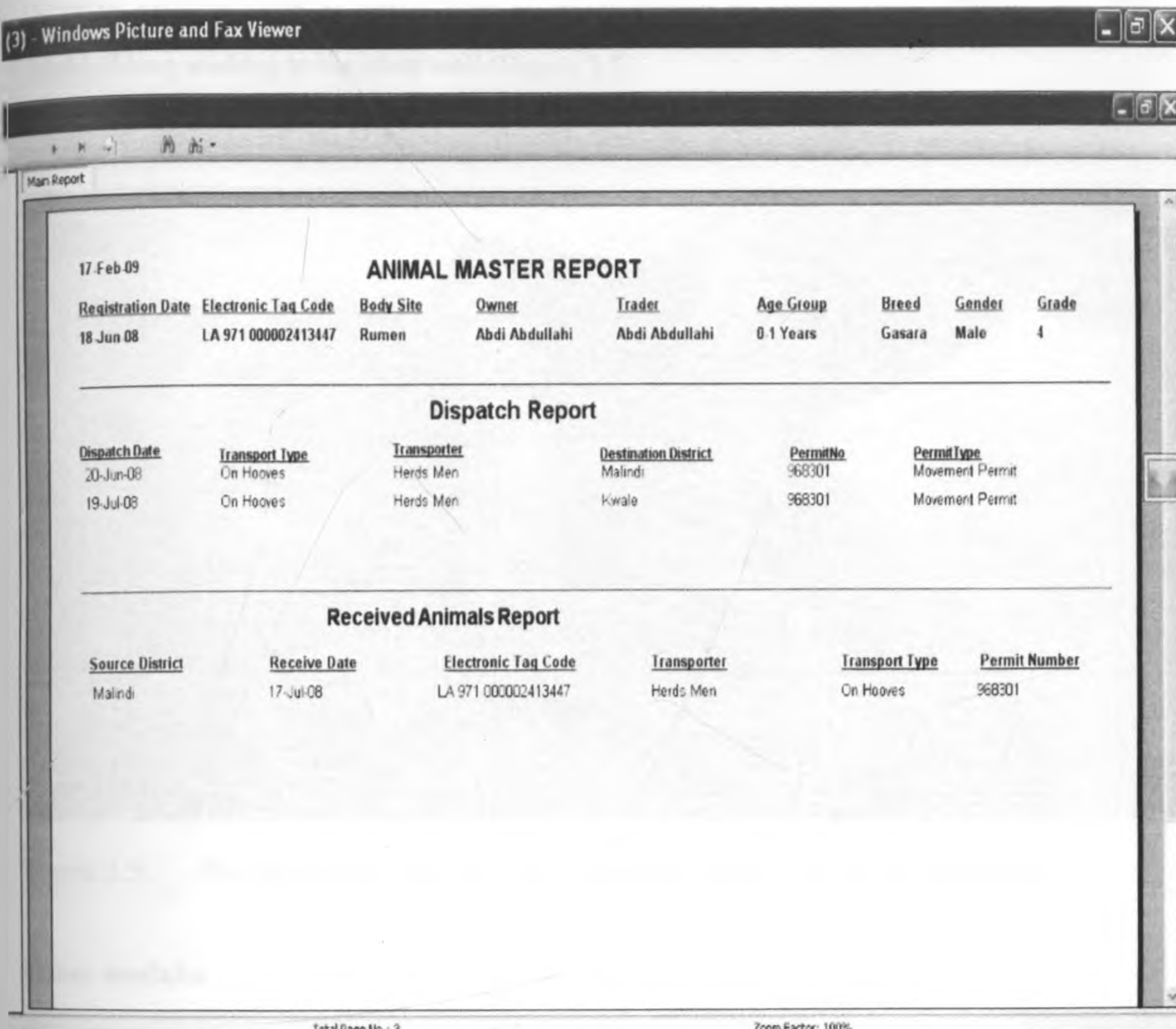
Body Site District	Electronic Tag Code	Registration Date	Owner	Trader	Age Group	Breed	Sex
Garissa	LA 982 000117870282	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Surco	Male
Garissa	LA 982 000117869965	24-Jul-2008	Dine Olow	Dine Olow	4-7 Years	Dauara	Male
Garissa	LA 982 000117870059	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Surco	Male
Garissa	LA 982 000117870287	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Dauara	Male
Garissa	LA 982 000117869957	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Dauara	Male
Garissa	LA 982 000111620180	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Surco	Male
Garissa	LA 982 000117869664	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Surco	Male
Garissa	LA 982 000111620215	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Surco	Male
Garissa	LA 982 000111619665	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Surco	Male
Garissa	LA 982 000111619736	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Dauara	Male
Garissa	LA 982 000111620100	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Dauara	Male
Garissa	LA 982 000111619964	24-Jul-2008	Dine Olow	Dine Olow	4-7 Years	Surco	Male
Garissa	LA 982 000111619906	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Surco	Male
Garissa	LA 982 000111619677	24-Jul-2008	Dine Olow	Dine Olow	4-7 Years	Surco	Male
Garissa	LA 982 000111619605	24-Jul-2008	Dine Olow	Dine Olow	4-7 Years	Surco	Male
Garissa	LA 982 000111619524	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Surco	Male
Garissa	LA 982 000111619544	24-Jul-2008	Dine Olow	Dine Olow	4-7 Years	Surco	Male
Garissa	LA 982 000111620088	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Surco	Male
Garissa	LA 982 000111619745	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Borana	Male
Garissa	LA 982 000111619977	24-Jul-2008	Dine Olow	Dine Olow	4-7 Years	Surco	Male
Garissa	LA 982 000111619723	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Surco	Male
Garissa	LA 982 000111619940	24-Jul-2008	Dine Olow	Dine Olow	4-7 Years	Surco	Male
Garissa	LA 982 000111619834	24-Jul-2008	Dine Olow	Dine Olow	4-7 Years	Surco	Male
Garissa	LA 982 000111619791	24-Jul-2008	Dine Olow	Dine Olow	4-7 Years	Surco	Male
Garissa	LA 982 000111619811	24-Jul-2008	Dine Olow	Dine Olow	1-3 Years	Dauara	Male

Total Page No.: 67 Zoom Factor: 100%

Figure 3.3: Registered animal report district module

Master report

The master report provides information regarding the individual animal. It was capable of revealing both the movement history and documentation with regard to an individual animal as it progresses along the marketing chain. Figure 3.4 shows the movement of animal number LA 971 000002413447, a one year old Gasara which was identified in Garissa on 18th June 2008 using a rumen bolus manufactured by Aleis. After passing the CBPP health test (P-1), the animal was dispatched to the coastal ranches on 20th June 2008. The animal reached Chakama staging post on 17th July 2008 where it was received and was tested for the second animal health test (P-2). On passing the test, the animal was allowed into the coastal zone. Through the Master report details on the entire life and movement of an individual animal could be retrieved.



(3) - Windows Picture and Fax Viewer

Main Report

17-Feb-09

ANIMAL MASTER REPORT

Registration Date	Electronic Tag Code	Body Site	Owner	Trader	Age Group	Breed	Gender	Grade
18 Jun 08	LA 971 000002413447	Rumen	Abdi Abdullahi	Abdi Abdullahi	0-1 Years	Gasara	Male	4

Dispatch Report

Dispatch Date	Transport Type	Transporter	Destination District	PermitNo	PermitType
20-Jun-08	On Hooves	Herds Men	Malindi	968301	Movement Permit
19-Jul-08	On Hooves	Herds Men	Kwale	968301	Movement Permit

Received Animals Report

Source District	Receive Date	Electronic Tag Code	Transporter	Transport Type	Permit Number
Malindi	17-Jul-08	LA 971 000002413447	Herds Men	On Hooves	968301

Total Page No.: 3 Zoom Factor: 100%

Figure 3.4: Master report

The LITS database capable of individually identifying stray/lost/stolen cattle. For example, cattle number LA 971 000002469821 that was registered in Garissa on 18th June 2008 was received in Malindi on 9th August 2008, but did not arrive with its batch in Kwale on 15th September 2008. The reason for this was established as the animal went astray.

Similarly, the system was able to isolate animal number LA 982 000088109693 that failed the P-2 test and was therefore removed from the system. On post-mortem examination, its lungs revealed cardinal signs of CBPP with an accumulation of yellow fluid, hepatic lung and marbled lung sticking to the chest wall (Figure 3.5).

Figure 3.5: Post-mortem findings in lungs of animal number LA 982 000088109693

Other modules

These include the Short Messaging Service (SMS) that is used to compile data into a SMS, route it to GSM modem and onward to different stakeholders. The abattoir and export modules all have reporting features both at the headquarters and the local databases.

3.4 Discussion

Ideal traceability systems are developed through negotiated circumstances by stakeholders. This situation is particularly important since the existing regulations have neither proposed nor imposed any concrete way of designing traceability systems. This implies that there is no single "correct" way of achieving the ideal. Countries have designed and built traceability systems that meet their own individual needs guided by the non-prescriptive guidelines provided by the OIE. For Kenya, the participatory workshop was an effective way of establishing a model framework and negotiating roles and responsibilities for implementing LITS.

The efficiency of a traceability system depends on the ability to identify uniquely each unit that is produced and distributed, in a way that enables the continuous tracking from the primary production to the retail point of sale. An efficient traceability system must follow some rules that define which data must be gathered and stored in each stage of the supply chain. The negotiated positions articulated in SOUR, enabled the needs of the various public and private sector stakeholders (whoever were meeting the cost) meet their needs (OIE, 2009). This allowed for standardization of the gathered data and typification of the messages that enable storing and communication of the data (Mankis and Manos, 2008).

The LITS provided a mechanism for systematic gathering of verifiable animal health data and information. Traceable data were critical in enabling an organised response in the recovery of stolen animals; implementation of efficient bio-security measures and as proof of compliance with export certification procedures. Good data underpin ownership/origin thus contributing to reductions in cattle rustling; support better disease inspections, surveillance as well as providing written guarantees and assurance of credible certification for export (Smith *et al.*, 2005).

Contemporary livestock identification and traceability systems tend to incorporate RFID as identifiers. These have been recognised as the most suitable technology relied on to implement mandatory animal identification (MAF Biosecurity New Zealand Information Paper, 2009). Its advantages include the ability to store more information, strong machine readability, no line of sight requirement, fast speed reads and having no additional cost once implemented.

IT-enabled systems using more sophisticated radio frequency identification technologies such as RFID have been developed and introduced, thus reducing errors associated with manual data handling, thus making tracking more feasible (Karkkainen, 2003). The development of software systems and databases (data pools) increased the efficiency in collecting, transmitting and analysing larger volumes of safety and quality related data (Wilson and Clarke, 1998). Such systems enable livestock to be tracked in the supply chain to be recognized uniquely. In addition, the way animals are identified should be consistent for all members of the supply chain. In the opposite case, data synchronization is essential; this leads to an increase of cost and lowers the quality of data whenever it is not done. The highest level of analysis possible in the supply chain is that of single item identification, in which case the cost and the complexity of information management are significantly increased. Consistent with global trends, Kenya opted to try an electronic traceability system with centralised database based at the headquarters supported by district level (distributed) located at either the secondary market or staging posts. The system effectively used a combination of simple dropdown menus and SOP's. The primary justifications were huge mortality of livestock before market age, cost consideration and the potential for it to be extended back into the production areas. Registrations of livestock were limited to trained veterinary personnel.

The LITS database was designed from the onset with involvement of private sector and industry champions such as processers. This helped to clarify user requirements, enabled capture and exchange of data with existing sources and added greater value to the end users. It also incorporated the existing identification systems such as hot iron brands. It was flexible to accommodate additional enhancements and expanded functionality. With regulated access rights to protect the rights of the data owners, the system maximised the value accrued from the data collected.

Drawing from the Botswana experience a modular or phased approach was used. This enabled the design process to be in tandem with the available resources. Government and industry (private sector) collaborated in order to operate a joint industry-government partnership initiative. The use of a single central database reduced considerably the cost of implementation and minimized response time for impact analysis. Not only did it make LITS suitable for support of disease surveillance purposes, but also as a tool for all organizations interested in animal identification.

The credibility of LITS is a function of the business processes that characterised the way information was collected in terms of accuracy, timeliness and completeness. The integrity and accuracy of data held by LITS is ensured through continuous verification and immediate elimination of errors through correction. The experience of Great Britain showed that retrospectively "fixing" data problems was much more expensive than ensuring good quality data was obtained in the first place. This was the main reason for making the veterinary personnel responsible for collection of data. It was however noted that there was need for more extensive computer training to strengthen their data collection skills. LITS adopted a holistic approach presuming that communication, organisation and IT development are equally important.

Mandatory traceability was suggested as a necessity for developing countries that require proving credibility of their export certification procedures. Coverage and completeness of the data held and managed by LITS are strongly dependent upon the level of user compliance. However, of major concern is that stakeholders may not participate effectively if LITS data was used for punitive tax purposes (OIE, 2009). An effective system of incentives and disincentives shall be needed to encourage participants to align their behaviours and practices with system requirements. It was suggested that provisions be made in the statutes to ward off the concerns about confidentiality in the use of data. This was especially since as the laws stood now it was not possible to deny the Ministry of Finance and Economic Planning / Kenya Revenue Authority (KRA) access to the data and information. In the interim, the Department of Veterinary Services, the sole custodian, had been intent on using the traceability data to address specific diseases and livestock certification issues alone.

Stakeholder education and outreach is vital to achieving reasonable levels of participation in the program. Traceability systems are most effective when all business in the supply chain, both vertically and horizontally participate in the data collection processes. The outreach and promotion of the traceability system must be part of the system's maintenance. Promotion not only attracts more participants to the system, which ultimately increases the number of traceable supply chains, but it also educates consumers on the reasons for the sometimes higher price tags of traceable products. Print, audio and visual media could be used. It is proposed that the communication and outreach units of the Department of Veterinary Services could work to improve the consistency of program messaging and the timeliness within which those messages are shared with other stakeholders.

CHAPTER 4: ASSESSMENT OF THE TECHNICAL APPLICABILITY OF RADIO FREQUENCY IDENTIFICATION DEVICES IN THE BEEF MARKETING CHAIN FROM NORTH-EASTERN KENYA TO THE RANCHES IN COAST ZONE

4.1 Introduction

The main countries involved in the global trade of beef have already implemented beef and livestock traceability systems and the patterns reviewed (Souza-Monteiro and Caswell, 2004). However, suitable research on identification technologies and traceability models for regions that have populations practising pastoral systems such as transhumance and nomadism have not been identified (OIE, 2010).

The motivation for this chapter is that since two technologies (ear button tags and rumen boluses) were selected by the stakeholders (see chapter 3), it was essential that their technical feasibility be tested at field level. This chapter reports on the findings on the technical applicability (effectiveness, robustness and ease of use) of RFID identifiers in the pastoral cattle production systems in the north-eastern and coastal regions of Kenya.

4.2 Materials and methods

4.2.1 Deployment of the Livestock Identification and Traceability System

4.2.1.1 Identification and selection of livestock traders cum ranchers

The stakeholders' workshop (see section 3.2.2.2) was used to select four livestock traders cum ranchers to participate in the study. Those selected were members of the LTMS-K, who were involved in trekking large groups of cattle to the coastal ranches. The objectives and processes of implementation of the study were described to participants. Those identified as willing to participate were asked to commit themselves to complying with relevant veterinary procedures. As an incentive, the cost of CBPP testing was waived for participating traders.

4.2.1.2 Selection of beef cattle at livestock markets

One thousand, nine hundred and forty three (1943) cattle (approximately 2 % of cattle purchased and trekked to the Coastal ranches over a 12-months period) were purposively selected and tagged with either of the two types of tags systematically. Nine hundred and thirty four (934) cattle were assigned to ear button tags and 1009 assigned to rumen boluses. The majority of cattle were tagged at Garissa market, Chakama ranch in Malindi and a small number within the coastal ranches over a six months period.

4.2.1.3 Implementation of the dummy run and field deployment

A practice/dummy run on the system was carried out at the KMC - Athi River export standard abattoir over a two-month period. This tested the capability of LITS to capture relevant data. The dry-run was used for the identification of software failures and elimination of errors prior to the final deployment at remote field sites. Briefly, it involved the insertion of rumen boluses into cattle at the receiving area of the abattoir. This was followed by the registration of the animals, weighing before entry into the slaughter and bolus recovery process. It helped the investigator understand how the LITS modules could be operationalized.

Deployment of equipment and training at field level was carried out on a site-by-site basis over three months. The training on effective use of the LITS system was guided by SOP's. This provided recommendations on identification, reading, recovery, data recording and transmission of data and helped to avoid mistakes by the system operators.

4.2.1.4 Operation of LITS at the livestock market

Once trade cattle were consigned to the market, clinical inspection was conducted and individual animals mouthed to detect clinical signs of FMD. Suspected cases were removed from the market and handled appropriately. The cattle purchased for trekking and fattening were sero-tested for CBPP. Those found free of CBPP antibodies had one type of RFID tag applied, the animal registered and data collected transferred by synchronisation with the central database at the end of the day's operation. The hot iron brand P-1 was subsequently applied and the process of facilitation movement permits completed (inspection of the no objection and provision of movement permits) prior to dispatch.

In order to ensure reliability of the RFID traceability system, automatic reading and recording of data was performed from a single lane crush and with an eye on the expected count of livestock in each instance. In the case of disparity in the actual count versus the expected count, an explanation was immediately sought to establish the cause.

(a) Application and monitoring of rumen bolus in cattle

Each bolus was read immediately before administration to check for possible breakages or reading failures during tagging. A trained operator then administered the boluses using an adapted balling gun (Allflex®). Briefly, with each animal properly restrained, a metallic balling gun was introduced laterally as far as the end of the tongue while holding the diastema (Figure 4.1). The bolus was deposited into the bottom of oropharyngeal region in order to stimulate involuntary deglutition (Carné *et al.*, 2009 $_{a, b}$). A second readings of the electronic tag was then done using a directional caudo-cranial sweep behind the left front leg of the animal using the hand-held stick readers at 1, 30, 60 days, 8 months and 1 year according to the "Guide Procedures of the IDEA Project" (Caja *et al.*, 1999; Rib'o *et al.*, 1999; Ghirardi *et al.*, 2006).

Figure 4.1: Tag (insert) and the process of insertion into an animal

(b) Application and monitoring of the ear tag in cattle

Similarly, each ear button tag was read immediately before tagging to check for possible breakages or reading failures. Ear button tag was then applied to the middle of the left ear at one third the distance from the ear base using a standard trigger applicator recommended by the manufacturer, but with the plastic tip removed (Universal Total Tagger, Allflex® Europe). The "Female" piece was located on the internal side of the ear. The applicator was sterilised using alcohol between each insertion. Reading was done by pointing the wand to the ear tag at a minimum distance of 12-20mm. At least five readings were carried out for each tag over a one year period.

(c) Registration of cattle into LITS database

Registration involved the transfer of the unique identification number within the tag via a stick reader (middleware) to the LITS - compliant computer. Ancillary data such as trader names, origin of cattle and grade were subsequently entered into the relevant windows using the drop down menus.

4.2.1.4 Operations at the staging post in the Chakama Ranch

Chakama ranch is the staging post located in Malindi District, Coast Province. At this ranch the operations included new registrations, receiving then health and dispatch modules. An initial synchronization was also used to confirm presence of data on the animals registered in Garissa. The animals were again clinically inspected, physically mouthed for FMD and serologically tested for CBPP. A repeat serological testing was conducted at least 21 days after the initial test. Only animals that passed the second CBPP test were branded P-2. In addition, the cattle were treated for trypanosomosis, de-wormed and vaccinated for blackquarter and anthrax. At the end of the process, the reports of various operations were uploaded to the central database through synchronization. Animals passing the P-2 test were released and dispatched to enter the coastal ranches.

4.2.1.5 Operations at the coastal ranches

At the coastal ranches animals were received and cleansed (sprayed for ticks and dewormed) using the standard LITS protocol. Cleansing involved treatment and fattening of the animals.

One month to slaughter or export tests for transboundary diseases such as FMD and RVF were also performed on individual animals.

4.2.1.6 Operations at export standard abattoirs

At the export abattoir, the cattle were received and the accompanying documents inspected and verified before offloading. They were consigned to the holding yard where clinical inspection was done for 24 hours. Each animal was then individually identified by the RFID identifiers, ear tag and mob number as they were being individually weighed. The cattle were then washed, stunned and slaughtered. Upon slaughter, the Department of Veterinary Services meat hygiene personnel recovered the respective identifying devices and also linked them with the rest of the carcass at post-mortem examination. After overnight chilling the carcasses were graded.

Records of carcass grade, post mortem findings and the individual identification number were linked to the traceability system and transferred to the central database. The system modules used at the abattoir included those for receiving of animals, health and slaughter. This was one of the exit points where the boluses were flagged off the system and recovered for recycling. All boluses collected at the abattoir were sent back to the Department of Veterinary Services headquarters for sterilisation and redistribution. All ear tags were discarded.

4.2.1.7 Operations at the Mombasa livestock export point

Animals meant for export were dispatched from the Kilindini Port. Individual RFID identification numbers of cattle entering the ship were flagged off the system using the export module.

4.2.3 Capacity building and human resource development

4.2.3.1 Training of veterinary personnel at field level

One-day training sessions for a total of 66 Government of Kenya personnel were conducted in eight locations. The training included the operations and functional use of the traceability system; field application of the electronic tags (ear and rumen bolus), reading, entry and manipulation of data within the system (editing and synchronization) and the use of traceability equipment. The training was done in Mandera, Wajir, Garissa, Garsen, Malindi, Taita, Kwale and Athi River over a period of five weeks.

4.2.3.2 Training of super users at the Department of Veterinary Services headquarters

A three-day training session for super users (data-managers) was implemented. The purpose was to enable the super users manage the central database. The super users were responsible for managing the access and permissions of the field operators to the system. The training provided the super users with skills in editing and verifying data from the field and generating reports at headquarters level.

4.2.4 Tagging Activities

Successful tagging of cattle depended upon a group of discrete activities, which were assessed. These included: -

- Time taken to perform various operations
- Performance of the EID equipment, including malfunctions;
- Effectiveness of reading devices and actions taken;
- Effectiveness of transfer data to the central database and actions taken;
- Retrieval and verification of information from central data base; and,
- Animal health and welfare standards.

4.2.6 Trader survey

A questionnaire survey was administered to traders along the livestock marketing chain. The structure questionnaire (Annex 5) was used to collect information about the methods used to identify livestock, the effectiveness of the identification system and willingness to participate in the electronic identification system.

4.2.7 Data analysis and evaluation of traceability data

The SPSS System (v. 17) was used to perform inferential tests on the different parameters influencing the performance of LITS. This was also used to evaluate technical applicability and tags readability at day 0, month 1, 2, 6, 8 and 12 respectively. This included a determination of tag losses, electronic failures and readability; these were analysed on the basis of the categorical nature of these variables. This analysis permitted the comparison of the longitudinal readability of ID devices without excluding right censured data (data from animals that left the study before a device failed) (Cantor, 2003; Kleinbaum and Klein 2005). Survival monitoring started at device administration and as continuous cattle monitoring was not possible, time of device readability was registered as interval data.

4.3 Results of field implementation of electronic livestock identification

4.3.1 Application of RFID tags

A total of 1943 tags were applied with 1009 (52%) rumen boluses and 934 (48%) ear button tags respectively. The proportions of cattle tagged according to breeds were Borana (47%), Surco (34%), Daura (15%), Small East African Zebu (3%) and Gasara (1%). Figure 4.2 depicts the various breeds of cattle used in the study.

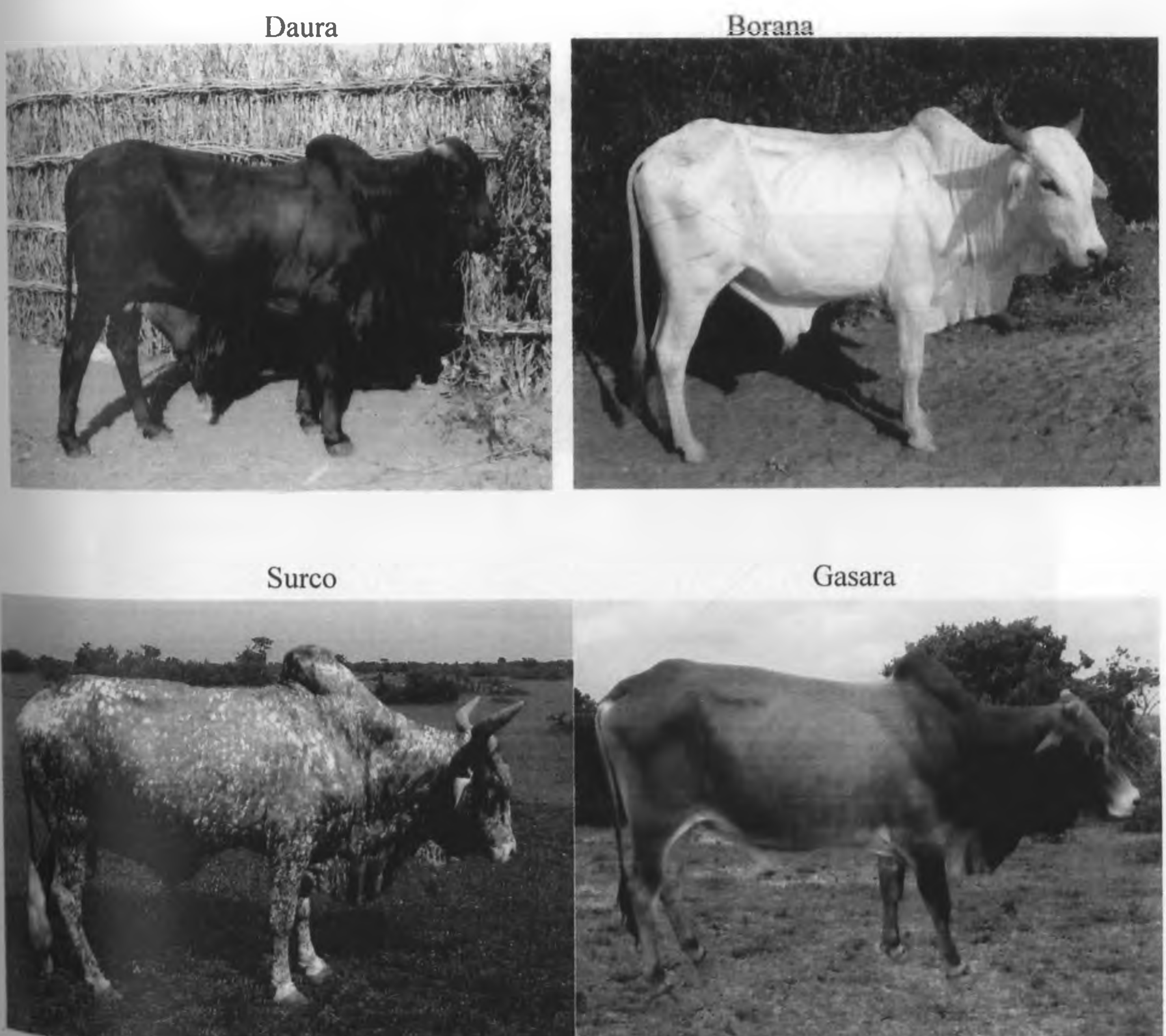


Figure 4.2: Pictorial representation of cattle breeds participating in the study

Sixty four percent of the cattle were tagged in Chakama ranch (Malindi District) after the batches were consolidated with cattle from smaller markets like Ijara and Tana River. Thirty-five percent were tagged in Garissa and an experimental group of weaned animals (1%) born and reared exclusively at the coastal ranches were also tagged in Kwale. The age groups of tagged cattle varied from > 1 year (35, 2%), 1-3 years (850, 44%), 4-7 years (1054, 54%), and > 7 years (4, 0%), while their grades were Primo thus first class (50%); Secundo thus second class (47%) and Goroba thus third class (3%). The four traders who were members of the LTMS-K provided 52%, 17%, 16%, and 16% of the cattle tagged respectively. Figure 4.3 shows a group of animals awaiting tag reading.

Figure 4.3: Cattle awaiting tag reading.

4.3.2 Tag readability

Table 4.1 gives the outcome of tag readings during the study.

Table 4.1: Outcome of tag readings during the study

Table 1.					
Tag type and time	**Readability of RFID tag types**				
	Ear button tag				
	Day 0	**One month**	**2 months**	**Six months**	**>eight months**
Successful readings (%)	99	99.20	98.30	97.40	94.60
Electronic tag lost and not read	2/934	8/934	16/934	25/934	50/934
Electronic tag broken	0	0	0	0	0
Readers failed to function.	2/934	8/934	16/934	25/934	37/934
Animal not present and therefore reading not performed	0	30	14	22	0
Tag type and time	**Rumen bolus**				
	Day 0	**One month**	**2 months**	**Six months**	**>eight months**
Successful readings (%)	100	100	100	100	100
Electronic tag lost and not read	0	0	0	0	0
Electronic tag broken	0	0	0	0	0
Readers failed to function	0	0	0	0	0
Animal not present and therefore reading not performed	0	2	0	10	0

Both types of tags had a high readability but when the two types of tags were compared a lot more problems were experienced with the ear button tag. These included loses and breakages. The restraining crushes were of variable quality with a significant number of cattle breaking out of weak crushes.

4.3.2.1 Tagging time

The number of cattle identified per day per tagging team varied marginally between individual operators. The tagging efficiency ("number of animals/day") was dependent on the team as well as the quality of the crush used to restrain cattle. The time spent to apply tags averaged 1.5 minutes for ear tags and 3.5 minutes for boluses respectively. On average a total of 250 cattle (with a range of 120-300) were identified/day/ tagging team. This time included that spent in sampling blood from the tail vein and mouthing for FMD.

4.3.2.2 Losses of RFID devices

The average tag loses were aggregated and causes recorded. The main source of losses of ear button tags due to ear infections evidenced by a hole on the ear. These were less than 5 % although the likelihood of losses increased after 120 days.

Only one ear button tag failed to read before the end of 120 days, while fifty ear button tags were lost during the same period. No ear button tag was lost due to death or predation. Figure 4.4 compares the survival distribution of the electronic tags.

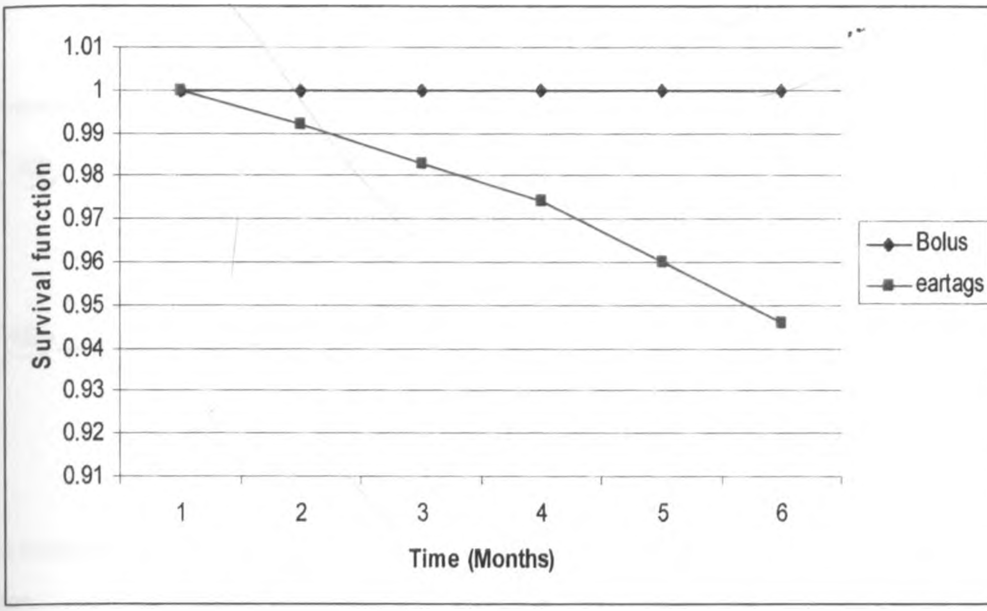
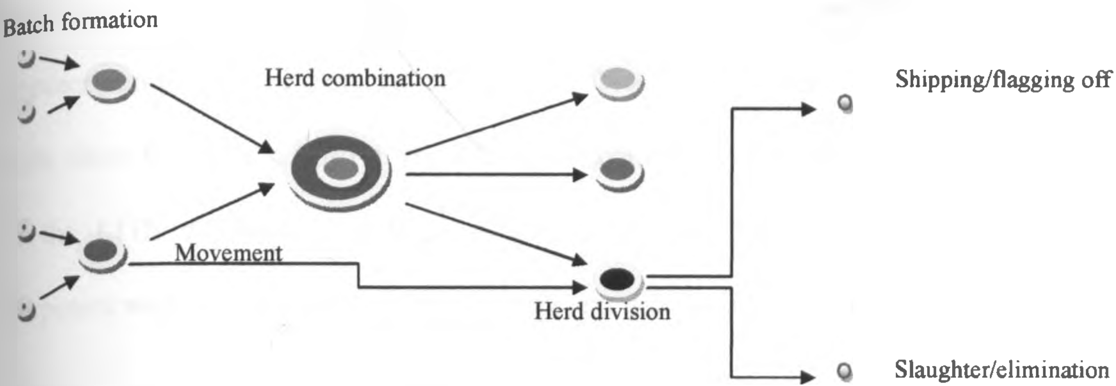


Figure 4.4: Survival distribution function of electronic tags verses body site

4.3.2.2 Operations of LITS at field level

Figure 4.5 provides a summary of the function of LITS at field level and illustrates its ability to follow a single animal consistently, combine them into a single batch or divide a single herd into different batches as well as identify whether the individual animal was eliminated from the system either through slaughter or export.

Receive animal module
Shipping module
RFID is flagged off



Batch formation	Herd combination	Herd Division	Elimination
Registration, livestock and its Movement permit. In case the one step back operator has not implemented the traceability system, give register ID on the incoming animal CBPP testing Hot iron branding (P-1) Movement facilitation Check the incoming Dispatch module	If simple movement compare the lot and its information (movement permit). Record the information such as the location and the date and time into the receive animal module Health module CBPP testing (21 days) Vaccinations and treatments Dispatch module Check the pre-combined herds and its information & movement permits instruction), and record the information in the received animal modules. Assign a new herd number on the newly combined lot. Link IDs of the lot before the combination with the herd after the combination and record the information. Record information about date of combination, the numbers in the herds prior to and after the combination.	Check the pre-divided herds and its movement permit and record the information in the registration module. Assign a new herd ID to the newly divided lot. Record the ID linkage so that the lot before the division and the lot after the division can be linked. Input or record information about division work e.g. date of division, numbers before the division and after the division, Prepare new movement permits for the divided herds and attach them to the lot. Sale module Individual animal testing for transboundary diseases Animal health module Dispatch animal module	Receive animal module Check the individual animals clinically prior to the disposition and record its information e.g movement permit For each batch, record the necessary information (extinct date and time, place in the slaughter module

Figure 4.5: Operations of LITS at field level

4.3.3 Computer competency of veterinary personnel

Most of the veterinary personnel engaged in the study did not exhibit sufficient levels of computer competence. Figure 4.6 provides a subjective evaluation of their competence. The results show that only a third of the personnel available could actually be used to enter data into the LITS database. Of these, 7% were entirely proficient in computer use, 15% (competent without training) and 11% (competent with basic format training) respectively.

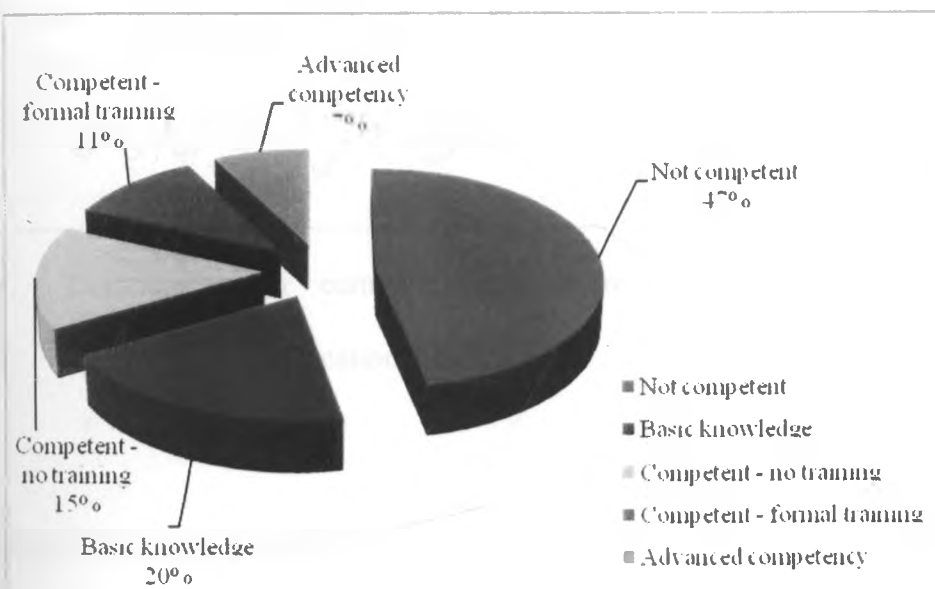


Figure 4.6: Level of computer literacy of participating personnel from the Department of Veterinary Services

When the same data was disaggregated for the various districts in which the study was implemented, only Garissa, Mombasa and Taita had at least one staff proficient in computer application and thus participated in the study (Figure 4.7).

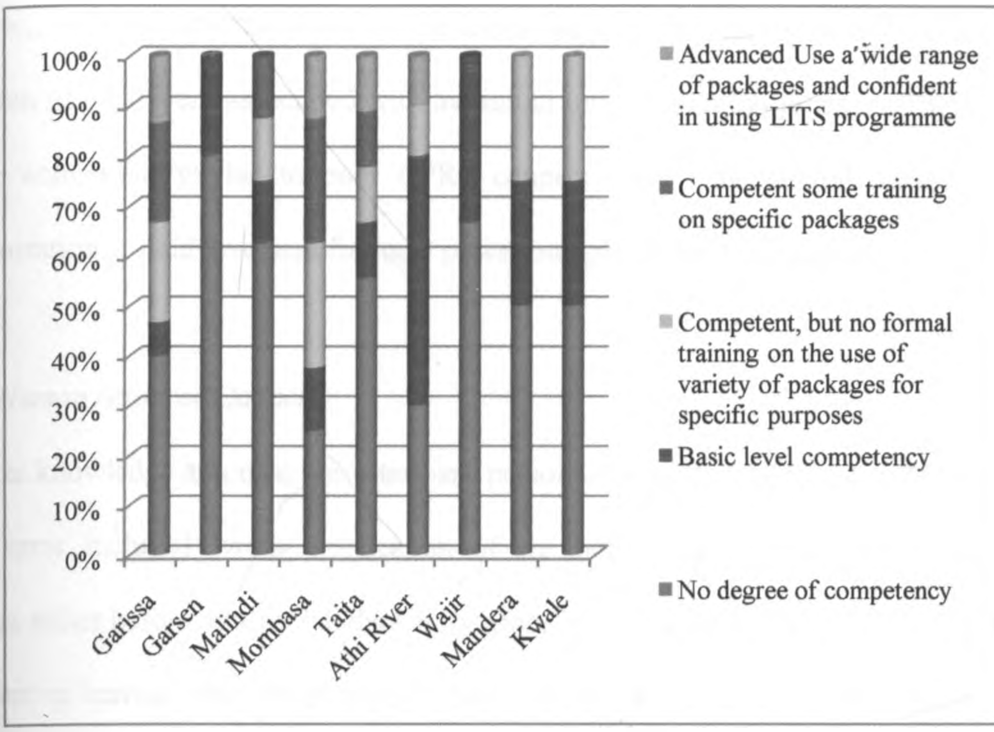


Figure 4.7: Competency in computer applications amongst veterinary personnel disaggregated by location

4.3.4 Constraints to implementation

Four broad areas of constraints namely technology (middleware), human resource Capacity, software issues and market infrastructure were identified.

4.3.4.1 Technology

Electromagnetic interference or mechanical (noise), while operating the RFID readers was seen to occasionally affect the readers due to set-up and technology compatibility issues. This sometimes resulted in an inability to transfer the RFID numbers to the computers using affected readers. Such problems were either addressed by setting up a paper back-up of the RFID numbers, installing Opto Isolators and providing backup readers.

In general, it was evident that most of the technology issues (hardware, software, scanning, application of tags) were associated with the initial implementation process. These included: software compatibility; due to poor GPRS connectivity to the central database delaying synchronisation at field level and frequent power outages at the headquarters.

4.3.4.2 Human resource Capacity

Computer knowledge amongst the veterinary personnel varied considerably. The elements of human error included wrong application of ear button tags, failure to synchronise the databases either before or after the data entry procedure, data entry errors; forgetting to charge equipment or leaving vital components of the system at the base while travelling to the field as a result on inadequate duration of training initially. Consequently, Standard Operating Procedures (SOPs) were used as one of the options of reducing human errors during the study. In addition, carrying a soft copy backup of the final database and uploading it manually to the central database solved this problem.

4.3.4.3 Software

Data problems arose from issues related to the software. These generally fell into two categories: software incompatibility and uncertainty arising from outputs. Software compatibility problems were with: livestock management procedures; hardware and LITS systems errors in software design; and inadequate testing before deployment. This showed the limitations in the duration of training.

Uncertainty arising from outputs was due to the use of intern software engineers. This resulted in substandard outputs that were only addressed when quality assurance procedures were implemented. In addition, the central database suffered a massive virus attack when it was initially interconnected with the existing server. This destroyed the software infrastructure of the central database and infected some remote databases. It took over one month to strip the central server, reformat it and reconstruct the database. A recommendation to counter this is to establish a mirror server on the Internet in order to avoid loss of data.

4.3.4.4 Traceability system gaps or shortfalls

At the time of writing, a number of limitations continued to plague the system. These included:

Data: Limited breadth and depth of information were captured specifically neglecting information at the production level; besides, critical information for purpose of export certification remained with the Department of Veterinary Services and was not readily available to third parties;

Organization / Culture: The Department of Veterinary Services maintained a compliance driven mindset limiting full deployment of the system. Then pastoral productions straddling national boundaries implied that the system required a regional approach to implementation; and some of the veterinary procedures and processes were not standardized within the districts.

It is with the realisation that addressing such gaps would have to be sorted out in the long-term, the study focused on implementing the study straddling two provinces rather than national boundaries. This was because the study lacked the mandate to operate beyond national boundaries

4.3.4.5 Limitations in infrastructure

A number of infrastructural deficiencies were noted during implementation of the system. This included lack of market infrastructure such as stock routes, holding grounds and quarantine facilities. This necessitated the encroachment into and use of private property such as Chakama ranch. In addition, there was poor Capacity to transfer data through the GPRS modem because of the presence of large areas of 'dead zones' that had limited or no internet connectivity. Figure 4.8 shows part of the route into the coastal ranches. The portion passing through the Tsavo National Park was marked in red.

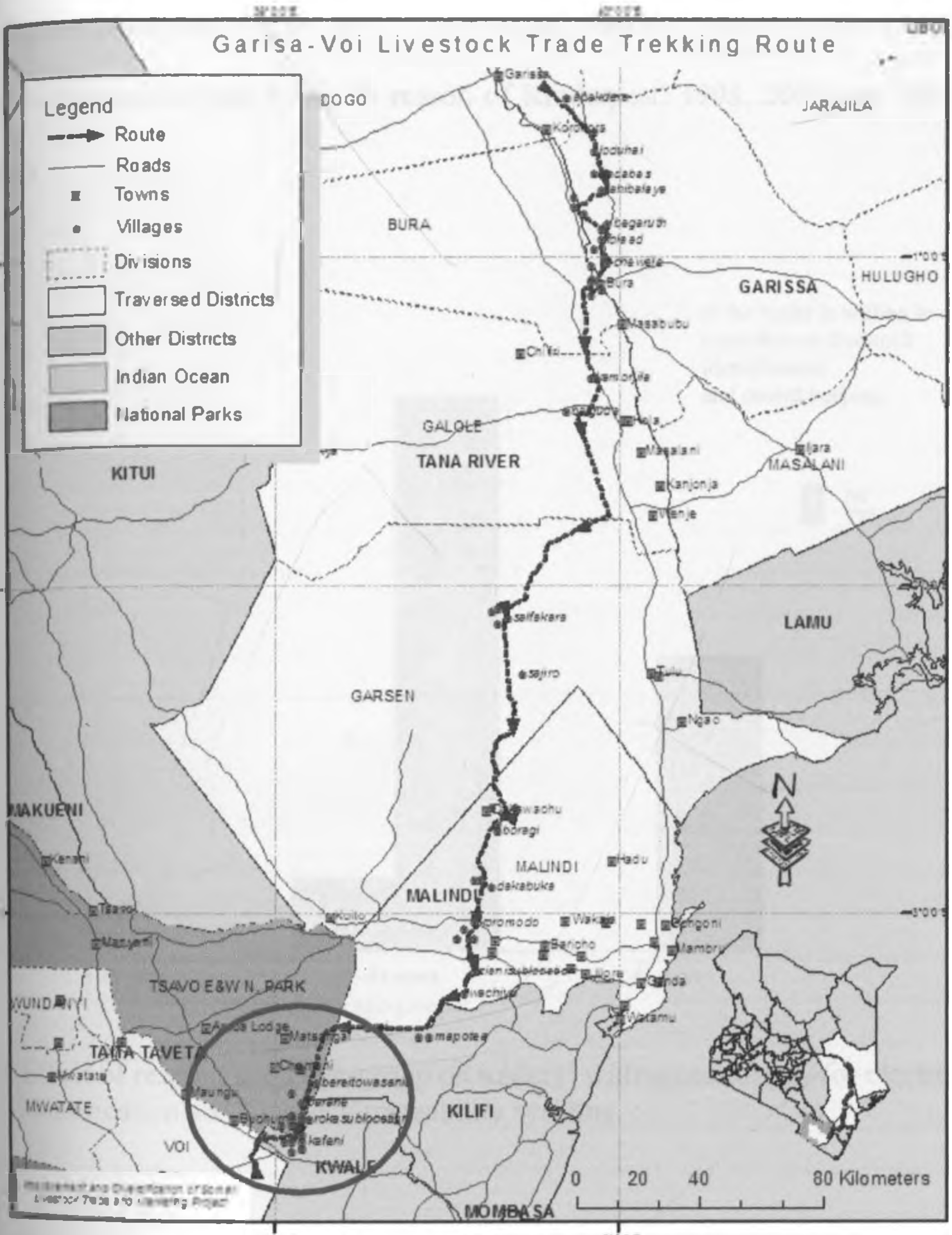


Figure 4.8: Garissa-Voi livestock trekking route

4.3.5 Respondents' willingness to pay for LITS

Cross tabulation was done in order to appreciate how willingness to pay changes as the age-group of the traders increased for this trial. The trend reveals that older traders cum ranchers were more willing to pay for traceability over and above the quality assurance programmes then being implemented (Figure 4.9). This was attributed to repeated experience of livestock bans with the region from 1983 for reason of Rinderpest, 1998, 2000 and 2006/7 for RVF outbreaks.

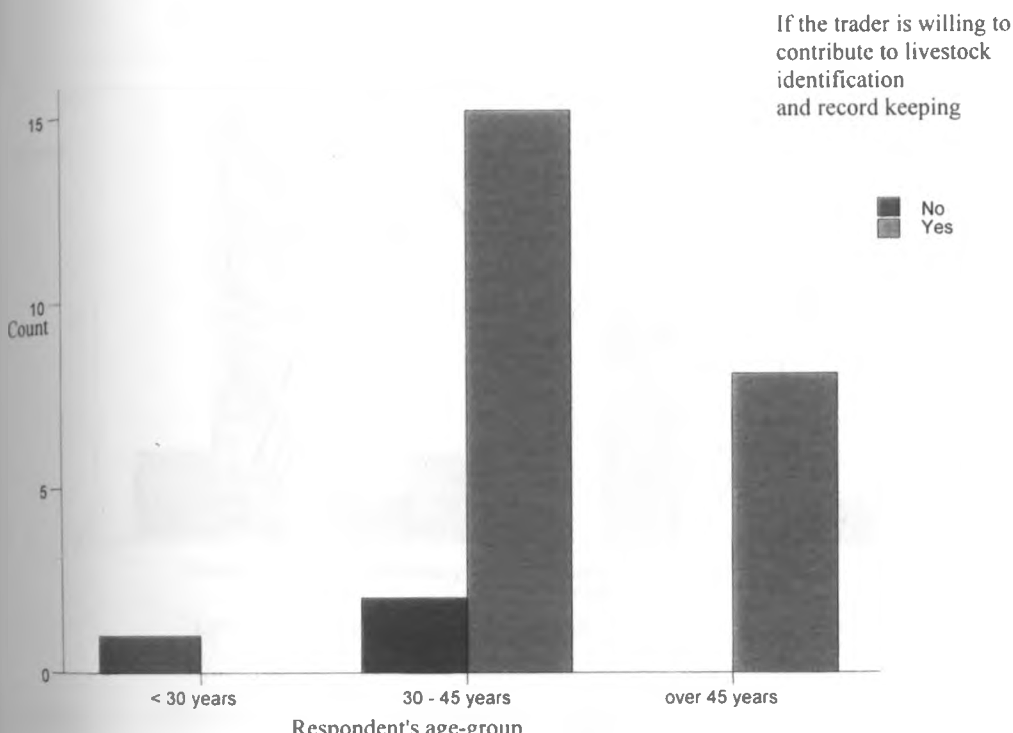


Fig 4.9 Effect of respondent's age-group on traders' willingness to pay for electronic identification and livestock traceability systems

Similarly, traders with the different levels of education were all willing to pay for electronic livestock identification and traceability system. Those traders with lower level of education were surprisingly more willing to pay for LITS (Figure 4.10).

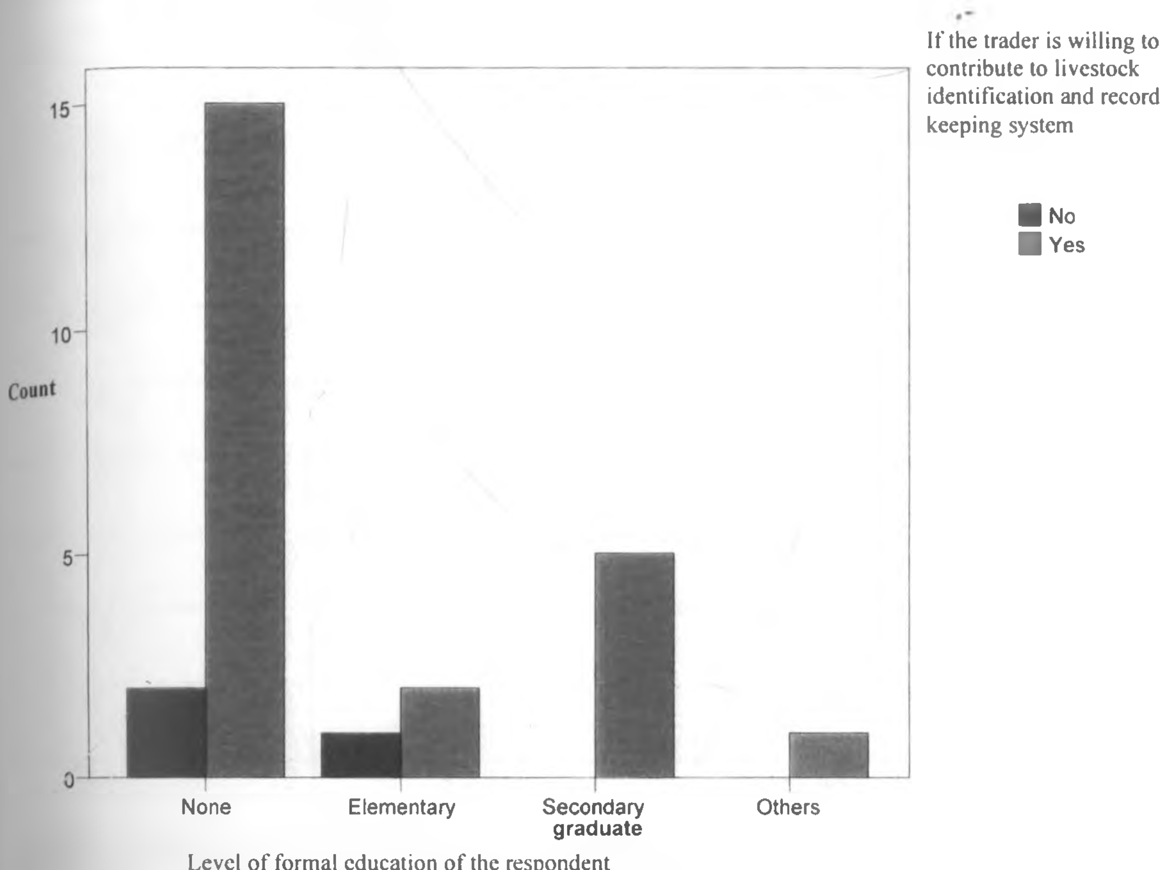


Figure 4.10: Effect of level of education on WTP for LITS

An analysis was carried out to establish the traders' willingness to pay for LITS. The findings revealed that most traders were willing to pay approximately USD$ 3. This amount was between 40% for the cost of registration with rumen bolus and 58% cost for ear button tag respectively. The percentage willingness to pay ranged from 0.14% to 202% for rumen bolus and 0.19% to 289.8% for ear button tag respectively (Table 4.2). Such response was attributed to livestock trade having been affected by the ban in livestock exports by Middle East countries and closure of the Garissa market in 2006/7 during the RVF outbreak.

Table 4.2: Traders willingness to pay for LITS

USD$	Number of respondents	Percentage of respondents	Percentage cost of LITS as implemented with	
			rumen bolus	ear button tag
0.01	1	4.3	0.14	0.19
0.15	1	4.3	2.03	2.90
0.75	2	8.7	10.15	14.56
0.9	1	4.3	12.18	17.48
1.2	1	4.3	16.24	23.30
1.5	2	8.7	20.30	29.13
1.8	1	4.3	24.34	34.95
2.2	3	13	29.77	42.72
2.4	2	8.7	32.45	46.60
3	6	26.1	40.6	58.25
4.5	2	8.7	60.90	87.38
14.93	1	4.3	202.00	289.81

4.4 Discussions

Two aspects are covered in this discussion, first the technical feasibility on the use of RFID as identifiers under pastoral production systems; second, the overall feasibility of electronic LITS in meeting the three objectives of the Department of Veterinary Services.

The use of RFID tags (ear button tags or rumen boluses) was both technically applicable for automatic individual identification and traceability in a pastoral environment with no differences in the applicability. This was particularly so when supported by robust SOPs.

This finding is consistent with the finding of other studies (Peets *et al.*, 2009). Of the two types of tags, were more preferred by the Department of Veterinary Services because they could be recycled up to ten times and were also tamperproof, thus cheaper in the long-term. In comparison, although cheaper in cost, ear button tags deteriorated rapidly and six percent (50) were lost after two months. This was attributed to ear infections (84%), ear tearing and the locking system expanding (46%) attributed to exposure to the intense sun in causing plastic deformation or breakage.

LITS was able to integrate electronic data capture and reporting technologies into existing disease control programs, automated data capture technology and integrating handheld computers/ readers to replace paper-based forms. Animal health officials were therefore able to electronically record and submit essential data to the central data base. This resulted in increasing the volume and quality of data collected, minimized data errors, and increased the speed of data entry into a central database (Gasparin *et al.*, 2007).

The experience of this study showed that retrospectively "fixing" data problems was considerably more expensive when compared to the process of ensuring good quality data is obtained in the first place. In order to secure sound data, the Department of Veterinary Services personnel were exclusively tasked with collection and entry of livestock data. However, it was recognised that their skills in computer data entry and manipulation needed further upgrading through training.

Some of the benefits observed were that electronic LITS ascribe specific responsibilities to individual veterinary personnel. By focusing on the individual practitioner, the system was able to inject greater diligence in administering procedures and inspections since any errors could be traced to an individual. This resulted in minimal errors and therefore a more stringent application of certification procedures.

The LITS was able to meet rigorous and defined performance standards such as determining the location(s) where a specific animal was registered, its cohort (same herd) as well as those animals it has been in contact with from the central database. It is notable that such a level of performance is not achievable without electronic recording and submission of data enabled by RFID. By adopting electronic data submission, the system avoided inefficiencies associated with paper-based systems.

Use of RFID was likely to support a switch to specific niche markets by selling higher quality verified products that are embedded with information about the product, process and place (Atterton and Ward, 2007). Their use in traceability systems have been recommended for livestock populations exceeding 600,000 (Carné, 2009_a). This makes the shift towards RFID livestock identification inevitable.

Development of the traceability model showed through the individualised, concurrent, *ad hoc* and localised effort at developing traceability system within both the beef and dairy sub-sectors that a common commitment on LITS was lacking at cattle industry level. This meant that the agreement reached on the end-user requirements was focused on beef sector stakeholders only. The situation was exacerbated by lack of human and financial resources as well as technological skills. Moreover, there was limited demand for traceability from the domestic market. Here, price rather than safety was the primary signal for meat purchases.

With the perception that traceability systems rated as a low priority within all government projects, it would be difficult to find support for investment in LITS from the central government. Indeed, the different roles that practitioners needed to assume in order to obtain, organise, document and maintain the required information has often been poorly articulated due to the perceived imbalance between the work involved and the potential benefits.

In Kenya, whilst needing to upscale public veterinary services delivery, it was imperative that the coordination problems that characterised beef production systems be solved. A suggestion was that the establishment of intermediary institutions that preserve pastoral livestock from the decadence of drought and disease be supported. Such an institution could then provide stable and credible market signals as an incentive for market participants to optimize and adopt livestock traceability in the long-run.

It was also noted that traceability systems were likely to be effective when all segments of the supply chain stakeholders were participating. Indeed, unless the veterinary authorities were able to provide credible and verifiable evidence of disease control and traceability, the country stood no chance in trying to move its meat to foreign markets. In the interim, Non-Governmental Organisations were capable of stepping in to solve a "coordination failure", providing the institutional infrastructure necessary for a functioning and cost-competitive industry. This could address the unwillingness of government departments to share information.

The LITS was able to facilitate near real time transfer of data. This improved efficiency, reduced errors and saved time and/or labour along the livestock marketing chain. In addition, the system was able to identify a single CBPP infected case from the total of 1943 animals, thus demonstrating a high level of sensitivity and reliability during sero-surveillance. LITS was thus able to contribute towards increased transparency along the supply chain, reduced the risk of liability claims, improved recall efficiency, enhanced the control of livestock epidemics, ensured easier product licensing and increased price premium (Dinsey *et al.*, 2001; Meuwissen *et al.*, 2003).

The system was also able to facilitate niche marketing, potentially capturing price premiums during purchase by Farmers Choice and export to Mauritius. Such processes have worked around the problem of weak interaction with the various livestock related agencies of the public sector by developing links with international sources of knowledge and technology. This allowed the sector to respond rapidly to different challenges. While the country's historical development explains this pattern of innovation response Capacity, public policy appears to be failing in its role of nurturing and contributing to the capacities needed for development in emerging economies, such as that of Kenya (Keskin *et al.*, 2008).

If developed further, the system was thought likely to restore the potential for meat exports to the European Union. Information asymmetry between lower and higher level players has resulted in failure to properly define the public good aspects of traceability. While there was incentive to help generate and declare information on credence attributes of value to premium markets, this was not the case with credence attributes that have a negative value such as disease occurrence. This finding was similar to the findings of previous authors (Golan *et al.*, 2005 and Hobbs *et al.*, 2007). In such cases, the market solution results in less disclosure than desired by consumers or less traceability than is socially optimal (Lüth and Spiller, 2005).

Market innovations and investments are key elements contributing to the health and success of any industry (Bailey, 2007). The adoption of appropriate technologies and innovations were a critical element in economic development because of the investment and economic activities they attract (Galliano and Orozco, 2008). In Kenya, LITS was embraced by traders cum ranchers, provided proof of compliance to food safety and quality regulations in the face of possible fraud and unfair competition. Due to its strict enforcement of procedures, one of the traders cum ranchers appreciated the role of traceability systems in enabling them to avoid purchase of infected animals and therefore losses during transit. The Department of Veterinary Services has been at the heart of these efforts in providing objective validation of quality attributes and traceability systems. They reassure final consumers about the location of production that the products are free-range with no hormones used.

The Kenyan beef sector may have experienced difficulty in responding to food safety threats due to limited accountability and traceability. Buyers of beef depended upon processors such as KMC, Alpha fine foods, Framer's Choice; Karen Butchery who adopted the role of channel captains and monitored the safety of products up and down the supply chain. By demanding safer products from their suppliers, they successfully created niche markets for food safety spurring the development of traceability systems. The success of such markets rested on the ability of these large buyers to enforce standards through testing and process audits- and to identify and reward suppliers who met safety standards and punish those who did not.

Mandatory traceability would therefore be a good tool for increasing the credibility of livestock certification systems. Indeed traceability systems are driving increased preoccupation with certification requirements, product safety guarantees and rising demands for animal welfare and environmental standards. In addition, prior to the study, market disruptions due to recent outbreaks of RVF had affected meat trading and consumption patterns resulted in a ripple effect beyond the livestock sector.

The participation of traders was entirely in proportion to their sizes. They operated by either trekking or trucking bulls between 4 and 6 years of age depending on the prevailing weather and climatic conditions. Cattle numbers in excess of 100 were trekked in order to reduce on cost (McPeak and Little, 2006).

Traders cum ranchers targeted animals aged between 3 and 6 years. These were finished (fattened) over a period of between six and nine months and later sold by weight from the coastal ranches. Three years old animals were usually kept one year for finishing in the ranches before sale on reaching four years of age.

The challenges posed by the end-users included: inability to satisfy predefined stereotypical end-user. Their requirements of the traceability system differed immensely and were often inconsistent; the quantity, heterogeneity and depth of detail of the potential information required, often precluded predefinition; inability to predefine how access to information and its subsequent presentation; and non-registration of transfers of animals occurred due to delays with the veterinary team not going to check the animals in the field. The great distance between Chakama and Garissa implied that personnel had to be transported from Garissa at great cost and inconvenience.

CHAPTER 5: BENEFIT-COST-ANALYSIS OF ELECTRONIC IDENTIFICATION AND TRACEABILITY SYSTEMS IN TEN BEEF PRODUCING DISTRICTS OF KENYA

5.1 Introduction

Livestock traceability has become a mandatory requirement for developing countries intending to access international premium beef markets (Souza-Monteiro and Caswell, 2004). By definition, it encompasses "*the ability to follow an animal or group of animals during all stages of life*" (OIE, 2010). Traceability systems have been designed to prevent accidental or intentional food safety problems in the food chains (Meuwissen *et al.*, 2003; Hobbs *et al.*, 2007). However, in spite of its perceived benefits, there exists considerable debate on the value of investing in livestock traceability systems (Pouliot, 2008). Therefore, it was important to analyse the potential benefits in order to establish the value of investing in RFID-based livestock traceability systems in Kenya (NAIS Benefit Cost Research Team, 2009).

In Kenya, livestock traceability systems were meant to bring about improvements in three main areas, namely: (i) reduction of cattle rustling and other related livestock-based insecurities: (ii) surveillance of transboundary animal diseases; and, (iii) access to premium international markets for livestock and livestock products.

The objective of this chapter was therefore to undertake a benefit-cost analysis (BCA) based on lessons from an experimental electronic-livestock traceability system for beef production systems in Kenya. It was envisaged that this would provide valuable information on whether or not countrywide implementation of a livestock traceability system was a worthwhile investment.

5.2 Materials and methods

The benefit-cost analysis was done using the method described by Boardman *et al.*, (2005). It involved the following steps: 1). Identification of benefits and costs; 2). Estimation of benefits and costs; 3). Comparing the benefits and costs such as computation of the Net Present Value (NPV), internal rate of return (IRR) and the 'pay-back' period.

5.2.1 Definition of terms

Standing: This referred to the group (or groups) of individuals who were either positively or negatively impacted by the effects of a particular policy or project. By standing the project tried to answer the question: in whose eyes did the project benefits really count? On the benefits side, the standing was Kenyan citizens as well as the rest of the countries of the world where Kenyan livestock products were consumed. They included the external markets where Kenyan meat was consumed in the past or could potentially be consumed in the future. These were the North African, Middle East countries, and the EU. Within Kenya, standing was restricted to the beef industry (thus producers, input suppliers, exporters, consumers and output distributors)[9].

Present Value of Benefits: This term which is used in cost-benefit analysis and project appraisal refers to the discounted stream of benefits associated with a project (Freeman, 2003) in the case of this study, LITS. It is calculated using the following formula:

$$\textbf{\textit{Present value of benefits}} = (1 + r)^\wedge(-t)$$

Where r = annual rate divided by 100 and t = time in years.

[9] Previous studies shows that only Botswana (15,220 MT), Sudan (12,130 MT), Namibia (11,670 MT) and Zimbabwe (11,240 MT) had significant exports of beef from Africa (Government of Kenya, 2004).

Present Value of Costs: This term refers to the discounted stream of costs associated with a project or program. It is calculated using a formula similar to the present value of benefits:

$$Present\ value\ of\ costs = (1 + r)^\wedge(-t)$$

Where r = annual rate divided by 100 and t = time in years.

Net Present Value (NPV): The term refers to the discounted value of an investment's stream of benefits less the costs. If positive, the investment should be made, otherwise it should not be made. It is calculated using the formula below:-

$$\frac{R_t}{(1 + i)^t}$$

Where t =the time of the cash flow

i = the discount rate (the rate of return that could be earned on an investment in the financial markets with similar risk.)

R_t = the net cash flow (the amount of cash, inflow minus outflow) at time t (for educational purposes, R_0 is commonly placed to the left of the sum to emphasize its role as (minus the) investment.

Internal Rate of Return (IRR): refers to a common financial valuation metric used by financial analysts to calculate and assess the financial attractiveness/viability of investments. It also refers to the maximum interest that a project/program can pay for the resources used if the project is to recover its investment and operating expenses and still just break even or the rate of interest at which the NPV=0.

Given the (period, cash flow) pairs (n, C_n) where n was a positive integer, the total number of periods N, and the net present value NPV, the internal rate of return was given by r in:

$$NPV = \sum_{N=0}^{N} \frac{C_n}{(1+r)^n} = 0$$

Benefit Cost Ratio (BCR): This refers to the ratio of discounted benefits and discounted costs of a project or program. It is often used as an indicative ratio that attempts to summarize the overall value for money of a project or program. It was obtained by PVB divided by PVC. The project or program would be economically feasible if the BCR was greater than 1.

Ideally, because a BCA is a social level analysis, benefits should be valued on the basis of beneficiaries' willingness to pay while costs are valued at opportunity cost of undertaking the project or program.

5.2.2 Identification of benefits and costs

5.2.2.1 Identification of benefits

Two categories of benefits were identified based on (Hobbs *et al.*, 2007) 1). Primary (direct) benefits; and, 2). Secondary (indirect/enabling) benefits.

These benefits were envisaged to occur at two levels within the livestock marketing chain, thus at producer and industry level as illustrated in Table 5.1.

Table 5.1: Various levels and forms at which the benefits of LITS occur

Level	BENEFITS	
	Primary	**Secondary**
Producer	Production losses avoided	Trace-back of strays, theft and rustling
Industry	Enhanced food safety	Losses avoided upstream and downstream
	Enhanced quality assurance	Reduced occurrence of beef-borne illnesses (reduced morbidity)
	Export losses avoided	Lives saved (reduced mortality)

5.2.2.2 Identification of costs

Similarly, the costs of the LITS were envisaged to exist in two forms 1). Primary (direct) costs; and, 2). Secondary (indirect) costs. In addition, these were experienced at three different levels namely 1). Producer level, 2). Control centre level; and, 3) Market chain level, as summarised in Table 5.2.

Table 5.2: Outline of the levels at which the major costs of the LITS occur

	COSTS	
Level	**Primary (direct)**	**Secondary (indirect)**
Producer	Purchases of ear-tags, ear-tag readers and applicators	Government compensation
	Trace backs	Risk of infection on ear-tag site
	Labour and learning/awareness	-
Control Centre	Database, training, Monitoring (vehicles); staff (labour)	-
Marketing Chain	Purchases of ear-tag readers, database system, labour	-

5.2.3 Estimation of benefits

The implementation of a cattle identification and traceability system in Kenya was envisaged to result in several advantages disaggregated as follows:

5.2.3.1 Primary benefits

(a) Losses from cattle theft avoided

Livestock related insecurities arising from cattle rustling cause great loss in the Kenyan pastoral production system. Its impact includes human displacement and or fatalities and high cost of policing and redress (hot iron branding) in an attempt to address the problem. LITS would reduce the incidence of cattle theft due to high likelihood of recovery, its benefits would then be the product of the number of cattle stolen per year (ACS) and the mean market value[10] of each animal (AV), thus,

$$Cost\ of\ cattle\ theft = ACS * AV \qquad \textbf{(1)}$$

Total number of cattle lost due to cattle rustling and theft was estimated through expert opinion and averaged for the years 2000 to 2007.

(b) Production losses avoided

The most important and direct benefit of a national traceability system was perceived to be in the area of risk and disease management for livestock. The primary *raison-d'etres* for such systems includes managing the risks associated with potential livestock disease *ex-ante* and assisting in controlling the spread of the disease *ex-post*. The LITS would support more rapid and targeted response in the case of transboundary disease outbreaks.

Intuitively, one expects a higher demand for beef *with* the LITS program than *without* the program. On the other hand, increased quality assurance would imply increased beef supply because producers have a guaranteed market. Theoretically, the benefits to society/country as a result of the LITS consist of the estimated difference in consumer and producer surpluses[11]. Aspects of consumer surplus were translated into actual benefits as socioeconomic losses avoided, production loss avoided (actual cost of the disease thus mortality, morbidity,

[10] Market value was used for this study although the value of cattle to the pastoralist is a summation of not only market value, but also the value of milk, calves and manure that it would bring in a year. The other contributions are ignored in this study.

[11] The consumer surplus is the amount that consumers benefit by being able to purchase a product for a price that is less than they would be willing to pay. The producer surplus is the amount that producers benefit by selling at a market price that is higher than they would be willing to sell for. Producers will therefore supply a quality attribute if the marginal revenue of adding (improving) a quality attribute is larger than the marginal cost associated with adding (improving) that attribute (Rosen, 1974).

treatments) and loss of productivity (milk, abortions and discards) for three transboundary diseases (FMD, RVF and CBPP). It required an estimation of;

1).**Total number of animals infected (TNI):** This was estimated from herd size at risk (HSR) and the derived long-term prevalence rate (PR) derived from literature, thus;

$$TNI = HRS * PR \quad (2)$$

2).**Total vaccination cost (TVC):** Following an outbreak, a given proportion of the herd at risk is vaccinated. The cost of vaccination was obtained from the proportion vaccinated (PV) and unit vaccination cost (UVC), thus;

$$TVC = HRS * PV * UVC \quad (3)$$

3).**Total treatment cost (TTC):** This was computed from TNI, proportion treated (PT) and unit treatment cost (UTC), thus;

$$TTC = TNI * PT * UTC \quad (4)$$

4). **Cost of the animals destroyed/dead:** (Total mortality cost - TMC). This was estimated from the proportion that die (PD) and unit market value of animal (UVA)

$$TMC = TNI * PD * UVA \quad (5)$$

These values were used to estimate the benefits of a LITS at the producer level and benefits were computed from the losses due to various disease outbreaks avoided. As a result, the Total Production Losses Avoided (TPLA) was calculated as:

$$TPLA = TVC + TTC + TMC \quad (6)$$

In this study, estimation of the losses and control costs attributable to the three major cattle diseases preventable in the presence of traceability system were derived from various literature (Thompson, 2003; Tambi *et al.*, 2006; GoK, 2004; Kasiiti, 2009, East African, May

18th 2009). The losses avoided due to LSD were assumed to be equivalent to the normal cost of delivering veterinary services whether or not a LITS is in place.

(c) Export losses avoided

The value of beef exports lost was estimated from the total cost of bans imposed on Kenyan beef following outbreaks of FMD or RVF by importing countries. These countries were signatories to the WTO Sanitary and Phytosanitary (SPS) agreement. Towards this end export losses were estimated through the following steps:

The value of all beef exports for years 2000-2007 were used to estimate the mean annual beef export volume from Kenya. The estimated value (EQ) obtained from literature was multiplied by 2007 meat prices for Botswana to the European Union mean export price (PE) for the same time period thus, 2000-2007 to provide the value of export loss avoided (ELA).

$$ELA = EQ * PE \qquad (7)$$

A modest 30% growth of exports annually was used to estimate entry of Kenyan beef into the EC market (Godiah – personal communication).

(d) Food safety

One of the benefits of implementing LITS was improved safety of animal products based foods. This would manifest in the form of reduced incidence of food-borne infections among consumers. In the case of RVF this was estimated as the cost of illness (mortality and morbidity) avoided. According to Freeman (2003), the value of preventing the death of an individual of age t at present is the discounted present value of that individual's earnings over the remainder of his expected life. Mathematically this is given by:

$$Value = \sum_{i-1}^{T-t} \frac{\pi_{t+i} - E_{t+i}}{(1+r)^i} \quad (8)$$

where π_{t+i} is the probability of the individual surviving from age t to age $t+i$; E_{t+i} is the expected earnings of the individual at age $t+i$, r is the discount rate, and T is the age at retirement from the labour force. In addition, there was also intangible value of human life that is impossible to evaluate in monetary terms.

5.2.3.2 Indirect benefits

The indirect benefits of LITS included reduced losses avoided upstream and downstream, trace-back of strays, theft and rustling, reduced occurrence of beef-borne illnesses (reduced morbidity) and lives saved (reduced mortality).

(a) Losses avoided upstream and downstream

Upstream losses were those that would accrue to input suppliers to the beef industry. In case of a major disease outbreak, these sectors would have to contract to accommodate the change. Losses avoided were the proportion of business lost (contraction) due to disease outbreak - thus, the reduction in the turnover of the business arising from disease outbreak. Losses mainly accrued to (i) drug, vaccine and insect/pest control agents, manufacturers, and (ii) feed manufacturers.

Downstream losses would accrue to the beef processors, hotel industry, transportation and financial services. These losses were estimated from literature.

5.2.4 Estimation of costs of the LITS

Compared to benefits, the costs of a LITS were easier to estimate from the costs of pilot-test experiment of implementing the LITS in Kenya from this study.

5.2.4.1 Primary (direct) costs

a) Costs at the producer level

At the producer level, the costs were estimated to include purchases of tags, tag readers and applicators, labour for tagging, and Capacity building.

The total cost of the program at the producer level was calculated by multiplying the market price of each of the cost items (tags, readers and applicators) by the quantity purchased. Lost tags were replaced at the rate of 5% per annum (manufacturers' recommendations) and for boluses at the rate of lives cattle off-take for export. To calculate the cost of labour and Capacity building, these were computed from data collected from the trial and extrapolated for ten ASAL districts accordingly.

b) Control centre costs

These costs were estimated from the costs of running the trial and extrapolated accordingly. The specific costs included:

(i) Wages and salaries

(ii) Enforcement costs

(iii) Computers and other electronics and power sources

(iv) Software (Units)

(v) For mainframe (Server)

(vi) Networking for data harvesting, accumulation and transfer.

Maintenance Costs per year included:

(vii) Stationery (volume)

(viii) Vehicle purchase, operation and maintenance.

c) **Costs in the marketing chain**

In order to ensure ease of traceability, tag distributors were supposed to operate a database containing numbers of all the tags sold to the customers. These costs included purchases of computers, stationery and labour

At the beef processing level, abattoir operators were also expected to maintain a database of all animals slaughtered until the carcasses were approved for human consumption or were condemned. Cost items included: computer, stationery and reader. The number and costs of these items were estimated from the trial and then extrapolated accordingly.

d) **Trace backs**

In any year, one of the main benefits of LITS was the number of tracebacks made. These were the number of tracebacks undertaken by the pilot project per year in its investigation of reportable diseases and other conditions. Such costs were captured within the labour costs at the control centre.

5.2.5 Comparing benefits and costs

5.2.5.1 Choice of Social Discount Rate

Discounting for time constitutes a fundamental part of proper BCA. This was based upon the principle that money at hand is worth more than that earned sometimes in the future. In addition, people prefer to consume a given amount of resources in the present rather than in the future. According to Boardman *et al.* (2005), the choice of an appropriate social discount rate (SDR) matters because different values change the ranking of projects leading to different policy recommendations. In this study, the discount rate was estimated as the average rate of interest on the 91-day Treasury Bond for 2007/2008. Government bonds represent the minimum rates of return that investors can expect on safe investments.

5.2.5.2 Present Value of Benefits of LITS

Based on the useful life of the main capital investment under the LITS, a time length for which the project would last before a major overhaul was estimated at five (5) years. Such an overhaul would consist of incorporating other livestock species into the identification program and probably replacing some of the capital items. The benefits that would continue to accrue after the first year include export losses avoided (because importers may take some time before they fully open up their markets), decreased morbidity and mortality from beef-borne illnesses (due to increased food safety) and upstream and downstream losses avoided. It was assumed that the benefits of food safety would accrue at the same rate throughout the year. Based on expert opinion, it was also assumed that up/down-stream avoided losses would accrue at 50 and 25% of the first year during the second and third years respectively. On the cost side, the cost items were primarily the running costs. These were staff salaries and director's allowances, vehicle and computer maintenance, and the annual replacement of lost ear-tags and marker pens, assumed at a rate of 5% annually- (manufacturers' recommendations). The benefit of reduction in livestock rustling was assumed to be equivalent to the budget for policing and branding over a five year period.

5.2.6 Cost Computation of LITS from farm to fork

The model developed by Dhuyvetter and Blasi (2010) available in (www.beefstockerusa.org/rfid) was used to compute the cost of RFID systems for different sizes and players in the supply chain. The model takes into consideration the following variables to provide cost estimation of RFID system for various players in the beef supply chain. The following section uses the following terms freely.

D = Annual Depreciation
I_V = Initial Value of the Equipment
S_V = Salvage Value
E_L = Expected Life of the Equipment
R = Annual Interest Rate
r = Monthly Interest Rate
t = Time Month
T = Time Year
A I C = Accrued Interest Cost
S_H = Size of Herd
P = Percentage Use of the Equipment Goes to RFID
M = Monthly Cost of the Operational activity

The equipment used in the model for cost computation was depreciated over a number of years depending on the expected life of the equipment. In this case it was assumed that the whole system has a shelf life of five years before requiring a major overhaul. Equation (9) was used to compute the annual depreciation of the equipment.

$$D = \frac{I_V - S_v}{E_L} \qquad (9)$$

In addition, the model divided the cost of establishing the traceability system into investment and operational costs. The scope of the investment in the model included the reader, accumulator and software.

In the equation (10), for example, $T_0 = 0$, $T_1 = 1$ among others

$$\sum_{t=1}^{N} (I_v - D * T_{t-1}) * R \qquad (10)$$

In order to find the total cost of the equipment per head of cattle annually equation (11) took into account the cost of borrowing as well as the initial value of the equipment. By using equation (11) the cost of the equipment was computed.

$$Cost\ of\ the\ Equipment\ per\ Head = \frac{\frac{[A.I.C + I_V] * P}{E_L}}{S_H} \qquad (11)$$

The operational cost included the price of RFID tags, internet access fees and labour. Equation (12) was used to find operational cost per head of cattle and was computed in a similar manner to annuity.

$$\textbf{Operational cost per head} = \frac{\left[\left(\frac{(1+r)^t - 1}{r}\right) * M\right] * P}{S_H} \qquad (12)$$

The sum of the results of equation (11) and (12) provided the annual per head cost of the RFID system.

All the prices used within the BCA were the actual prices of equipment and materials for the study. It was however envisaged that these costs are likely to reduce if government purchases materials directly, in bulk and with government subsidising the customs duty.

5.2.6.1 Base scenario analysis

The cost model used an analysis of the Base Scenario. This utilised a system that met minimum traceability compliance. Readers, computer equipment, and electronic communications were supplied to the veterinary offices at district level.

Facilities modification: The low cost assumption reflects the scenario where traceability systems are installed with limited or minor modification to the market infrastructure. The study used the Department of Veterinary Services mobile or fixed crushes.

RFID tags and applicators: The tag cost range was based on costs inclusive of freight from the vendor marked up with the price of customs duty. It was presumed that this could have been lower had government imported the tags directly.

Computers: Laptop computers with basic software and communications were purchased from local retailers in Kenya. The computers were provided with basic modems for internet connectivity. The laptops were exclusively dedicated to the traceability system, assigned a five-year useful lifespan and its cost is amortized accordingly.

Database software: The database software was based on the actual price of software development. Again software was assumed to have a five-year useful life before requiring an upgrade. The cost of the server was included in that of the software.

5.2.7 Indirect Costs

5.2.7.1 Risk of Infection

The only conceivable indirect cost of such a national cattle identification program relate to disease transmission during bolus application. This risk would arise when a single applicator is used repeatedly on several animals without disinfecting. In this study, these costs were deemed to be minimal as the animals were all handled by qualified veterinary personnel and were therefore excluded from the analysis.

5.2.8 Comparing benefits and costs

5.2.8.1 Present value of Benefits of LITS

The study assumed that the project would last for five years before a major overhaul is made. The benefits that would continue to accrue after the first year include export losses avoided (because importers may take some time before they fully opened up their markets), decreased morbidity and mortality from beef-borne illnesses (due to increased food safety), and upstream and downstream losses avoided.

5.2.8.2 Choice of social discount rate

The average return to Government bond paper at 7.5% for years between 2000 and 2007 was used. In order to take into account the interest on the investment and operational cost of the system, a 7.5% annual interest rate of the 91 day Treasury bond was used.

5.3 Results of Benefit Cost Analysis

5.3.1 Direct and indirect benefits

Based on literature, all the direct and indirect benefits of implementing LITS in Kenya were estimated and summarized. Table 5.3 provides the annual value of benefits over a five year period. The cost of implementing full traceability for a bovine using rumen boluses and ear tags were computed based on Dhuyvetter and Blasi (2010) and available in (www.beefstockerusa.org/rfid). The results of the computations are provided (Table 5.4-5.7) respectively

Table 5.3: Annual value of benefits in US Dollars over a five-year period

Benefits accrued by implementing LITS	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Cost of cattle rustling, policing and iron branding avoided	8,700,000.00	8,700,000.00	8,700,000.00	8,700,000.00	8,700,000.00	43,500,000.00
Socio-economic impact and transboundary diseases control costs avoided	146,931,041.50	145,770,619.50	145,717,803.50	24,813,320.00	24,917,422.00	488,150,206.50
Market access and exports opportunities enhanced due to LITS	2,200,200.00	2,860,260.00	3,718,338.00	5,577,507.00	7,249,659.00	21,605,964.00
Total benefit	**157,831,241.50**	**157,330,879.50**	**158,136,141.50**	**39,090,827.00**	**40,867,081.00**	**553,256,170.50**

Source: Compilation from Thompson, 2003; Tambi *et al.*, 2006; Government of Kenya, 2004; Kasiiti, 2009, East African, May 18th 2009 (Appendix 6)

Table 5.4: Estimated Costs for a RFID System based on the use of rumen boluses

Average herd size in 10 ASAL districts', number of head	2,655,997
Interest rate, %	7.50%

RFID Components[1]

Description	Initial cost, $[2] Total	Per Head	Useful life, yrs	Salvage value, $	Annual Cost, $	Percent to RFID	RFID Cost Total	Per Head	
eID Transponder (electronic tag)									
Electronic tag	---	$6.49	---	---	$17,883,824	100%	$17,883,824	$6.73	
Tags for cattle (one-time purchase)	---	$1.46	5	0	$958,444	100%	$958,444	$0.36	
Electronic reader									
Wand/stick reader	1058.5		5	0	$210.9	100%	$210.9	$0.00	
Server and computers									
Laptop computer	$1,489.2		5	0		100%			297.84
Software / web-based analysis and storage									
Computer software	78,840		5	0	$19,486	100%	$19,486	$0.01	
Other									
Internet access	204.4		---	---	$212	50%	$106	$0.00	
Subscriptions/upgrade fees	$0		---	---		0%			
Labour	730,000		---	---	$757,375	100%	$757,375	$0.29	
Total annual cost							**$19,619,497**	**$7.39**	

Table 5.5: Total annual cost per head (US$) RFID system based on the use of rumen boluses

Total Annual RFID System Cost, $/head

RFID Components	Base	Size of Herd, percent of base 40%	60%	80%	100%	120%	140%	160%
Description	2655997	Size of Herd, number of head 1062399	1593598	2124798	2655997	3187196	3718396	4249595
eID Transponder (tag)								
Electronic tag	$6.73	$6.73	$6.73	$6.73	$6.73	$6.73	$6.73	$6.73
Tags for cows (one-time purchase)	$0.36	$0.36	$0.36	$0.36	$0.36	$0.36	$0.36	$0.36
Electronic reader								
Wand/stick reader	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Computer/server								
Software/ web-based analysis and storage								
Computer software	$0.01	$0.02	$0.01	$0.01	$0.01	$0.01	$0.01	$0.00
Other								
Internet access	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Labour	$0.29	$0.71	$0.48	$0.36	$0.29	$0.24	$0.20	$0.18
Total annual cost	**$7.39**	**$7.83**	**$7.58**	**$7.46**	**$7.39**	**$7.34**	**$7.30**	**$7.28**

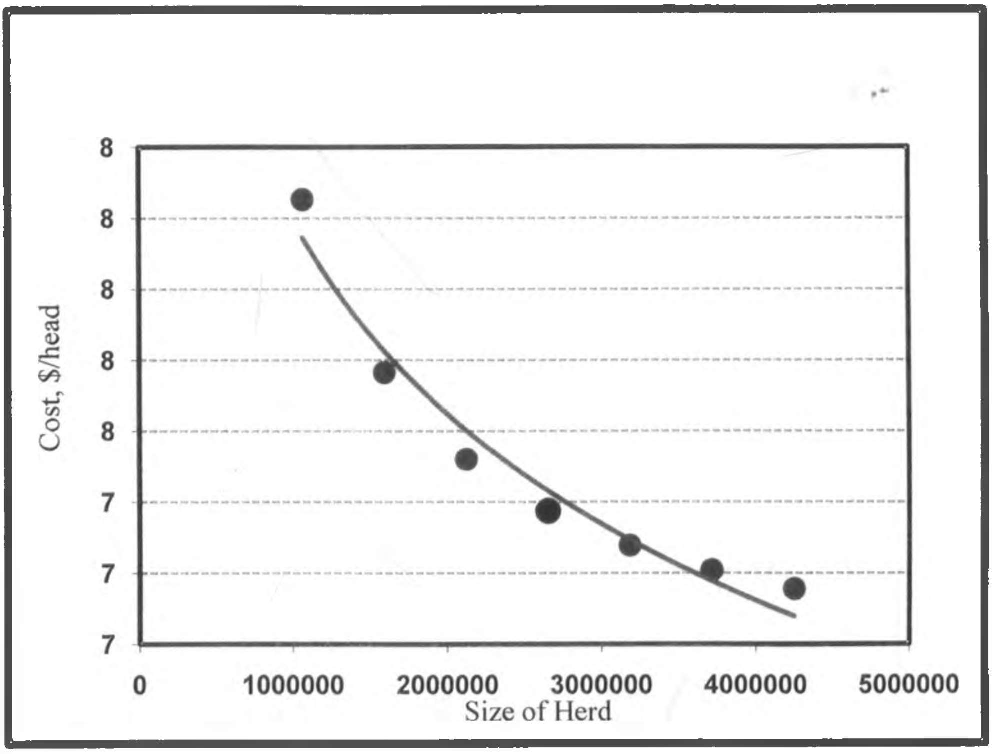


Figure 5.1: Variation in total annual cost of RFID system based on the use of rumen boluses

Similarly, the cost when using ear button tags was estimated at US$ 5.15 for registration (Table 5.6) and US$ 4.87 for annual maintenance (Table 5.7) respectively. The average cost approximates US$ 5 (Fig. 5.2).

The total cost of the program at the producer level was US$ 19,619,497 for the 10 ASAL districts while the NPV at an interest rate of 7.5% was estimated at US$ 352,223,378.84 at 2007 prices and the Benefit Cost ratio of 4.73 (Table 5.8). The financial internal rate of return was estimated at 29.4%. The total cost of implementing LITS with the ear button tag was US$ 13,668,863; similarly, the NPV was US 386,647,911.8 and the BCR 7.34. The IRR while using the ear button tag was 46.66% (Table 5.9)

Table 5.6: *Estimated Costs for a Radio Frequency Identification (RFID) System (ear button tags)*

Average herd size, n 2,655,997

Interest rate, % 7.5%

RFID Components[1]

Descriptio	Initial cost, $[2] Total	Per Head	Useful life, yrs	Salvage value, $	Annual Cost, $	Percent to RFID	RFID Cost Total	Per Head
eID Transponder (electronic tag)								
Electronic	---	$4.44	---	---	$12,234,850	100%	$12,234,850	$4.61
	---		---	---				
Tags for c	---	$1.00	5	0	$656,469	100%	$656,469	$0.25
Electronic reader								
Wand/stic	$1,059		5	0	$262	100%	$262	$0.00
Data accumulator								
Laptop cc	$1,489		5	0	$368	100%	$368	$0.00
Software / web-based analysis and storage								
Computer	$78,840		5	0	$19,486	100%	$19,486	$0.01
Other								
Internet ac	$204		---	---	$212	25%	$53	$0.00
Subscripti	$0		---	---		50%		
Labor	$730,000		---	---	$757,375	100%	$757,375	$0.29
			---	---				
Total annual cost							**$13,668,863**	**$5.15**

[1] See the **RFID components** tab for a brief discussion of the different components of the RFID system.

[2] Only enter **Total** *and* **Per Head** costs if there is a fixed and a variable componenent (i.e., do not enter costs twice).

Table 5.7 Variation in total annual RFID System Cost, US $/head based on the use of ear button tags

RFID Components	Base	40%	60%	80%	100%	120%	140%	160%
		Size of Herd, percent of base						
		Size of Herd, number of head						
Description	2655997	1062399	1593598	2124798	2655997	3187196	3718396	4249595
eID Transponder (tag)								
Electronic tag	$4.61	$4.61	$4.61	$4.61	$4.61	$4.61	$4.61	$4.61
Tags for cows (one-time purchase)	$0.25	$0.25	$0.25	$0.25	$0.25	$0.25	$0.25	$0.25
Electronic reader								
Wand/stick reader	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Data accumulator								
Laptop computer	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Software/ web-based analysis and storage								
Computer software	$0.01	$0.02	$0.01	$0.01	$0.01	$0.01	$0.01	$0.00
Other								
Internet access	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Labor	$0.29	$0.71	$0.48	$0.36	$0.29	$0.24	$0.20	$0.18
Total annual cost	**$5.15**	**$5.59**	**$5.34**	**$5.22**	**$5.15**	**$5.10**	**$5.06**	**$5.04**

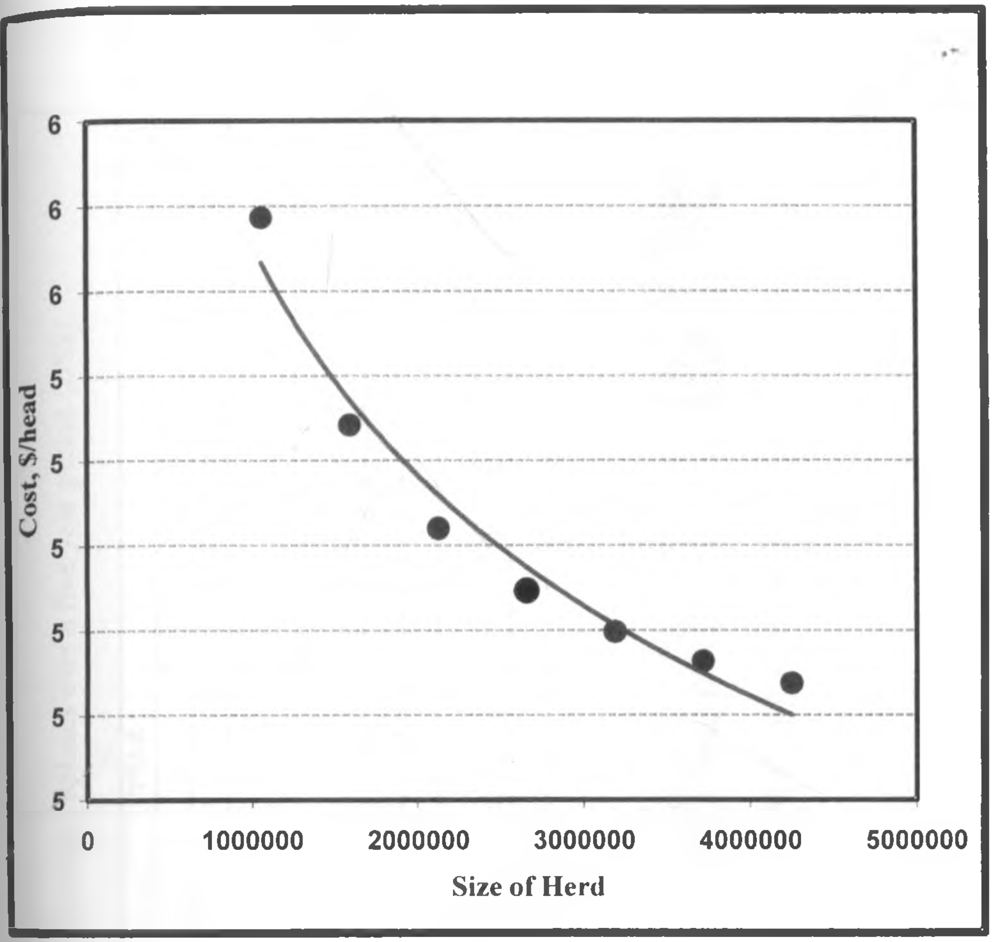


Figure 5.2: Variation in total annual cost of RFID system based on the use of ear tags

Table 5.8: Benefit cost analysis for implementing LITS using rumen boluses over a five year period (US$)

	YEAR					
BENEFITS	1	2	3	4	5	TOTAL
Cattle Rustling	8,700,000.00	8,700,000.00	8,700,000.00	8,700,000.00	8,700,000.00	43,500,000.00
Transboundary disease socioeconomic impact	146,931,041.50	145,770,619.50	145,717,803.50	24,813,320	24,917,422	488,150,206.50
Exports opportunities due to LITS	2,200,200.00	2,860,260.00	3,718,338.00	5,577,507.00	7,249,659.00	21,605,964.00
Total benefit	157,831,241.50	157,330,879.50	158,136,141.50	39,090,827	40,867,081	553,256,170.50
	0					
COSTS	0					
Producer level	20641556.92	21,260,803.63	21,898,627.74	22,555,586.57	23,232,254.17	109,588,829.02

TOTAL BENEFITS OVER 5 YRS	553,256,170.50
PV OF BENEFITS	**446,755,665.42**
TOTAL COST OVER 5 YRS	109,588,829.02
PV OF COSTS	**94,532,286.58**
NPV	**352,223,378.84**
BENEFIT COST RATIO	**4.725958522**
INTE[redacted]AL RATE OF RETURN	29.3991241454%

(Interest rate at which NPV is zero)

INTEREST RATE EFFECTIVE PER ANNU [redacted]
RATE OF INFLATION PER ANNUM

REAL RATE OF INTEREST 0.04368932

10,000,000,000 153846153.8

Discount for values was done as follows: Present value of benefit or cost $= (1 + r)^{(-t)}$ where r = annual rate divided by 100 and t = time in years.

Table 5.9: Benefit cost analysis for implementing LITS using ear button tag over a five year period (US$)

	YEAR					
BENEFITS	1	2	3	4	5	TOTAL
Cattle Rustling	8,700,000	8,700,000	8,700,000	8,700,000	8,700,000	43,500,000.00
Transboundary disease socioeconomic impact	146,931,041.50	145,770,619.50	145,717,803.50	24,813,320	24,917,422	488,150,206.50
Exports opportunities due to LITS	2,200,200	2,860,260	3,718,338	5,577,507	7,249,659	21,605,964.00
TOTAL	**157,831,241.50**	**157,330,879.50**	**158,136,141.50**	**39,090,827.00**	**40,867,081.00**	**553,256,170.50**
COSTS						
Producer level	13678388	13,386,225.00	13,787,811.75	14,201,446.10	14,627,489.49	69,681,360.34

TOTAL BENEFITS OVER 5 YRS	553,256,170.50
PV OF BENEFITS	**446,755,665.42**
TOTAL COST OVER 5 YRS	69,681,360.34
PV OF COSTS	**60,107,753.54**
NPV	**386,647,911.88**
BENEFIT COST RATIO	**7.432579645**
INTERNAL RATE OF RETURN (Interest rate at which NPV is zero)	46.66%

INTEREST RATE EFFECTIVE PER ANN[redacted]	[redacted]
RATE OF INFLATION PER ANNUM	[redacted]
REAL RATE OF INTEREST	0.04368932

5.4.6.3 Sensitivity analysis

A sensitivity analysis was undertaken on the NPV to test its variability under different discount rates. Both a 0% (i.e. no discounting scenario[12]) and 15% discount rate (double the government return on bonds – i.e., a likely return in the event of increased government borrowing in the local market) were used. Summary findings of the final costs and results BCA done under field conditions in Kenya is provided in Table 5.10 below.

Table 5.10: Summary data of vital BCA statistics

BCA Result summary		**Rumen bolus**	**Ear button tag**
Cost/head registration (US$)		7.39	5.15
Cost /head annual maintenance (US$)		7.28	5.04
Interest rate			
0%	NPV (US$)	546,843,248.33	581,267,781.37
	BCR	6.78	10.67
7.5%	NPV	352,223,378.84	386,647,911.88
	BCR	4.73	7.43
	IRR (%)	29.4	46.7
15%	NPV	224,344,707.96	258,769,241.01
	BCR	3.37	5.36
Total cost of implementation (US$)		19,619,497	13,668,863

[12] Some studies show that many federal agencies (particularly in the US) do not discount (see Boardman *et al.*, (2005).

5.5 Discussion

The LITS was initiated out of the need to test the applicability and potential benefits of a system that would increase the rate of tracing back a diseased animal or animal product through the food chain. This study found a high and positive NPV and BCR. Therefore, it was established that the LITS is a worthwhile undertaking in the continued presence of transboundary diseases and periodic livestock bans.

Traceability has become a global standard that will most likely affect the competitiveness of Kenyan beef. Managing the risks associated with potential livestock disease *ex-ante* to an outbreak and assisting in controlling the spread of the disease *ex-post* was the primary purpose *(raison-d'êtres)* for such a system. Other costs include that of livestock related insecurities which due to the associated human injuries and fatalities and internal displacement of affected persons attracts more attention. It is therefore necessary to avoid the economic loss attributed to cattle rustling related conflicts. For instance, between 1999 and 2002, cattle raids in Kenya significantly drained the national economy by UD$ 225 million (Mwadime - personal communication). Finally, implementation of LITS is likely to consistently open up opportunities for market access. It was realised that within the livestock industry, the effect of not implementing some aspects of LITS (maintaining status quo) may result in significant losses as high as US$ 4 million on average per year over a 5-year period due mostly to reduced export market access.

It was realised also that the implementation of LITS was likely to be more cost-effective as participation levels increase and may not be economically viable at lower participation levels. In Kenya, it was much cheaper to implement LITS than continue with actions such as

"*Dumisha Amani*" (hot iron branding plus policing) that are largely ineffective. It is also envisaged that since the BCA is based on cattle species alone, the cost is likely to substantially come down when small ruminants are brought on board. This is because they are unlikely to require a different system but rather an expansion of the same.

Estimated tag and tagging costs vary for cattle producers and was US$ 7.39 compared to US$ 5 in Botswana (Ferguson, personal communication) and between US$ 3.30 and US$ 5.22 per cow in the USA (Evans, 2009). The cost of animal identification in Australia is absorbed mainly by producers who spend approximately US$ 3.50/RFID tag (Evans *et al.*, 2009). The total cost for implementing LITS in the beef cattle sector in Kenya as described in the study would be US$ 110 million. In addition, there would be an annual cost of US$ 193 million annually (at a 90 percent level of participation). A benefit-cost analysis performed on project costs and benefits indicated positive indicator of net project benefits (US$ 352,223,378.84 and BCR of 4.73) over a five-year period. The main effects of the project are linked to employment promotion which is the base of the project's efficiency and solvency. The analysis indicates an internal rate of return of 29.4%. Sensitivity analysis conducted on the data proves all underlying assumptions to be robust and the project to be viable.

It is ironical that identification and traceability systems are often seen by many developing countries as obstacles to trade. The reality is that LITS is a major opportunity to equip our animal health and production systems in order to play their full role in meeting our society's many needs. For effective implementation, developing countries must first clearly understand the broad costs (investment and operating) and potential benefits involved.

The main beneficiaries of LITS are consumers (through increased food safety, access to markets and reduced livestock related securities), and export traders and ranchers through access to premium markets, the veterinary authorities through reduced disease outbreaks and cost of surveillance, input suppliers and output distributors. Hobbs *et al.* (2007) estimated that consumers and traders are likely to enjoy approximately 35% of the benefits during the first year while producers would enjoy 30% of the benefits. Over the life of a LITS project consumers were likely to reap the highest benefits (Hobbs *et al.*, 2007). Beef farmers would enjoy the rest of the benefits, but in mandatory systems the government was likely to bear the largest portion (62%) of the costs of the project during the initial year.

The greatest challenge identified was that of comprehensive information with regard to benefits because not many such studies are available. The study used expert opinion or the scientific literature to fill the gaps where no field data existed. The study also realised that labour costs were much lower than initially envisaged. This was attributed to the fact that the burden of implementation which rested upon the Department of Veterinary Services in the form of salaries and allowances had been largely accounted for elsewhere. This is similar to the findings of studies in the USA (Evans *et al.*, 2009).

This study limited itself to examining the primary benefits of LITS whereas the benefits of controlling endemic and production diseases were not included. In any case the estimation of primary benefits was constrained by the deficiency of easily quantifiable information in monetary terms. The study therefore explored benefits to the livestock industry using past disease events as described by Evans *et al.* (2009).

Costs were inversely proportional to the number of cattle tagged within a country. While it was realised that a complete RFID system is more expensive due to the expenditure on readers, software, computers and the cost of establishing a communication infrastructure, it would minimise the respective costs of recording and reporting. It is envisaged that while visual identification like hot iron branding could be cheaper (US$ 3-5), the task of collecting data and reporting that meets international requirements may remain formidable. A large proportion of the costs of implementing RFID were for capture and validation of data provided from the secondary market by the veterinary personnel. Within this study, the veterinary personnel were also responsible for enforcing identification (registration), movement facilitation, tracking of cattle, electronic capture and transfer of data and validation within a central processing unit.

CHAPTER 6: INSTITUTIONAL AND ORGANISATIONAL REQUIREMENTS FOR IMPLEMENTATION OF LITS IN KENYA

6.1 Introduction

The application of electronic traceability systems requires institutional, organisational and processes alignment that address the tensions and conflicts that are inherent in international negotiations. This is an important precondition to widespread adoption, a process often organized within both institutional and market constraints. The process of organisation integrates a technological sphere that incorporates both information and communication (Galliano and Orozco, 2008).

This chapter focuses on those formal and informal elements that set the framework and that influence and govern interactions and exchanges among parties/actors in society. Formal elements are broadly of two kinds: the legal provisions that sanction a particular event (constitutions, acts, laws, ordinances, among others) and the instruments that operationalise and regulate these provisions (rules, regulations, systems and procedures among others). Informal elements include traditions, customs, practices and taboos. This chapter reports on the broader institutional, procedural and organisational requirements to up-scale the pilot RFID based LITS trial to national level. It also describes the legal changes proposed to make electronic identification of livestock possible in the short-term.

6.2 Methodology

In order to define the institutional and organisational arrangements, consultations were held with stakeholders at policy level, who included the Permanent Secretary, Ministry of Livestock Development. Second level consultations were also held with technical officers and administrators in the Ministry of Livestock Development. In addition, various considerations were made on the rules and procedures for revising or updating CAP 357 and other relevant documents as follows; i)The processes and challenges in amending CAP 357 and prescribing the best possible option for hinging electronic livestock identification in legislation; ii) Emerging issues, international guidelines and benchmarking the operations of LITS in other countries; iii) Desk study on related legislation such as Animal Diseases Act CAP 364 and the Prevention of Cruelty to Animals Act CAP 360 iv) Desk study of Sessional paper No. 2 of 2008 on the National Livestock Policy and the Draft Strategic Plan 2008 – 212 of the Ministry of Livestock Development; and v) Desk study of the Attorney General's circular on "Proposed Legislation" on Bills and Legal Notices.

Finally, a workshop was facilitated for a group of technical officers and legal experts in order to establish the best way to address the matter in the interim.

6.3 Results

6.3.1 Institutional framework at implementation of LITS

For effective implementation of LITS, an inclusive legal framework would be required. The livestock policy propounded in 2008 mentioned livestock identification in two portions. Section 3.9.2 of the livestock policy document states "*The government will discourage livestock rustling and ease recovery of stolen animals, through instituting measures to identify all livestock and register identification marks*"; and section 3.4.2 that states: "*The existing legal and regulatory framework is inadequate to address the current and future challenges in disease, pest and quality control*" (Government of Kenya, 2008). However, at the time of the trial, the Branding of Stock Act CAP 357 was the principle legal instrument concerned with effecting the identification of livestock never-the-less, its enforcement was wanting.

The review of the various documents established that CAP 357 was the only Act dealing with livestock identification in Kenya. This Act had a number of limitations 1) identification of animals was restricted to the level of the location and did not identify individual animals 2) the Act did not provide for mandatory branding and therefore its enforcement, policing and implementation was inadequate. Penalties prescribed under the Act were lenient and woefully inadequate as deterrents 3) The Act did not recognize other methods and technologies in animal identification.

Whereas the most meaningful proposal of the Department of Veterinary Services was to repeal CAP 357 and come up with a new "Livestock Identification and Traceability Act", in the interim there was need to identify where to anchor them while a full review was being undertaken. The department further felt that any new rules made under this section on identification would have been *ultra vires* and exceeding Ministerial mandate. This was in realisation that the Act specifies only hot-iron branding and therefore inclusion of alternative methods of livestock identification would have required a change in the objectives and name of the Act. In addition, Section 28 may have required legal interpretation whether to apply a restrictive interpretation or a wide interpretation that takes cognizance of the spirit of the Act. It is therefore recommended that the rules be incorporated in the Animal Diseases Act (CAP 364) vide Ministerial decree after wider consultations with stakeholders. Only the livestock policy document and CAP 364 made mention of livestock registration. It was realised that in the short-term the most prudent method for revising and up-dating CAP 357 was to formulate rules under section 9(a) of the Animal Diseases Act CAP 364.

Rules cited as the draft Animal Identification and Traceability Rules 2009 were developed for gazettement by Ministerial decree (Table 6.1).

Table 6.1: Animal Identification and Traceability Rules

Legal notice No........................

THE ANIMAL DISEASES ACT

(CAP 364)

In exercise of the powers conferred by section 9(a) of the Animal Diseases Act, the Minister for Livestock Development makes the following Rules:-

Citation	1.	These Rules may be cited as the Animal Identification and Traceability Rules 2009.
Interpretation	2.	In these Rules, unless the context otherwise requires –
		"Animal Identification" means identification by means of brand-marks, tattoos, animal passport, electronic impregnated ruminal bolus, electronic microchip skin implant, electronic ear button, biological identification and any other device conventionally used in animals.
		"Animal passport" means a passport prepared in accordance with international standards for the purpose of identification

of cattle, camels, donkeys, horses, dogs, cats and other animals;

"Traceability" means the *ability to locate an animal, commodity, food product or ingredient and follow its history in the supply chain forward (from source to consumer) or backward (from consumer to source)."*

"Electronic impregnated ruminal bolus" means a device made up of an electronic chip containing animal identification and traceability information which is implanted into a rumen bolus for the purpose of insertion into the rumen;

"Electronic microchip skin implant" means a device made up of an electronic chip containing animal identification and traceability information which has been prepared for insertion into the skin of stock, dogs, cats or other animals;

"International standards" means the standards developed from time to time by the World Organization for Animal Health also known as *Office Internationale des Epizooties* (OIE);

"Inspector" means a person appointed an inspector for the purpose of the implementation of these rules, and as defined in section 3 of the Animal Diseases Act;

"Livestock identification and traceability system" means the central livestock identification and traceability information database located at Veterinary HQ Kabete together with other linked-databases in administrative units;

"Registrar " means the Registrar appointed under CAP 357 and who shall also keep records of all animal owners, animals, animal premises, identification numbers or codes and identification devices for carrying out the provisions of these rules;

"Tattoos" means the insertion into the skin of an animal with indelible ink for the purpose of identification and traceability;

"Zone" means an area of the country set aside through gazettement for the purpose of eradication and suppression of diseases in accordance with international standards.

Purpose of Rules

3. These Rules shall apply to prescribe means and devices for animal identification.

Animals to be identified

4. 1) Animals may be identified by one or more of the following means: a brand, electronic impregnated ruminal bolus, electronic microchip skin implant, electronic ear button, animal passport or a tattoo or in case of products use of DNA profiling;

2) All animals resident in a zone, administrative unit or village and any animal being moved into or out of or through a zone, administrative unit or village shall be registered and identified;

3) Provided that the Director of Veterinary. Services shall specify the means of identification for trade and other circumstances;

4) Animals received in a zone, administrative unit or village shall be registered by the owner into the livestock identification and traceability system within seven days of arrival;

5) All animals imported into Kenya shall be identified at the ports of entry;

6) Any person who keeps animals in a zone, administrative unit or village and who moves animals into or out of or through a zone, administrative unit or village, when the animals are not identified or fails to register his animal shall be guilty of an offence and liable to imprisonment for a term not exceeding twelve months or a fine not exceeding fifty thousand shillings.

Application for animal identification

5. 1) Application for identification of animals shall be made to the registrar;

2) The application shall be made in the form prescribed and shall be accompanied by the prescribed fees by Director from time to time;

3) The registrar shall consider the application and the means of identification and where it appropriately identifies the animal; he shall register the identification in the register and

issue the applicant with a certificate of registration in the form prescribed;

4) The certificate of registration shall be valid for five years and may be renewed on re-application.

6. All animal identification devices for use in Kenya shall be the property of the government;

No person shall manufacture or procure an animal electronic identification device unless under the authority of the Director of Veterinary Services. No person shall introduce into an animal, tamper or remove an animal identification device unless with authority of the Director of Veterinary Services

Device to provide standard information

7. All electronic impregnated ruminal boluses, electronic microchip skin implants and animal passports shall provide animal identification and traceability information as provided by the schedule and in accordance with international standards.

Prescribed on the.................., 2010

....

MINISTER RESPONSIBLE FOR LIVESTOCK DEVELOPMENT

6.3.1.1 Implications of institutional change

The OIE recommends that countries should have formal agreements in place with importing countries and an assurance of markets before adopting specified traceability measures. In addition, a clear regulatory framework for animal identification and traceability, including requirements for enforcement; coordination; data management, ownership, confidentiality and access; technical and, at least initially, financial support are essential (OIE, 2009). In line with this recommendation, the study sought to develop interim rules to guide traceability after implementing the trial in North Eastern Kenya.

The provision for licensing of animal producers under CAP 364 section 9(a) implied traceability, which could accommodate a device that generated a certificate of ownership. Section 9(e) that prohibited movement of animals was also pertinent to traceability and food safety. Powers given to the Minister had a provision for creation of general rules. These aspects made CAP 364 a suitable anchor. However, in the long term, it is recommended that a repeal of CAP 357 be effected and that a new livestock identification and traceability Act be formulated in its stead. The National Livestock Policy of Sessional Paper no. 2 of 2008 (GoK, 2008) Section 3.9.2 and 3.4.2 identified gaps in the CAP 357 that needed to be addressed. The current situation in Kenya is similar to the experience from Botswana where LITS has been anchored in policy rather than law.

Institutions are usually effected and controlled by formal or informal organisations within a sector. If delivery of services has to be more responsive to the end users and deliver quality services, reorganization and fundamental changes, particularly in relation to organizational culture and attitude are essential. Limitations in structure have been eluded as probably the main constraint to government service delivery.

6.3.2 Organizational mapping for LITS in Kenya

This process helped identify all the related stakeholders, examine their roles and functions and separate them into categories of importance. It further enabled the study focus actors essential for implementation of LITS. Identification of stakeholders can be done through discussions with knowledgeable people, and by reading available documentation and records. In line with tradition, Department of Veterinary Services proposed a top down and resource heavy structure of management of LITS in Kenya. This typifies the highly bureaucratic structure of veterinary service delivery with many layers of clear hierarchies, compartmentalized functioning and tedious procedures. In addition, there is slow speed of vertical and horizontal communication.

Such structures are not designed to be responsive to the people and their needs, but rather to the demands of the political and bureaucratic authorities. Such organisation would require transformation into flatter (less layered), horizontally oriented (focused on the clients), responsive and flexible in operation (easy interdepartmental collaboration and sectoral collaboration across agencies). Issues such as decentralization (shifting of power from the centre to the periphery), devolution (decentralization in regard to law-making and the creation or revitalization of local bodies with legislative powers) and deconcentration (shifting power within the bureaucracy from the centre to the local level) were also important.

Various players were identified and the proposed functions of each of the committees were provided thus:

1. Inter-Ministerial Advisory Committee comprising Ministers of (livestock, Internal Security, Trader, Information, Northern Kenya Development, Health Fisheries and Finance).
    i. Resource mobilization, coordination; and,
    ii. Policy direction.
2. LITS Steering Committee comprising Permanent Secretary (PS) (Ministry of Livestock, Finance and Internal Security) Provincial commissioners, Directors of Veterinary Services, Livestock Production (DLP) and Information (DI).
    i. Overall guidance in LITS implementation; and,
    ii. Resource mobilization.
3. Technical Co-ordinating Committee comprising the DVS, Chief of LITS, Chief Veterinary Fields Officer (CVFO), LITS registry, DLP, Deputy Police Commissioner (DPC) in charge of livestock movement and three alternate members.
    i. Implementation of the programme;
    ii. Monitoring and Evaluation; and,
    iii. Programme / Management review.
4. Chief of LITS (Chief implementer of the programme) (Registrar of Brands and other identification devices, Head database, Chief Inspector of LITS)
    i. Co-ordinating the Implementation of LITS;
    ii. Making budgets;
    iii. Preparation of reports; and,

iv. Supervision, monitoring and evaluation

(NB - These functions of the Chief of LITS cascaded downwards to provincial, district, divisional and locational committees).

From a technical perspective, the study therefore proposed a triangular coordination hub of the steering, technical coordination committees with the Director of Veterinary Services (DVS) in order to address policy and technical advisory functions as an organisational model. Creation of the post of deputy director responsible for coordinating the implementation of LITS both country- and species-wide was also suggested. Concurrently, the CVFO was proposed to retain responsibility for ensuring livestock certification, disease surveillance procedure while the Chief Meat Hygiene Officer (CMHO) for recovery of the rumen boluses (Fig 6.1).

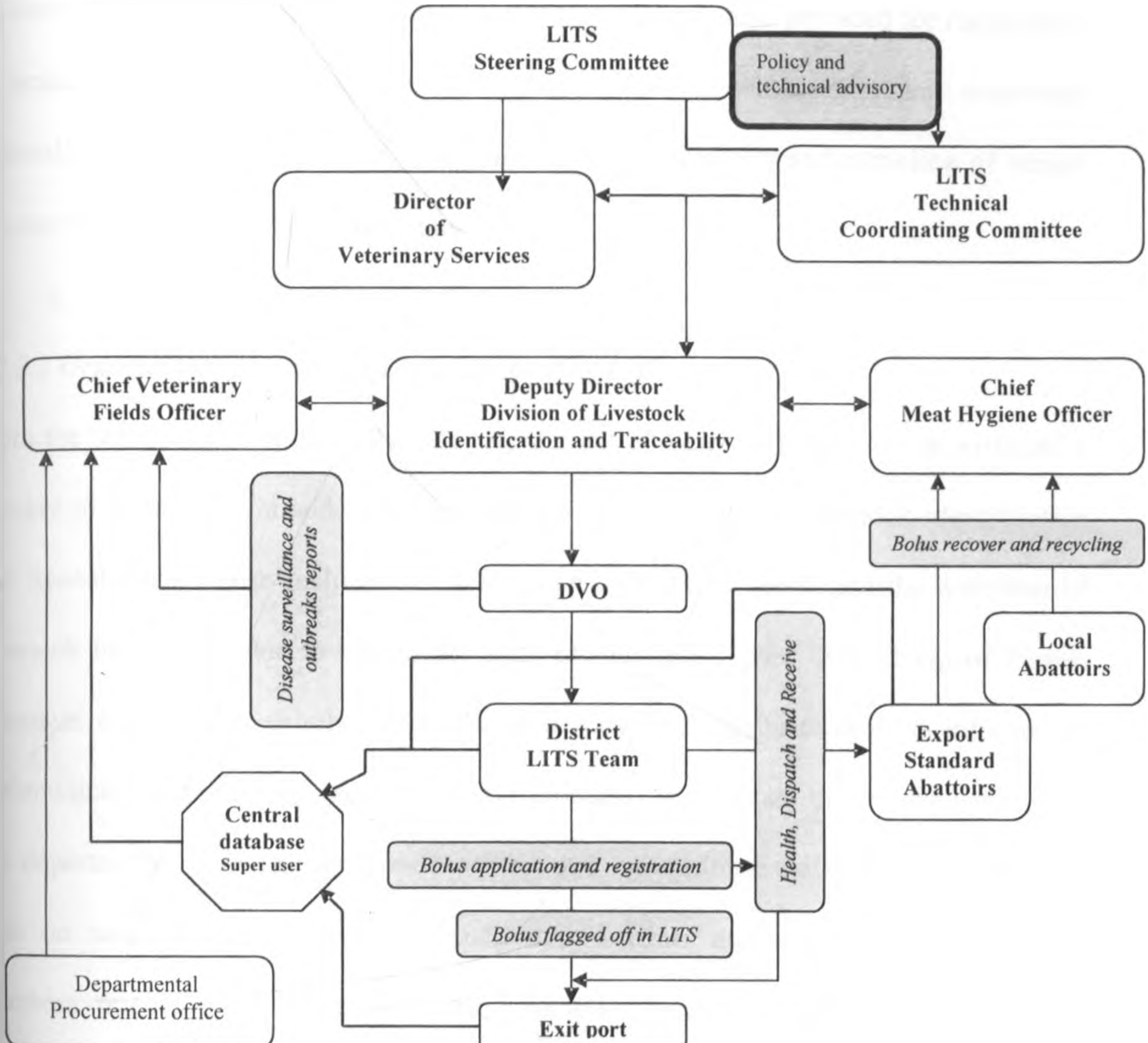


Figure 6.1: Alternative organisational structure proposed for implementing LITS

6.3.2.1 Functions of the Department of Veterinary Services in the implementation of LITS

The core functions of the Department of Veterinary Services were recruitment and registration of traders as well as compliance with market related veterinary procedures related to export certification. Veterinary personnel were also responsible for application of RFID devices to cattle. In addition, they were responsible for collection, entry, validation and verification of market data, uploading of file and transferring of the information to the local database. Finally synchronisation of the information was done to the central database. The Department of Veterinary Services also provided for registration of brands, ensured overall adherence to procedures and sensitisation and awareness nationally. The Meat Hygiene Division undertook the recovery and recycling of rumen boluses from Hurlingham slaughterhouse.

6.3.2.2 Organisational constraints to implementing LITS

From the study, it was realised that the Department of Veterinary Services experienced a number of limitations in addressing its core functions as regards livestock identification and traceability. These included: 1).Inadequate capacity to coordinate the activities of livestock traceability due to inadequate staff establishment, poor deployment of human resources and inability to retain highly trained staff; 2). Inadequate skills in information communication technology (computers and modems) to facilitate the implementation of the departmental activities on disease control and international trade; 3).Lack of reliable data on national herd numbers, productivity, slaughter numbers and imported cattle numbers, prices, livestock weights and consumption levels per capita; 4). Limited/ poor market infrastructure due to loss of land and livestock handling facilities such as holding grounds, water pans, sale yards, weighbridges, crushes, loading ramps along the strategic livestock trade and marketing routes; 5). The Department of Veterinary Services lacks a dedicated Division that deals with livestock identification and traceability on a full time basis; and, 6). Inefficiency in the marketing chains: There are too many middlemen, traders and brokers taking relatively high margins, plus restrictive practices in parts of the chain, leading to overpriced meat.

6.3.2.3 *The process of implementing LITS*

Each DVO was required to establish the number of RFID tags (rumen boluses or ear buttons) and this information summarised into a District RFID Requisition form, which was transferred electronically to the Chief Veterinary Field Officer (CVFO). The information would then be collated into a National Total RFID Summary sheet for purchase, distribution and storage. Ideally, storage was after confirmation that each RFID tag had a valid read. Tags that could not be read were discarded in order to avoid their entry into the central database.

At the Garissa market, cattle from registered traders were consigned to the market sale yard 24 hours prior to market day. The cattle were then clinically inspected for signs of ill health to determine their fitness for sale. Emphasis was on presence of trans-boundary diseases, in particular FMD (through presence of mouth lesions and excess salivation). Those fit for sale were then normally traded after all the requisite cess and levies were paid to the county and the municipal council. After sale, cattle were transferred to the veterinary holding ground at Modika market for ease of handling.

At Modika, the ancillary information was collected, while the cattle were checked by scanning with an RFID reader for any RFID tags already inserted. Subsequently, the study tags were inserted and the individual cattle registered into the local LITS database. The cattle were then subjected to a serological test for CBPP using the Complement Fixation Test. Animals that tested negative were branded P-1 and dispatched using a dispatch animal module to the staging post. Such animals were accompanied by a movement permit given to the trader. The animals dèparted from Garissa while grazing along one of a number of predetermined routes. They would reach Chakama staging post approximately one month from the day of departure from Garissa.

On the other hand, positive testing animals were dispatched to the slaughter house, where they were received, slaughtered and the boluses/tags recovered. The tags were then sent to the CVFO for recycling.

After arrival in Chakama-Malindi District, the whole process of RFID reading and serological testing was repeated. This included use of receive animal, animal health and dispatch animal modules. Occasionally, the animal sale module was used when the traders decided to sell their animals. The cattle were tested again for CBPP at least 21 days after the first and branded P-2. They were also treated for trypanosomosis, vaccinated for Anthrax and black quarter. Cattle that passed the second serological test (P-2) were released to enter the ranches within the Coast Province of Kenya. Positive animals were dispatched for immediate slaughter.

Animals reaching the coastal ranches were cleansed over a period of one year. This was done until the country received trade enquiry from an importing country. Based on this enquiry, the DVS sought a no-objection that provides conditions for import. The DVS liaised with the Coast Provincial Director of Veterinary Services to get the traders mobilise the desired numbers of cattle. Samples were taken 30 days before export for RVF and FMD. If confirmed negative, the animals had a health permit issued. They were then weighed; sprayed 24 hours before shipment and a movement permit to the exit port issued. The LITS dispatch module was used to release the animals to the port. After satisfying the

Kenya Revenue Authority (KRA) requirements, the cattle were again inspected as they were being consigned to the ship and the export module used to flag off the RFID.

Conversely, if the trader was able to obtain a supply order from the KMC, he was expected to ensure that all the relevant documentations were available as the animals arrived by road. The sick cattle were sent for emergency slaughter, while carcasses of those dead on arrival were removed for further processing. In either case the RFID boluses were recovered for recycling while the button tags are deregistered from the system.

If the cattle were negative for diseases, they were assigned a mob number, weighed and entered into the LITS slaughterhouse module. They were committed through the normal slaughter process and the RFID recovered for recycling. At the same time the animal is graded and sent out as fresh meat or to the chillers for further processing. The carcass information such as grade and weight were added using the slaughter module and linked to the identification applied to the cut portions. Overall flow chart and organisational processes for the traceability system as described above is shown in Figure 6.2.

In addition, the various LITS modules applied as the cattle moved along the beef cattle market value chain is depicted in Figure 6.3 and the audit trail that facilitated proper content management for LITS in Figure 6.4.

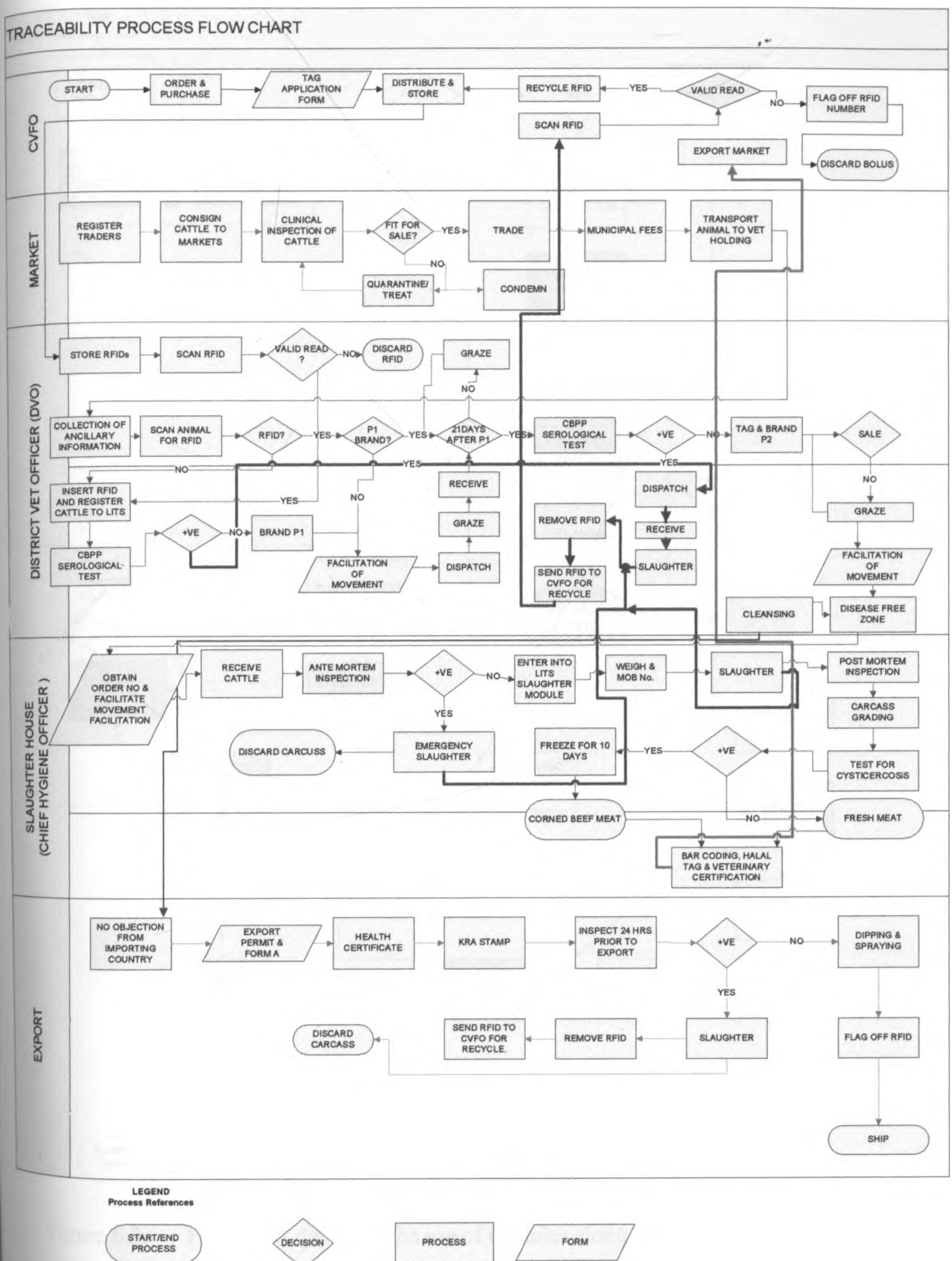


Figure 6.2: Overall flow chart and organisational processes for implementation traceability system

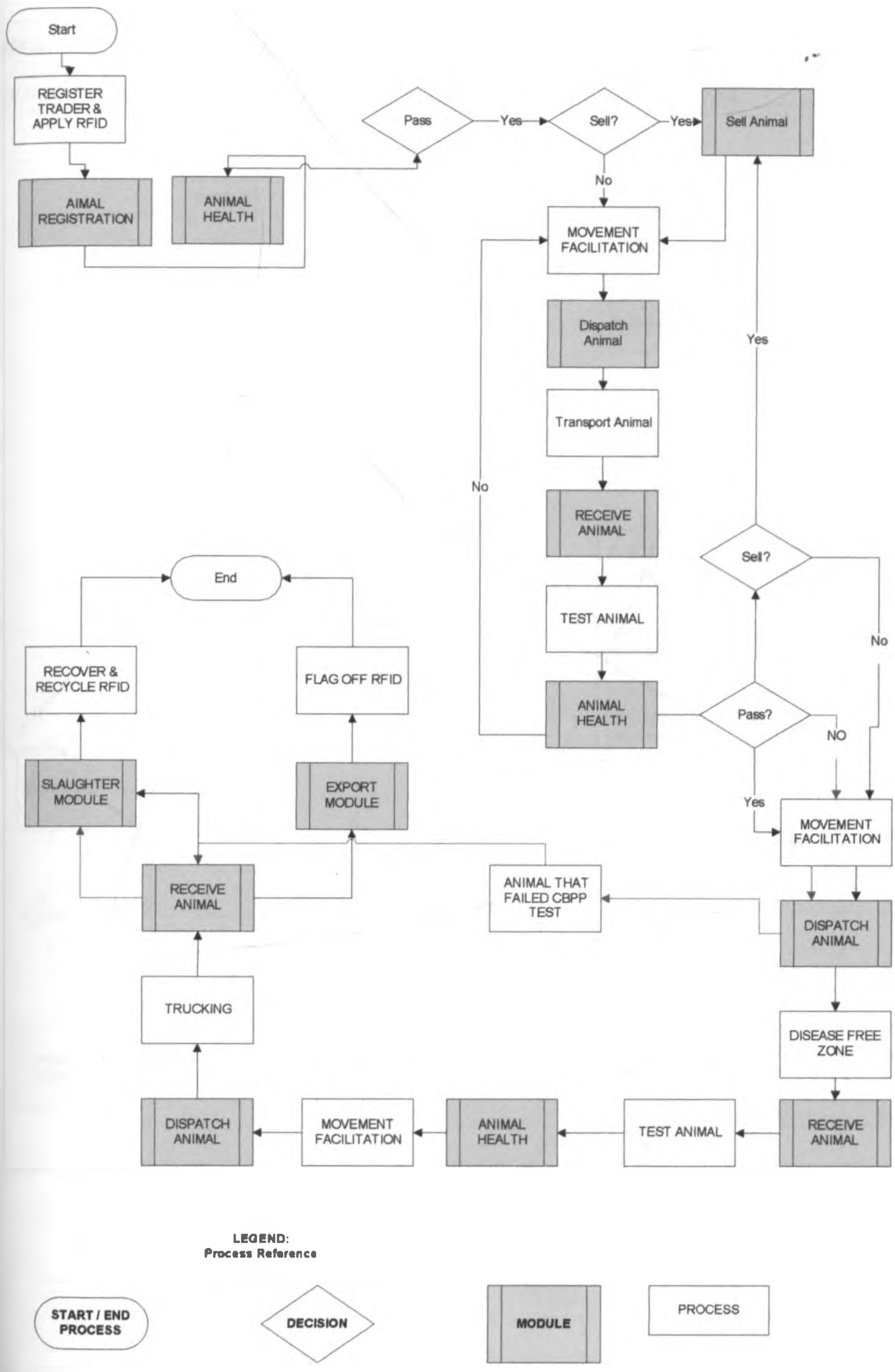


Figure 6.3: Flow chart depicting the use of modules along the livestock chain

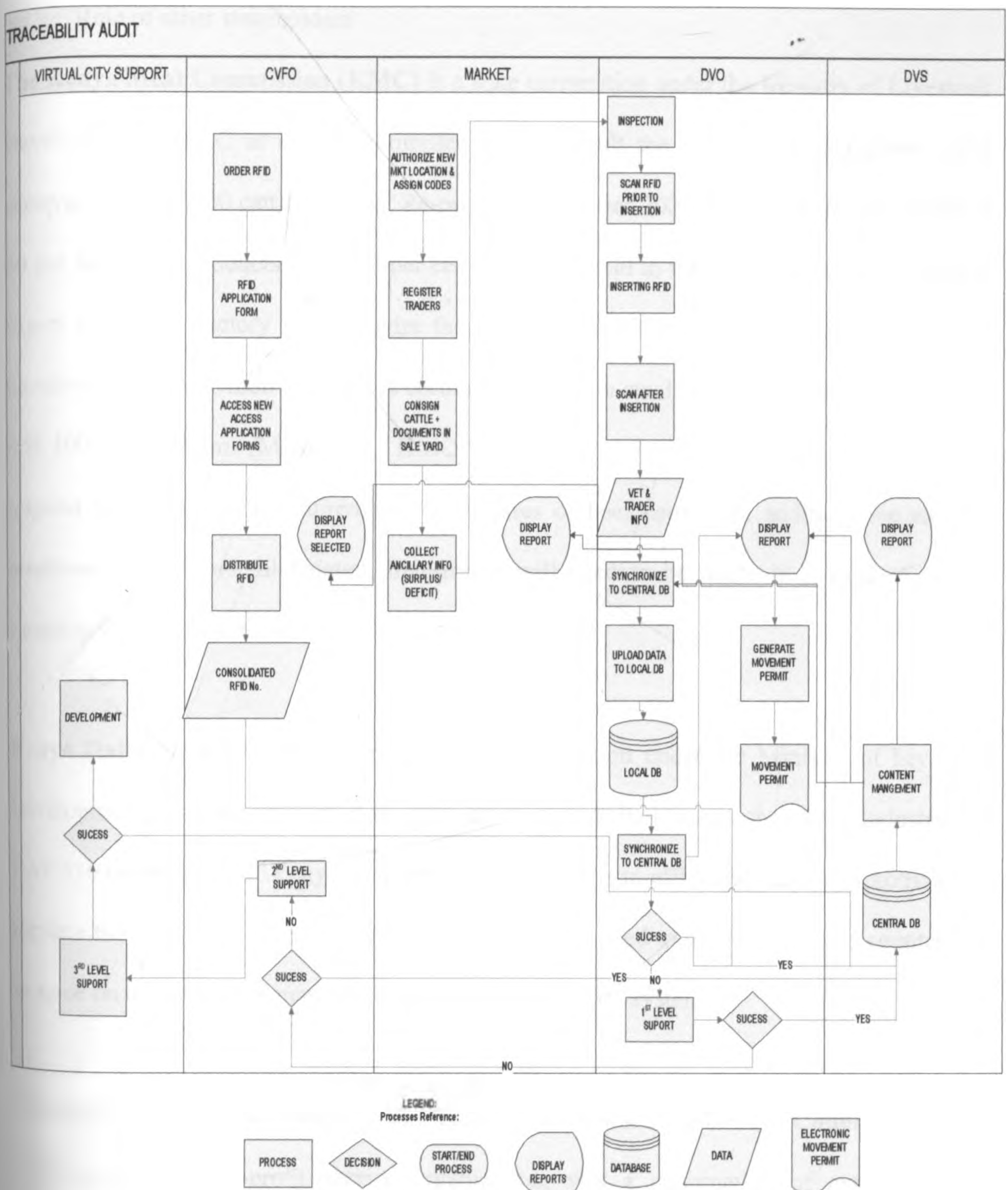


Figure 6.4: Traceability audit trail

6.3 Role of other stakeholders

The **Kenya Meat Commission (KMC)** is a state corporation under the Ministry of Livestock Development. KMC is a state controlled abattoir with the Capacity to slaughter 1,200 sheep/goats and 1,000 cattle per day. Re-opened in the year 2006, KMC is expected to export 60 per cent of its products while 40 per cent would be sold in the local market. To meet the export target, the factory must acquire the requisite certifications enabling it to access the lucrative European Union market. A second plant with a smaller Capacity was re-opened in mid 2007 in Kibarani (Mombasa). KMC would need to be privatised if it is supposed to respond to the payment requirements of supplies of beef cattle. In addition, the existing machinery is old and dilapidated. Investment will need to be made in a state of the art slaughter infrastructure.

Kenya Dairy Board (KDB) refers to a state corporation under the Ministry of Livestock Development. It was established in 1958 by an Act of Parliament, the Dairy Industry Act CAP 336 of the Laws of Kenya. The mandate of KDB is to efficiently develop, promote and regulate the dairy industry in Kenya. The KDB would need to sit with the beef counterparts to agree on common informational need for the traceability system.

Livestock traders associations: the **Kenya Livestock Marketing Council (KLMC)** established as a non-profit service organization, was a culmination of extensive work involving livestock and livestock products marketing stakeholders. The core purpose is to protect and develop the interests of livestock producing communities for greater contribution to economic development of Kenya. The **Livestock Trading and Marketing Society of Kenya (LTMSK)** refers to the only private sector livestock organization that deals in the export of both live animals and chilled meat. They run and maintain ranches across the country and represent the sector in all forums. Both trader associations should be engaged in awareness and recruitment of their members to register their livestock.

6.4 Implications of organisational infrastructure to LITS

Developing countries face a number of organisational challenges during the development of LITS. Primary to this includes the perception that traceability systems are optional and of low priority. Often, allocation of time, staff, and resources has been insufficient. The different roles of stakeholders were poorly articulated due to the perceived imbalance between the work involved and the potential benefits.

Individual country efforts are *ad hoc* and localised, whereas a combined commitment and responsibility is required. For example, in Kenya there was a parallel effort to develop traceability systems for both the beef and dairy industry at the time of the study. The two sub-sectors did not establish a common understanding of the end-user requirements (SOUR). This resulted in a tendency to focus only on their immediate and visible needs. Poor feedback regarding best practice and little dedicated support (be it clerical, procedural, or computer support), perpetuated the same problems and restricted advances.

Implementing traceability systems provides an effective means of facilitating communication among the success-critical stakeholders that eases the determination of the impact of changes and supports their integration, preserves knowledge and dependencies created during the design process to ensure quality and prevent misunderstandings.

The introduction of traceability systems implied more than just another way of registering information. Information was exchanged amongst organisations and responsibilities became more visible. Arrangements on responsibilities, information exchange, authorisation and liability were established. This information included: "Who performed which actions, which information was captured and stored?" and "Who had access to this information?"

CHAPTER 7 GENERAL DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

There are opportunities for Kenya to market its beef as a natural product and its ASAL areas have a comparative resource advantage in the production of livestock and meat products. Gaining access to markets in developed countries, however, has been challenged by strict importing country policies that display extreme risk aversion on issues concerning the health and wellbeing of their citizens. This has reinforced the need to establish traceability systems by African countries hoping to access niche European markets. Such markets require quality verified products with information, process and place confidence in credence attribute embedded in traceable products (Atterton and Ward, 2007).

An experimental LITS trial was implemented as a means of demonstrating the challenges and opportunities for competitiveness of the Kenyan beef chain. The system took into consideration the prevailing social and economic circumstances of the country and the need for certification as a key component of rural development. The LITS model implemented in Kenya was comparable to the systems developed by Botswana, Brazil, Uruguay and New Zealand (Aguiar and Lago da Silva, 2002; Stevens *et al.*, 2005). It was also cognisant of the fact that the OIE in collaboration with the Codex Alimentarius Commission begun to promote minimum standards of identification and traceability (OIE, 2010).

In Kenya, three different but interrelated motivations for the establishment of LITS were proposed: (i) to ascertain origin and ownership and deter livestock related insecurities such as cattle rustling and misrepresentation of animals and meat; (ii) use in disease surveillance in order to minimise the spread of transboundary animal diseases, and (iii) improve external market access through exports. Uncontrolled livestock movement due to rustling has been most responsible for the spread of transboundary diseases.

If effectively implemented, traceability systems provide reliable information about individual livestock as they moved along the supply chain. Adoption of the LITS would enable the authorities identify, localise and quickly intervene in the event of a transboundary disease outbreak. It would also contribute to better planning of routine vaccinations and treatments. Since livestock identification is an integral part of the LITS, it was hopeful that it could be a disincentive to the cattle-rustling phenomenon seen in most pastoral production systems. These steps are also essential for the verification of compliance with certification procedures, making it an important element for the producers in obtaining the trust of buyers and consumers in importing countries. Implementing such a system would in the medium and long term definitely promote better terms of trade as well as access to external markets.

In the light of the prevailing transboundary animal diseases situation in the Horn of Africa region, the implementation of traceability systems is none negotiable if assurance of adequate food safety to potential buyers is to be provided. This is in spite of the high capital investment. The acceptance of traceability systems in less progressive economies has been curtailed by stakeholders who imagine that it could be used for punitive tax purposes. In the light of this, it will be important to address the concerns of such stakeholders early, otherwise adoption of LITS would be jeopardised. In addition, domestic consumers make their meat purchasing decisions based on price alone. This situation only changes in the event of outbreaks of food animal borne zoonoses when the consumers insist on greater rigor in the safety of meat by demanding for certification.

Like in the situation seen in Brazil and Argentina, mandatory traceability may only be effective if initially implemented for animals from disease free zones/compartments and targeting the export market (Bowling *et al.*, 2008). The system would then be up-scaled to cover the rest of the country. The information frontline staff of the competent authority would provide an equivocal assurance that the animal was free of diseases and did not originate from an area where disease persists.

Use of requirements traceability (RT), the process through which the statement of user requirements was obtained was the most critical means through which communication among the critical stakeholders was facilitated. Requirements traceability implied more than just another way of registering information. Information is exchanged between organisations, and responsibilities become visible.

Relevant OIE and Codex Alimentarius standards demand that animal traceability and traceability of products of animal origin be linked through proper identification of the animals. Modern technological innovations in livestock identification have created redundancy in relevant legislation which necessitates the development of a new legislative and legal framework to achieve compliance with global trends. With this understanding, there was need to revise the legal framework through an overhaul of CAP 357. In the interim, the entrenchment of LITS in the existing statutes, especially CAP 364 represented the best way forward.

7.1 Design of traceability system

Ideal traceability systems are developed through negotiated circumstances by stakeholders and guided by the non-prescriptive guidelines of standard setting bodies. In this study, the participatory workshop was used to establish the framework of implementation and negotiated roles and responsibilities for implementing LITS. This allowed for standardization of the gathered data and typification of the messages that enable storing and communication of the data (Mankis and Manos, 2008).

RFID was incorporated as identifiers in order to exploit its capability of greater information storage rapid speeds of data recording. The use of a central database as well as distributed (local ones) at district level and the use of veterinary personnel for verification increased the efficiency of operating LITS. A well-planned central database influences the cost effectiveness of the system. This in turn depends on the scope of a traceability system, data requirements, the needs of the industry and its goals. A crucial part of planning a traceability system was carefully researching and agreeing on what data is needed, how it will be inputted and how to provide the output.

Application of identifiers to individual cattle resulted in a high level precision essential in countries where the credibility and resource availability of the competent authority are in question. A modular approach was also used as a cost cutting measure exemplified in the Botswana system. However, the weak link remained in data synchronization due to extensive patches of dead zones (without network coverage) that would have to be addressed on up-scale.

Stakeholder involvement, especially for the private sector, was ensured early since this is pertinent for uptake and LITS. Their participation helped to clarify the business processes that characterise the way information was collected thus; accuracy, timeliness and completeness. Efficiency of LITS was dependent upon two key issues: completeness of the data within the system as well as the level of participation. However, a concern that must be addressed is that stakeholders may not participate effectively if LITS data were used for tax purposes (OIE, 2009). Stakeholder education and outreach is vital to achieving reasonable levels of participation in the program.

7.2 Technical evaluation of the identifiers and the electronic traceability system

RFID has been reported to improve the functions of traceability systems through better retention and readability over long duration, enhanced data integrity, full verification of animal movement and collation of livestock certification information. Other advantages in the supply chain include a reduction in labour cost and improved customer service (Tajima, 2007; Kumar *et al.*, 2009; Peets *et al.*, 2009).

If combined with better use of Information technology (IT) RFID improves the efficiency and accuracy of information gathered and communicated between the supply and the customer (Xue *et al.*, 2007). The key advantage of using ICT within a traceability system is that it allows information to be digitized for faster utilization, thus, transfer, share, query, and analysis of data. All indications suggest that ICT-based systems are safer and more reliable than paper-based systems. A safe traceability system can be seen as a worthwhile investment for industries in developing countries that are aiming to compete globally in the long term.

The use of RFID tags (ear button tags or rumen boluses) are both technically applicable for automatic individual identification and traceability in a pastoral environment when supported by robust SOPs (Peets *et al.*, 2009). Of these, the rumen boluses were more preferred by the by the Department of Veterinary Services because they could be recycled up to ten times and were also tamperproof, thus cheaper in the long-term. Electronic LITS has the Capacity to ascribe responsibilities to the individual veterinary practitioner. This implies personnel will require greater training if the efficiency of operating LITS will be improved, errors minimised and more stringent certification procedures applied.

The LITS was able to meet rigorous and defined performance standards such as determining the location(s) where a specific animal was registered, its cohort (same herd) as well as those animals it has been in contact with from the central database. It is notable that such a level of performance is not achievable without electronic recording and submission of data enabled by RFID. By adopting electronic data submission, the system avoided inefficiencies associated with paper-based systems.

It was also noted that traceability systems were likely to be effective when all segments of the supply chain stakeholders were participating. The individualised, concurrent, *ad hoc* and localised effort within both the beef and dairy sub-sectors revealed lack of common commitment at industry level. This implies that the agreement reached on the end-user requirements was focused on beef sector stakeholders only and may need redress with the dairy subsector in order to solve the "coordination failure", providing the institutional infrastructure necessary for a functioning and cost-competitive industry.

The LITS was able to facilitate near real time transfer of data. By identifying individually, CBPP infected case demonstrated excellent sensitivity and precision thus contributing to increased transparency along the supply chain, reduced the risk of liability claims, improved recall efficiency, enhanced the control of livestock epidemics, ensured easier product licensing and increased price premium (Dinsey *et al.*, 2001; Meuwissen *et al.*, 2003).

The Kenyan system is championed by industry captains such as Farmers Choice who demand for greater traceability. If developed further the system is likely to restore the potential for Meat Exports and simultaneously address the information asymmetry between lower and higher level players. This finding was similar to the findings of previous authors (Golan *et al.*, 2005 and Hobbs *et al.*, 2007). In such cases, the market solution results in less disclosure than desired by consumers or less traceability than is socially optimal (Lüth and Spiller, 2005).

7.3 Economics of implementing electronic traceability systems

LITS design should be informed by first understanding the financial cost implications as well as socio-political, institutional, markets and organisational constraints (Dinsey *et al.,* 2001; Meuwissen *et al.*, 2003; Gallina and Orozco, 2005; Bailey, 2007; OIE, 2009). Indeed consumers WTP for informational attributes of food products is important for supply chain participants and policy makers (Ubilava and Foster, 2009). Therefore, it is a critical issue to define who pays for the costs incurred at implementation. Traders in Kenya were willing to pay (WTP) partial cost towards implementation of LITS. The traders were also interested in how the benefits would be shared in the marketing chain (Dickinson and Bailey, 2002).

In Kenya, LITS was embraced by traders cum ranchers because part of the cost was borne by government, in an attempt to establish proof of compliance to the Department of Veterinary Services regulations' after an outbreak of RVF. Public funding for mandatory traceability was crucial for the inclusion of small firms, who participate in multiple stages of the supply chain and include smaller suppliers; public funding is crucial. Additional resources must be set aside to support sufficient consultation among stakeholders. This was essential to establishing early consensus among traceability system stakeholders. One of the traders cum rancher indicated that traceability enabled them to avoid purchase of infected animals and therefore reduced losses during transit.

Decisions to adopt traceability systems in Kenya may have a considerable economic implication. Botswana, the most successful country in Africa implementing a LITS, is wholly public sector driven. Willingness to Pay figures in excess of the Ksh 50 that was being applied at the time of the study was indicative of the importance traders have attached to its implementation. This finding is similar to that reported in other countries such as Canada (Hobbs, 2003; Golan *et al.*, 2005). implementation of LITS was both technically and economically feasible. The cost per head of between US$ 10 and 15 per head of cattle depending on the type of identifiers compared to US$ 3-5 for the hot iron brand and a nearly US$ 5 return on investment per dollar in pastoral areas were obtained in that study. It is, therefore, important to establish whether a country can meet the overall financial requirement based on its GDP. It is believed that the enormous livestock population in the region will considerably reduce the cost of implementation per head when compared to implementation at individual country level. This justified the need for a regional approach recommended herein.

7.4 Institutional and organisational issues affecting electronic traceability systems

The implementation of sound traceability system depends largely on the existing institutions, organisations and working practices of the Department of Veterinary Services Implementation must be congruent with the overall strategy and Capacity of a country. This requires the presence of a sound and innovative policy environment as well as an organisational and management organisational infrastructure that facilitates linkages and interactions (communication, coordination and cooperation) between complementary stakeholders. However, Africa trade systems are poorly organised, antithetical to value innovation and lacking in user focus as demonstrated by the limitations in intra and inter organisational interactions.

While the livestock policy propounds the need for identification and registration of livestock the country does not appear to have sufficient economic incentive for development and investment in livestock traceability systems due to the small size of her livestock economy as well as lack of market guarantees. Due to this situation, the public sector must participate in solving the coordination failure along the market chain by establishing intermediary institutions, rehabilitation of requisite supply chain infrastructure and provide stable and credible market signals as incentives to market participants in the long run (Omiti and Irungu, 2002).

On the other hand, mandatory traceability is one possible policy tool for increasing the food system's trace back capability. The key challenges of implementing LITS in Kenya have been the need to devise sound institutional arrangements, which are able to reduce transactions costs and also induce a much stronger strategic commitment to investing in needed specific (and co-specific) assets. The same arrangement must also integrate into the regional sphere. Having pastoral production systems along the common borders implies that cross border movements of livestock have been a norm. Therefore, it was critical that policy be developed on the basis of an understanding of what were likely to be broad outlines of appropriate institutional arrangements. Non-market coordination and deliberative mechanisms and institutional arrangements such as competitive coordination, interlocking and regulated monopolies need to be central to any analysis of the effects of trade liberalization on the poor.

If strategic commitment to asset-specific investment could be secured, both horizontally (among specific categories of players such as traders and farmers), and vertically (within supply chains), then much higher growth rates could probably be achieved. The way forward was to rethink the role of the state (at sub-national, national and international levels), that of producer organizations and other stakeholders (including trader) associations. It was imperative that the state deliberation that encourages asset-specific investments be initiated by government. At the same time, a graduated withdrawal from direct interventions should be planned for success to be achieved. Finally, a traceability system involving all the stakeholders along the supply chain can serve to increase consumer confidence in beef products by making traceability database accessible to the consumer (Shanahan *et al.*, 2009). The more successful path of LITS development has the state and other stakeholders (prominent among these producers) acting as equal partners.

Participation of the competent authority is considered vital for the implementation of livestock identification and traceability systems being the only stakeholder with reasonable capacity for LITS. Except in cases where private processors were present on a large-scale, there were few alternatives to a state-led approach. The alternative, feasible for beef only, of coordination being led by a dominant private interlocker, is politically unpalatable and perhaps had nearly as much scope for rent-seeking behaviour. Rolling back the state however does eliminate organizations and a policy framework, which have created scope for rent-seeking, while being technologically and managerially slothful. However, what has been largely ignored has been the fact that the involvement of the state was in place because of their role coordination in encouraging asset-specific investment-this was vital and frequently the state was the only actor available.

7.4.1 Information sharing

LITS was developed as a mandatory system with definition in line with the Canadian (On Trace) thus. *"...the ability to locate an animal, commodity, food product or ingredient and follow its history in the supply chain forward (from source to consumer) or backward (from consumer to source)."* By choosing individual animal identification, the precision (ability of the system to pinpoint the original source of a problem) was fairly accurate. It enabled the sharing of information in a transparent, global, integrated and harmonized way along the food chain. This was said to be one of the ways to regain consumer confidence in African beef.

7.4.2 Constraints

There were a number of financial, technological and human resource constraints related to the implementation of LITS. Limited access to credit, physical and technological infrastructure and lack of a transparent price signal from the production areas were among key constraints. Others included poor articulation of the '*disease free zone*' at the coast. While the ASAL areas reported a resource-based comparative advantage, successful beef-export industries have to be based on effective certification. Certification in turn required more efficient inspection and control of food safety and quality regulation procedures in the domestic market. Indeed, the challenge for the Kenyan beef industry was that the domestic market did not dictate an urgent need for safer and higher quality beef. Only high-end consumers purchasing Farmers Choice Company and KMC products were willing to pay premium prices. Adequate advertising/publicity needs to be used to convince consumers of the benefits of safer, better quality beef.

Buyers in the beef industry in Kenya are also increasingly relying on contracting or associations to improve product traceability and safety. Processors such as Farmers' Choice have begun adopting the role of industry captains, monitoring the safety of products up and down their supply chain. By demanding safer products from their suppliers, they have successfully created markets for livestock traceability. Indeed, successful integration of traceability systems into the markets rests on the ability of such large buyers to enforce standards through testing and process audits—and to identify and reward suppliers who meet safety standards and punish those who do not. These large-buyers are spurring the development of traceability systems throughout the Kenyan beef industry. This finding was in contrast to that of Souza-Monteiro and Caswell (2008) in the developed world, where the leadership of retailers and consumers were considered the main driving force for quality assurance and traceability systems across the supply chain.

As part of implementing the livestock identification and traceability, a number of lessons were learnt. These included:

The need to implement a mandatory system of individual identification: Most of the participating traders preferred such a system but with the cost borne by the market. This position was attributed to their potential savings by the traders Vis a Vis the losses incurred from the purchase of infected animals.

Adequate preparation: Before implementing such a programme, a comprehensive needs analysis must be undertaken by a multi-skilled and multi-disciplinary team including a comprehensive review of gaps in the current legislation, veterinary processes and structures, skills and resource levels, level of preparedness of the sponsoring ministry and the country, and current procedures and protocols should be undertaken as part of this exercise. The quality of the system would be improved by providing sufficient time and resources for the development of the necessary software and purchase of equipment prior to full-scale implementation. In addition, the equipment used in the field should be ruggedized in order to cope with the harsh environment where they are deployed. Similarly, the reader used should be versatile and not susceptible to electromagnetic interference (noise). The LITS study also recommends the need to retrain the existing staff and subsequently expand their roles in order to address the additional responsibilities.

Implementation infrastructure: If LITS is to be implemented on a wider scale, the Government of Kenya needs to invest in the infrastructure required to implement traceability systems. This includes opening up parts of the stock routes to the coast that have been encroached. Moreover, Chakama ranch which was used as the staging post during the study is a privately owned ranch. Government needs to consider establishing livestock holding grounds and veterinary inspection facilities at either Kulalu or Galana ranches owned by the Agricultural Development Cooperation (ADC).

Human wildlife conflict: The animals pass through Tsavo National Park on their way to the Coastal ranches, invariably leading to conflict with wildlife as well as spread of diseases between domestic animals and wildlife.

Project monitoring and evaluation: A system of continuous monitoring and evaluation of all deliverables shall be critical to ensuring that the project remains on-track and that changes in scope are either eliminated or minimised. This gives the opportunity to learn from each phase, for targets to be established and for the project to be assessed on a continual basis. Appropriate project management strategies must be maintained to ensure that the work processes are not aborted.

Project approach: Livestock Identification and Traceability Projects ought to be implemented and run as a "Project", i.e. run as an IT project, with the requisite project/risk/QA methodologies being utilised. This would minimise conflicts associated with the control of supra national projects. A modular approach is generally the best approach when dealing with such a large complex system.

CONCLUSIONS

1. Traceability systems are increasingly being adopted worldwide. In particular, with the global trend of increasingly strict standards, investment in traceability systems is

essential to ensure access to the markets in the developed world. Establishing traceability systems shall ensure that products are not subjected to trade barriers. Traceability systems also enabled stakeholders to handle future supply chain crises or changes in market dynamics. An efficient traceability system lowers the risk posed by potential accidents or market threats and is therefore an important investment for industries aiming to compete in the global market.

2. Traceability systems improve transparency throughout the supply chain and ultimately lower the transaction costs associated with recording, transferring, sharing, and querying information. This further promotes the sustainability of the supply chain as the foundation of environmentally and socially sustainable production and processing practices. Through this, traceability systems gain the confidence of not only international buyers, but also upper end domestic consumers who are increasingly concerned about food safety. Traceability systems can allow for direct communication with the public in the producing and buying countries, a type of communication that is increasingly in demand throughout global markets.
3. Of importance, traceability systems can improve business efficiency throughout the supply chain by quickly and accurately recording, sharing, and reporting information. This efficiency can ultimately improve profits, a benefit to both domestic industry in developing countries and their international trade partners.
4. Traceability systems help to prevent food safety crises and food scandals. The value and effectiveness of LITS became clear after the outbreak of RVF that put the meat industry in a crisis situation. ICT supports efficient traceability throughout the supply chain. Creating and running a traceability system requires coordination and agreement among the businesses at all stages of the supply chain. The case studies illustrate that

ICT allowed the industries to do something they had not been able to do before: quickly and efficiently share information related to their key concerns. ICT allowed for faster and more efficient sharing of information between different stages of the supply chain than a paper-based system could provide.

5. The contribution of LITS to better animal health was self-evident. Successful surveillance and eradication of animal diseases shall be easier if effective identification and traceability systems are in place.
6. To implement LITS effectively, the country has to first clearly understand the broad costs (investment and operating) and potential benefits involved, including the willingness to pay. The BCA provided an appropriate means by which the industry would be able to make informed judgments' about how important traceability systems are and the value of investing in them.
7. The high and positive NPV recorded in this study suggests that LITS would be a worthwhile investment in the beef industry in Kenya. After the initial investment, the costs are minimal, as they pertain to operational costs. As noted earlier, a tightly organized and vertically integrated supply chain with a strong competent authority control was more likely to succeed due to the high cost of initial investments compared to when it is purely private sector driven.
8. This study has added to the knowledge base by ensuring a better understanding of the drivers behind implementing traceability as well as the challenges to implementation and the cost benefit. The system must be feasible technologically, commercially, organisationally and socially. It must further be congruent with the overall strategy and Capacity of a country as shown in chapter 4.1 of the Terrestrial Animal Health

Code (OIE, 2010). To realize the full value of the traceability system, the Department of Veterinary Services needs to move forward on four broad themes, these include:

Leverage traceability to protect and empower the brand by:

- Developing better understanding of target consumers;
- Establishing a clear understanding of the risk elements in the beef marketing chain;
- Prioritizing traceability requirements within and across livestock species with priority of expanding into dairy and small ruminants; and,
- Ensuring that traceability investments deliver capabilities that support the individual livestock identification, disease control and trade and marketing regionally.

Define traceability vision and create a roadmap, through:

- Recognition that traceability is a complex yet strategic undertaking;
- Adopting an evolutionary path for the processes, capability and tool development;
- Establishing clear executive level and functional responsibility and sponsorship; and,
- Prioritizing desired/required functionality leveraging assessment of current IT and Supply Chain capabilities and product/brand risks and opportunities.

Integrate the physical and informational supply chain by:

- Leveraging international standards for data management architecture;
- Effectively and efficiently managing the capture, management and communication of data;
- Establish one version of the truth for customer, product and supplier data; and,
- Automate collection, analysis, and communication of data.

Proactively engage with traceability stakeholders, through:

- Embracing whole market value chain perspective;

- Identify stakeholders, define their traceability related stake and develop engagement plans that drive alignment with ministry vision.
- Create a shared traceability vision and development roadmap with vendors and suppliers.

RECOMMENDATIONS

1. A clear regulatory framework for LITS should be established. This should include mechanisms for enforcement; coordination; data management, ownership, confidentiality and access.
2. Technical and financial support for the development of education and scientific research programmes relevant to LITS should be directed to key players in the food production chain, particularly veterinarians, livestock owners and industry operators.
3. Community awareness and sensitisation should be conducted to ensure that all parties in the food production chain are aware, as appropriate, of the OIE and Codex standards for identification and traceability of animals and animal products and to promote the implementation of these standards, in partnership with the private sector (OIE 2009).
4. Considering the porous nature of the Kenyan border, it is imperative that countries within the Horn of Africa region, nominate national focal points and take steps to promote collaboration between the Veterinary Services and other governmental authorities (in countries where the responsibility for food safety lies outside the Veterinary Services) and with relevant private sector stakeholders; continue mobilise strategic resources by owning the system collectively and effectively anchoring the process in various chapters of the law and various ministries (e.g. Livestock and

Office of the President). Additional support could then be sought from developmental partners after demonstrating that Kenya has a commitment to economic development to help Veterinary Services and their partners in developing countries to implement the OIE standards for the identification and traceability of animals and animal products.

5. One of the gaps identified during the study is the need for the development of a clear labelling system that would distinguish the traced meat to the consumer. The label must include all information on measures taken to assure accurate and truthfulness of the indication on the product and the name of an independent auditor.

REFERENCES

Agritrade (2009): ACP-EU Trade Issues in the Beef Sector - Agriculture Executive briefs - Agritrade documents - Resources - Home - Agritrade.mht (Accessed October, 2009).

Aguiar, D. R. D., and **da Lago A. S. (2002):** Changes in Beef Consumption and Retailing Competitiveness in Brazil: a rapid appraisal, Agribusiness, **18**: 145-161.Available at http://www.scielo.br/scieloOrg/php/reflinks.php?refpid=S1807-76922006000100003000001&pid=S1807-76922006000100003&lng=en.

Anon (2009): Report of meeting of experts on livestock identification and traceability system. Mifugo Project, Combating Cattle Rustling and Advancing Human Security in Eastern Africa through the Implementation of a Multi-Disciplinary Approach. Hotel La Mada- Nairobi, Kenya, 2nd – 5th August 2009. 28 pp.

Arisland, K. Ø. and **Kjærnsrød, S. (2005):** Tracetracker Traceability Glossary, v. 1.9. *Tracetracker Innovation.* Available at www.tracetracker.com/cgi/doc.cgi?id=6.

Atterton, J. and Ward, N. (2007): Diversification and Innovation in Traditional Land-Based Industries, in Mahroum, S., Atterton, J., Ward, N., Williams, A., Naylor, R., Hindle, R. and Rowe, F. *Rural Innovation*, National Endowment for Science Technology and the Arts (NESTA): London.

AU-IBAR and NEPDP (2006): Kenya Livestock Sector study: An analysis of pastoral livestock products market value chains and potential markets of live animal and meat. 216 pp.

Bailey, D.V. (2006): Benefits and costs associated with an animal identification system for Cattle in the United States. Beef Quality Summit, Oklahoma City, OK, Utah State University.

Bailey, D.V. (2007): Political Economy of the US Cattle and Beef Industry: Innovation adoption and implications for the future. Journal of Agricultural and Resource Economics, **32**: 403-416.

Barcos, L. O. (2001): Recent Developments in Animal Identification and the Traceability of Animal Products in International Trade. Scientific and Technical Review OIE 20, **2**: 640-651.

Beulens, A.J.M., Broens, D.F., Folstar, P. and **Hofstede, G.J. (2005):** Food safety and transparency in food chains and networks: relationships and challenges. Food Control, **16**: 481-486.

Boardman, A.E., Greenberg, D.H. Vining, A.R. and **Weimer, D.L. (2005):** Cost-Benefit Analysis: Concepts and Practice. FT Prentice Hall, 2005. **ISBN: 0130871788 / 0-13-087178-8**

Bowles, D., Paskin R., Gutierrez M. and **Kasterine A. (2005):** 'Animal welfare and developing countries: opportunities for trade in high-welfare products from developing countries'. Scientific and Technical Review OIE, **24**: 783-790.

Bowling, M. B., Pendell, D. L., Morris, D. L., Yoon, Y., Katoh, K., Belk, K. E. and **Smith. G. C. (2008):** Review: Identification and traceability of cattle in selected countries outside of North America. The Professional Animal Scientist, **24**:287–294.

Caja, G., Conill, C., Nehring, R. and **Ribo, O. (1999):** Development of a ceramic bolus for the permanent electronic identification of sheep, goat and cattle. Computers and Electronics in Agriculture, **24**: 45-63.

Cantor, A. B. (2003): SAS Survival Analysis Techniques for Medical Research. 2nd ed. SAS Cary, NC: SAS Institute, Inc., 2003, ISBN 1-59047-135-0, 252 pages.

CHAPTER 355: Stock Produce Theft Act. Commencement Date: 1933-05-05.

CHAPTER 356: Meat Control. Commencement Date: 1976.

CHAPTER 358: Cattle Cleansing. Commencement Date: 1937-04-27.

CHAPTER 359: Hides, Skin and Leather Trade. Commencement Date: 1987-12-24.

CHAPTER 360: Prevention of Cruelty to Animals. Commencement Date: 1962-12-31.

CHAPTER 363: Kenya Meat Commission Act. Commencement Date: 1950-06-01.

CHAPTER 364: Animal Diseases Act. Commencement Date: 1965-04-13.

CHAPTER 366: Veterinary Surgeons Act. Commencement Date: 1953-10-13.

Carné, S. Gipson, T. A., Rovai, M., Merkel, R. C. and **Caja, G. (2009_a):** Extended field test on the use of visual ear tags and electronic boluses for the identification of different goat breeds in the United States. Journal of Animal Science, **87**: 2419-2427. Available at http/www.jas.fass.org/cgi/content/full/**87**/7/2419.

Carné, S., Caja, G., Ghirardi, J.J. and **Salama, A. A. K. (2009_b):** Long-term performance of visual and electronic identification devices in dairy goats. Journal of Dairy Science, **92**: 1500-1511.

Chryssochoidis, G., Karagiannaki, A., Parmatari, K., and **Kehagia, O. (2009):** A cost benefit framework for an electronic based traceability system. British Food Journal, **111**: 565-582.

Dessureault, S. (2006): An assessment of the business value of traceability in the Canadian dairy processing industry. MSc thesis. University of Guelph.

Dhuyvetter, K. and **Blasi (2010):** RFID Costs. Manhattan, Kansas State University. Available for 2010 at www.beefstockerusa.org/rfid.

Dickinson, D. L. and **Bailey. D.V. (2005):** Experimental Evidence On Willingness to Pay for Red Meat Traceability in the United States, Canada, the United Kingdom, and Japan. Journal of Agricultural and Applied Economics, **37**: 37-48.

Disney, W. T., Green, J. W., Forsythe, K. W., Wiemers, J. F. and **Weber, S. (2001):** "Benefit-Cost analysis of animal identification for disease prevention and control. Scientific and Technical Review OIE, **20**: 385-405.

EAPCCO (2008): Protocol on the Prevention, combating and eradication of cattle rustling in Eastern Africa. Institute for Security Studies.

East African (2009) East Africa May 18 Edition.

ECR Europe (2004): Using Traceability in the Supply Chain to Meet Consumer Safety Expectations. ECR (Efficient Consumer Response) Europe.

Evans, **J.L., Butler, L.J., Oltjen, J.W., Velez, V.J., Haque, F., Bennett L.H., and Caja G. (2009):** Cost-Benefit Analysis of the U.S. National Animal Identification System (NAIS) in California Presentation to the Animal ID Expo, National Institute of Animal Agriculture, Kansas City, MO. August 25-27.

FAOSTAT (2008): ResourceSTAT. http://faostat.fao.org/site/291/default.aspx>. Accessed: 28 April 2008

Freeman A.M. III, (2003): *The measurement of environmental and resource values: theory and methods.* : A Myrick Freeman III Resources for the Future, Washington, DC, 1994, 515 pp.

Füzesi, I., MezŐszentgyörgyi, D., and **Herdon, M. (2009):** Application of modern traceability systems and data storage technologies by Hungarian meat companies. 4th Aspects and Visions of Applied Economics and Informatics March 26 - 27. 2009, Debrecen, Hungary

Galliano, D. and **Orozco L. (2008):** Intra and Inter organisational determinants of electronic-based traceability adoption: evidences from the French agri-food industry. 12th Congress of the European Association of Agricultural Economists – EAAE 2008, 12 pp.

Gasparin, C.P., Peets, S., Blackburn, D.W.K and **Godwin, R.J. (2007):** Stakeholder requirements for traceability systems. In J.V. Stafford (Ed). Proceedings of the 6th European conference on precision agriculture (pp793-799). The Netherlands: Wageningen Academic Publishers.

Germain, C. (2005): Traceability implementation in developing countries, its possibilities and its constraints A few case studies. 159 pp.

Ghirardi, J. J. G., Caja, D., Casellas, G. J. and Hernandez-Jover, M. (2006): Evaluation of the retention of electronic identification boluses in the forestomachs of cattle. Journal of Animal Science, 84: 2260–2268. Available at http/www. jas.fass.org/cgi/content/abstract/85/1/248

Golan, E. H, Krissoff, B., and Kuchler, F. (2005): Food Traceability: One Ingredient in a Safe and Efficient Food Supply. Prepared Foods, **174**: 59-70.

Government of Kenya (2004): Support to NEPAD–CAADP implementation TCP/KEN/2908 (I) (NEPAD Ref. 04/06 E) Volume IV of IV. Bankable Investment Project Profile. Disease control and facilitation of livestock commodities marketing.23 pages Available: ftp://ftp.fao.org/docrep/fao/007/ae556e/ae556e00.pdf. (Accessed August, 2009).

Government of Kenya (2008): National Livestock Policy, Sessional Paper No., 2, 2008. 103 pages.

Halderman, M. and **Nelson, M. (2005):** EU Policy-Making: Reform of the CAP and EU Trade in Beef and Dairy with Developing Countries, PPLPI Working Paper 18, Rome:

Food and Agriculture Organization (FAO) www.fao.org/ag/againfo/projects/en/pplpi/docarc/wp18.pdf (accessed 2 June 2009).

Hisey, P. (2005): The trace-race. Meat Marketing and Technology, 1:60–67.

Hobbs, J.E. (2003): Traceability in Meat Supply Chains. Current Agricultural, Food and Resource Issues, **4**:36-49.

Hobbs, J.E., Yeung, M.T. and **Kerr, W.A. (2007):** Identification and analysis of the current and potential benefits of a National livestock traceability system in Canada. Prepared for Agriculture and Agri-Food Canada by Hobbs, Kerr and Associates. Cat No. A34-9/2007E-PDF. 50pp.

ICAR (2004): Development of Animal Identification and Recording Systems for Developing Countries ICAR Technical Series no. 9. Proceedings of the ICAR/FAO Seminar held in Sousse, Tunisia, 29 May 2004. Editors: R. Pauw, S. Mack & J. Maki-Hokkonen, 186 Pages.

ICAR (2009): International agreement on recording practices. Guidelines approved by the general assembly in Niagara falls. 517 Pages.

Karkkainen, M. (2003): Increasing efficiency in the supply chain for short shelf life goods using RFID tagging. International Journal of Retail and Distribution Management, **31:** 529–553.

Kasiiti J. L. (2009): Surveillance for RVF in Eastern Africa with reference to the outbreaks in Kenya and Tanzania re-emergence of Rift valley fever in Southern Africa: how to better predict and respond. Bloemfontein (South Africa), February 16 – 18th, 2009. http://www.rr-africa.oie.int/docspdf/en/2009/RVF/LICHOTI.pdf (Accessed May 2009).

Keskin, E., Steglich, M., Dijkman, J. and Hall, A., (2008): Private Capacity and public failure: contours of livestock innovation response Capacity in Kenya. **UNU-MERIT**

Working Papers ISSN 1871-9872. United Nations University - Maastricht Economic and social Research and training centre on Innovation and Technology Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands

Kleinbaum, D. G., and **Klein, M. (2005):** Survival Analysis: A Self-Learning Text (Statistics for Biology and Health). 2nd ed. Springer, New York, NY. 570 pp.

Korn, C. (2004): List of certificates of laboratory acceptance for the IDEA Project and list of certificates according to IDEA test procedure. v. 4.0. Dossier Reference: TL-AP-04/07. Tempest Laboratory, Joint Research Centre of the European Commission, Ispra, Italy.

Kumar, R., Reinitz, H.W., Simunovic, J., Sandeep., and Franzon, P.D. (2009): Overview of RFID technology and its application in the food industry. Journal of Food Science, **74**: 101-106.

Liddell, S. and **Bailey, D.V. (2001):** Market opportunities and threats to the U.S. pork industry posed by traceability systems. International Food and Agribusiness Management Review, **4**: 287-302.

Lüth, M. and A. Spiller, (2005): Brands as Quality Signals in the Meat Sector: A Conjoint Analysis. International Food and Agribusiness Management Association (IAMA). 15th Annual World Food and Agribusiness Forum: Symposium and Case Conference. 25-28 June, 2005. Chicago, United States of America. Retrieved 18 October 2007 fromhttp://www.ifama.org/conferences/2005Conference/Papers&Discussions/1127_Paper_Final.pdf.

MAF Biosecurity New Zealand Information Paper (2009): Review of selected cattle identification and tracing systems worldwide: Lessons for the New Zealand National Animal Identification and Tracing (NAIT) Project. MAF Biosecurity New Zealand Information Paper No: 2009/03 ISBN No: 978-0-478-33852-2 (online).

Mankis, I. and **Manos, B. (2009):** Design of an integrated supply chain model for supporting traceability of dairy products. Dairy Technology, **67**: 126-138. doi: 10.1111/j.1471-0307.2008.00444.x.

Hall, J. K.; and Martin, M. J. C. (2005): Disruptive technologies, stakeholders and the innovation value-added chain: a framework for evaluating radical technology. Research and Development Management, **35**, N° 3.

McPeak, J., and **Little, P.D. (2006):** Pastoral Livestock Marketing in Eastern Africa: Research and Policy Challenges. Warwickshire, UK: ITDG Publications, 288 pp.

Meat Board of Namibia. 2003. *Traceability in the Namibian livestock industry: Issues to be addressed – A technical discussion document prepared by the Meat Board of Namibia*, Farm Assured Namibian Meat. http://www.nammic.com.na/fan.php Accessed February 14, 2009.

Meuwissen, M.P.M., Velthuis, A.G.J., Hogeveen, H and **Huirne, R.B.M. (2003):** Traceability and certification in meat supply chains. Journal of Agribusiness, **21**: 167-181.

Morgan, N. and **Tallard, G. (2008):** Cattle and beef international commodity profile. Markets and Trade Division, Food and Agriculture Organization. Background paper for the Competitive Commercial Agriculture in Sub–Saharan Africa (CCAA) Study. http://siteresources.worldbank.org/INTAFRICA/Resources/257994-1215457178567/Cattle_and_beef_profile.pdf. 20pp.

NAIS Benefit Cost Research Team (2009): Benefit-cost analysis of the National Animal Identification System. Report of the Animal and Plant Health Inspection Service (APHIS), United States Department of Agriculture. 429 pp.

North, D. (1990): *Institutions, institutional change and economic performance.* Cambridge University Press.

North, D.C. (1991): Institutions. Journal of Economic Perspectives, **5:** 97-112.

North, D.C. **(1993)**: Institutions and credible commitment, Journal of Institutional and Theoretical Economics, **149:**11-23.

OIE (2009): Recommendations of the OIE International Conference on Animal Identification and Traceability Buenos Aires, 23-25 March, 2009. (Accessed October 2009).

OIE (2010): *Terrestrial Animal Health Code.* ©OIE - World Organisation for Animal Health, 12 rue de Prony 75017 Paris (France). http://www.oie.int/eng/normes/mcode/en_sommaire.htm (Accessed June 2010).

Omiti, J. and **Irungu, P. (2002):** Institutional and policy issues relevant to pastoral development in Kenya. Institute of Policy Analysis and Research, Discussion Paper No. 031/2002, 57 pages.

On Trace (2007): Traceability Backgrounder. Web Page, [Accessed 14 January 2008]. Available At Http://Www.Ontraceagrifood.Com/Documents/TraceabilityBkgder-2007.Pdf.

Paskin, R. (2003): *Economic and social welfare importance of transboundary animal diseases.* In Report of a workshop of Chief Veterinary Officers/Directors of Veterinary Services of SADC Member Countries on Transboundary Animal Diseases with special reference to foot and mouth disease and contagious bovine pleuropneumonia in Southern Africa, Pretoria, 21-22 July, South Africa.

Peets, **S., Gasparin, C.P., Blackburn, D.W.K and Godwin, R.J. (2009):** RFID tags for identification and verifying agrochemicals in food traceability systems. Precision Agriculture; **10**: 382-394.

Pinna, W., Sedda, P, Moniell, G. and **Rib'o, O. (2006):** Electronic identification of Sarda goats under extensive conditions in the island of Sardinia. Small Ruminant Research, **66**: 286–290.

Pouliot, S. (2008): *Estimating the costs and benefits of cattle traceability: the case of the Quebec cattle traceability system.* Paper presented in the American Agricultural Economics Association Annual Meeting, Orlando, FL, July 27-29, 2008.

RFID Journal (2005): *What is RFID?* [Online]. Available URL: http://www.rfidjournal.com/article/articleview/1339/1/129/ [Accessed October 2009].

Ribó, O., Poucet, A., Meloni, U., Korn, C., and **Cuypus, M. (1999):** Idea project-guide procedures (v5.3), Safeguards and Verification Techniques Unit, Institute for Systems Informatics and safety, Joint research Centre, Ispra, 78pp, (Technical Note No. 1.99.159).

Rosen, S. (1974): Hodenic prices and implicit markets: product differentiation in pure competition. Journal of Political Economy, **82**: 34-55.

Schwägele, F. (2005): Traceability from a European perspective. Meat Science, **71**: 164-173.

Scott, A., Zepeda, C., Garber, L., Smith, J., Swayne, D., Rhorer, A., Kellar, J., Shimshony, A., Batho, H., CAPorale, V., and **Giovannini, A. (2006):** The concept of compartmentalisation. Scientific and Technical Review OIE, **25**: 873-879.

Shanahan, C., Kernan, B., Ayalew, G., McDonnell, K., Butler, F. and Ward, S. (2009): A framework for beef traceability from farm to slaughter using global standards: An Irish perspective. Computers and Electronics in Agriculture, **66**: 62-69.

Smith, G.C., Tatum, J.D., Belk, K.E., Scanga, J.A., Grandin, T. and **Sofos J.N. (2005):** Traceability from a US perspective. Meat Science, **71**: 174–193.

Souza-Monteiro, D. M., and **Caswell, J.A. (2004):** The economics of implementing traceability in beef supply chains: Trends in major producing and trading countries. Amherst: Department of Resource Economics, University of Massachusetts, http://www.umass.edu/ resec/workingpapers.htm. (Accessed June 2009).

Souza-Monteiro, D. M., and **Caswell, J.A. (2008):** Traceability adoption at the farm level: an empirical analysis of the Portuguese pear industry. Food Policy. Doi: 10.1016/. j.foodpol.2008.2007.003 (Accessed September 2009).

Stevens, C., Kennan, J. and **Seleka,** T. **(2005):** *Botswana Beef Exports and Trade Policy.* Brighton: Institute of Development Studies, University of Sussex. www.steps-centre.org//VetScienceWorkingPaper1_updated.pdf (Accessed April 2010).

Tajima, M. (2007): Strategic value of RFID in supply chain management. Journal of Purchasing Supply Management, 13: 261-273.

Tambi, N. E., Maina, W. O. and Ndi, C. (2006): An estimation of the economic impact of contagious bovine pleuropneumonia in Africa. Scientific and Technical Review OIE, **25**: 999-1011.

Thompson, G. (2003): Contagious bovine pleuropneumonia: Possible future strategies for the control of the disease in the PACE region. PACE Programme, AU-IBAR, PO Box 30786, Nairobi, Kenya. Available: http://www.fao.org/docrep/007/y5510e/y5510e0r.htm (Accessed March 2010).

Toto, A. (2009): An enhanced animal identification and traceability information system in Namibia. 1st OIE conference on animal identification and traceability –Buenos Aires: 24 March 2009. Available: www.namlits.com.

Trautman, D., Goddard, E. and **Nilsson, T. (2008):** Traceability – a literature review. Department of Rural Economy, University of Alberta, Edmonton, Canada. Project Report No. 08-02.151pp.

Ubilava, D., and **Foster, K. (2009):** Quality verification vs. product traceability: consumer preference for informational attributes of pork in Georgia. Food Policy, **34**: 300-310.

Wanyoike, F. and **Rich, K.M. (2008):** An assessment of the regional and national socio-economic impacts of the 2007 Rift Valley fever outbreak in Kenya. Presentation for the Rift Valley fever workshop: Scientific pathways towards public health prevention and response, organized by the US Centres for Disease Control and the Kenyan Ministry of Health, 6 May 2008. Nairobi (Kenya): ILRI URI: http://hdl.handle.net/10568/1140.

Weimers, J.F. (2000): Developing a national farm animal identification system (pp. 1–20). Mimeograph Report by the National Animal Identification Coordinator, Veterinary Services, Animal and Plant Health Inspection Services, US Department of Agriculture, Washington, DC.

Wilson, T. P. and **Clarke, W. R. (1998):** Food safety and traceability in the agricultural supply chain: using the Internet to deliver traceability. Supply Chain Management **3**: 127–133.

Xue, L., Weiwei, G., Zetian, F., Peng, X and **Weiguang, L., (2007):** Traceability and IT: implications for the future international competitiveness and structure of China's vegetable sector. New Zealand Journal of Agricultural Research, **50**: 911-917.

APPENDIX 1: DESIGN OF THE LITS SYSTEM

The actual activities undertaken during design of the study included:

- Detailed design: Setup the Test-plan and Quality Assurance;
    - Installation of core development and walk through with contracting authority;
    - Test system together with client for various markets and staging posts such as Garissa, Chakama, Taita Taveta, Mombasa and Athi River, Mandera, Wajir, Moyale and Kwale);
    - Customization of the core system (fixing the gaps);
    - Parameters design and documentation;
    - Confirmation of receipt of data synchronised from the field;
    - Confirmation of reports generation;
    - Confirmation of delivery of responses to specific queries;
    - Installation and System Sign Off.
- Unit development / prototypes;
- Software integration and testing;
- Hardware design;
- Installation at site / deployment through a phased approach i.e. pilot test then followed by a full rollout;
- Site testing and acceptance included:
    - User Acceptance Testing Planning;
    - Test parameters setups and test cases designs;
    - User Acceptance Testing (UAT);

- UAT Reporting;
- Implementation, setup and commissioning along the chain;
- UAT issues fixing and retesting;
- Final UAT test run;
- Back up and disaster recovery planning (DRP);
- UAT Sign off.

- Training and documentation included:
    - Additional end user and super user (based at headquarters) Training;
    - Super beneficiaries (DVS);
    - User and administrators training sign off.
- Migration of System to User included:
    - System go live and data conversion;
    - Go live planning;
    - Preparation and update of manuals;
    - Parallel run (Manual evaluation against system);
    - Final go live and cut off;
    - System monitoring.

Other activities included

- Users and performance evaluation;
- Back up/ Disaster Recovery Programme (DRP) Setup;
- Post implementation review; annual maintenance cycle (AMC) discussions;
- Annual maintenance sign offs and support cycle procedures.

APPENDIX 2: REQUIREMENTS FOR EXPORT CERTIFICATION

a) <u>For live animals</u>

1. Trade inquiry;
2. No objection from the importing country based on SPS standards and the protocol of agreement outlining the export requirements that must be fulfilled (Serial No., Ref No.);
3. Importing country is specified;
4. Health certificate based on SPS requirements:
    i. Source of animal and the type of production systems;
    ii. Point of entry inspection systems;
    iii. Audit of exporting inspection systems;
    iv. Disease control strategies and health programme administered i.e. treatments, vaccinations, livestock disease and vaccination history;
    v. Laboratory health profile of the selected animals (Lumpy Skin Diseases, CBPP, RVF, FMD);
    vi. Chemical and drug residuals testing;
    vii. Feeds and additives (not less than 30 days before export);
    viii. Physical and clinical examination of the animals' such as mouthing for FMD (not more than 24 hour prior to export);
    ix. Examination for external parasites ticks;
    x. Certificate of health/permit;
    xi. Quality of the animals- identification device number and type; age, sex, distinctive markings, weight and grades;

xii. At animals should have remained in holding grounds/ quarantine for not less than 30 days for cleansing.

5. Export permit/ health certificate (Ref. No.);
6. Inspection report i.e. disinfection, sanitization of sea vessel and loading of the animals at exit point;
7. Date and means of shipment from exit port;
8. Welfare issues are adhered.

b) <u>Livestock Products</u>

1. Trade inquiry document identification (ref. No);
2. No objection – from importing country, based on SPS and Technical Barriers to Trade rules (Serial no., Ref no);
3. LC- Letter of credit trader- from the importing issued by the bank and is payment mode;
4. Pro-forma invoice;
5. Ordinary certificate of origin- bureau of standards (Ref. No.);
6. Chamber of commerce- stamp the certificate of origin;
7. Supreme Council Muslims- *Halal* certification (Ref. No.);
8. Certificate of authenticity identification (from Ministry of Foreign Affairs)- to check and endorse the documents;
9. International Sanitary Health Certification identification (Ref. No.) – from the Ministry of Health;
10. KMC- International Health or Sanitary certificate;

    i) KMC no objection (Ref. No/Order No.).

ii) Livestock movement permit identification (serial no).

iii) Animal identification number.

iv) Arrival date of the animals.

v) Mob and slaughter numbers.

vi) Slaughter/inspection date.

vii) Carcass Grade.

viii) Source of animal.

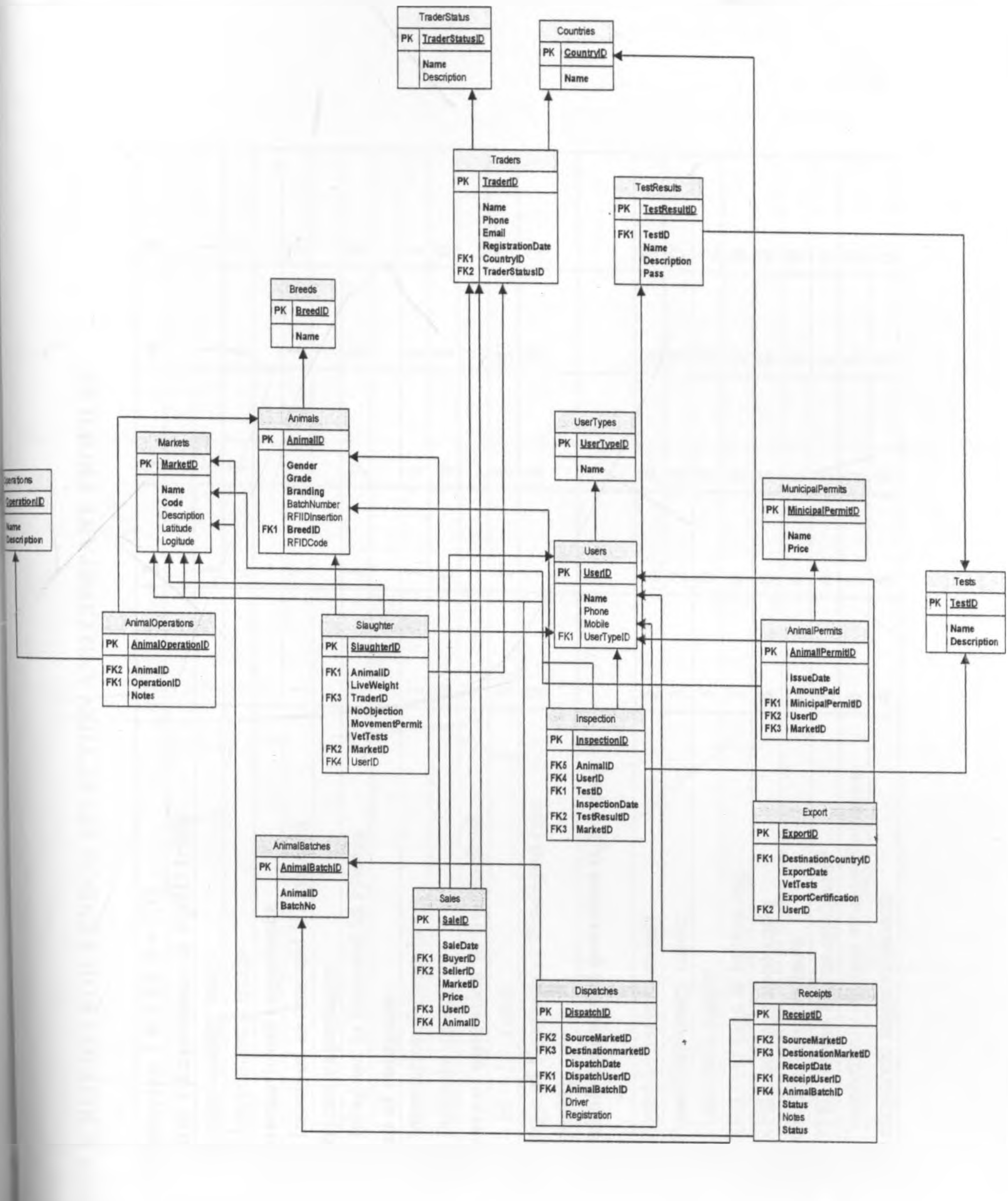
ix) Electronic label identification for carcass/meat cuts.

x) Date of manufacture.

xi) Better consumed before.

xii) Company/ country produced for.

APPENDIX 3: STAKEHOLDERS INFORMATIONAL NEEDS ANALYSIS



APPENDIX 4: CRITERIA FOR VENDOR SELECTION AND COMPANY PROFILES

	Criterion 1 = YES 0 = NO	1	2	3	4	5
1.	**Firm's Experience in RFID trials**					
	a) own country trails	1	1	1	1	1
	b) International trials	1	1	1	1	1
2.	**International experience**					
	a) Involved in national ID systems	1	1	1	1	1
3.	**African experience**					
	a) Involved in National Id system	0	1	0	0	0
4	**Size of company**					
	a) International Branches	1	1	1	1	1
	b) Publicly quoted	0	0	0	1	0
5	**Years of operation in livestock id**					
	a) > or = 10 Years	1	1	1	1	1
6	**Range of Equipment Provided (see criteria)**	9	7	6	5	2
7	**Cost of equipment provided (Cheapest = 5)**					
	a) Portable reader (wand)	5	3	0	4	0
	b) Panel/Stationary reader	3	2	4	5	0
	C) Hand held reader	3	0	5	4	2
	d) RFID ear tags & button tag	2	4	5	3	0
	8) RFID ear tags applicator	4	0	5	0	0
	f) RFID rumen Boluses	2	4	5	0	0
	g) RFID rumen Bolus applicator	3	4	5	0	0
	h) Connectivity & data storage Software	4	5	0	0	0
	i) Telephone support/month	4	5	0	0	0

	Criterion 1 = YES 0 = NO	1	2	3	4	5
8	**Equipment ISO Compliance**					
	a) ISO 11784	1	1	1	1	1
	b) ISO 11785	1	1	1	1	
	9 Tracking and traceability solutions					
	a) Web based tracking database solution	0	0	0	0	1
	b) Web based tracking database solution	0	0	0	0	1
	c) Added value programs	0	0	0	0	1
10	**Certifications**					
	a) EU certification (EU Joint Research Centre)	1	1	1	1	1
	b) USDA approved	1	1	0	1	1
	C) ISO 9001:2000 certified	1	1	0	1	1
11	**Business Focus**					
	a) Livestock id and tracking solutions only	1	1	0	0	1
	SCORE (Total possible = 69 points)	50	46	43	35	17

APPENDIX 5: COST-BENEFIT QUESTIONNAIRE
ESTIMATION OF COSTS & BENEFITS AND THE PREFERENCE FOR THE LIVESTOCK IDENTIFICATION AND TRACEABILITY SYSTSEM IN KENYA

The objective of this survey is to gather information that was used to estimates the costs and benefits of the Livestock identification and Traceability System in Kenya. The questionnaire is collecting information about the methods you use to identify livestock, the effectiveness of the identification system and willingness to participate in the new identification system. The information collected was treated with ultimate confidentiality and the names of the respondents will not be disclosed.

Livestock Traders Survey

1. Date of Interview (dd/mm/yy)	
2. Place of Interview	
3. Name of Respondent	
4. Contact address for Respondent	Tel.No. ______ Email address ______
5. Gender of Respondent	1=Male 2=Female [____] (insert code)
6. Name of interviewer	
7. Filled questionnaire checked by	

A. Business and Personal Profile

A1. How old are you? [____] (Insert code)

Codes

1= Less than 30 years 2= 30 to 45 years 3= Over 45 year

A2. What level of formal education did you reach? [____] (Insert code)

Codes

1= None 4= Secondary Graduate

2= Elementary 5= University

3= Intermediate 6= Others specify

____

A3. Which languages or dialects do you speak? [____][____][____]

Codes

1= Somali 4= Swahili

2= Arabic 5= Others (specify)

3= English ______________________

A4. In which year did you start the livestock trade business? __________

A5. How was the business started? [____] (Insert code)

Code

1= Self started,

2= Inherited from parents

3= Purchased from parents/relatives/others

4=Others (specify)

____

Please answer the following questions about the nature of ownership of your livestock trading business

A8. What is the current ownership nature of your livestock trade business? (Insert code)	A9. If the nature of ownership of the business is sole ownership;		A10. If the business is a partnership, who are the partner(s)? (Insert code)
	A9.1 How many people do you have helping in the business	A9.2 If you have people who help you in the business, who are they? (Insert code)	
[ ]		[ ]	[ ]

Code

Ownership nature of business	**Types of people helping in the business**	**Types of people in the partnership**
1= Sole ownership,	1= Family member (s)	1= Other family member(s)
2= Partnership with another person	2= Relative (s)	2= Relative(s)
3= Partnership with more than one person	3= Hired labourer(s)	3= Friends
4= Others (specify) ________	4= Others (specify) ________ ____________________	4= Other (specify) ________ ____________________

____

A6. Apart from livestock trading, which other economic activity are you engaged in? [ ][ ][ ] (Insert code)

Code
1= None
2= Farming
3= Livestock producer
4= Other types of business (specify type)________________________________
5= Other occupations (specify) ________________________

If trader is involved in any other economic activity/activities, ask questions A7 – A9 and if not go to question A10.

A7. Does livestock trading help to finance these businesses? 0=No 1= Yes [ ] (Insert code)

A8. Does other business help to finance livestock trading? 0=No 1= Yes [ ] (Insert code)

A9. What is the percentage (%) share of your income coming from livestock trading? ________

A10. Which of the following strategy do you practice in the livestock business?

A10a. Buying and selling animals in different markets to exploit the difference in prices 0= No 1= Yes [ ] (Insert code)

<u>If YES and based on the latest batch of livestock for which you completed transacting:</u>

(i) How far is it from where you bought animals to where you sold? [ ] Km

(ii) For what length of time did you keep the animals between buying and selling? [ ] Days

(iii) How many animals were in this transaction? Cattle [ ]; Sheep and Goats [ ]

(iv) How do you identify such animals you purchase?
[____][____]
1. Marking using paint
2. Branding on the skin
3. Ear-tagging
4. By assigning names
5. Others specify
____

(v) Did you loose any of these animals 0=No 1= Yes [__]

(vi) If YES, How many Cattle [______]; Sheep and Goats [______]

(vii) If YES, how did you loose them? (Tick) Predation [________]; Stolen [________]; Died [________]; Others, specify________________________________ [________]

A10b. Buying animals, fattening them on good pasture before selling them within markets in Kenya 0= No 1= Yes [__] (Insert code)

If YES and based on the latest batch of livestock for which you completed transacting:

(i) How far is it from where you bought animals to where you fatten [________] Km

(ii) How far is it from where you fatten animals to where you sell [________] Km

(iii) How did you move your livestock (Tick): Trucking [__], Trekking [__]

(iv) How many animals were in this transaction? Cattle [______]; Sheep and Goats [______]

(v) For what length of time did you fatten the animals before selling? [________] Days

(vi) How do you identify such animals you purchase?
[____][____]
1. Marking using paint
2. Branding on the skin
3. Ear-tagging
4. By assigning names
5. Others specify
____

(vii) Did you loose any of these animals 0=No 1= Yes [__]

(viii) If YES, How many Cattle [______]; Sheep and Goats [______]

(ix) If YES, how did you loose them? (Tick) Predation [________]; Stolen [________]; Died [________]; Others, specify________________________________ [________]

A10c. Buying animals, fattening them on good pasture before selling them in export markets 0= No 1= Yes [__] (Insert code)

If YES and based on the latest batch of livestock for which you completed transacting:

(i) How far is it from where you bought animals to where you fatten [________] Km

(ii) How far is it from where you fatten animals to where you sell [________] Km

(iii) How did you move your livestock (Tick): Trucking [___], Trekking [___]

(iv) For what length of time did you fatten the animals before selling? [________] Days

(v) To which country did you export?

____

(vi) How many animals were in this transaction? Cattle [_______]; Sheep and Goats [_______]

(vii) How do you identify such animals you purchase? [_____][_____]

1. Marking using paint
2. Branding on the skin
3. Ear-tagging
4. By assigning names
5. Others specify

____

(viii) Did you loose any of these animals 0=No 1= Yes [___]

(ix) If YES, How many Cattle [_______]; Sheep and Goats [_______]

(x) If YES, to what did you loose them? (Tick) Predation [_________]; Theft [_________]; Death [_________]; Others, specify________________________________ [________]

A11. From whom do you buy livestock for most of the time (Rank in order of importance?)?

Seller	Rank
Livestock producers	[____________]
Small traders	[____________]
Others, specify ____________________________	[____________]

A12. Over the last 12 months, indicate which type of customers you sold animals to, what the type of business relationship you have with them and also the nature of payment.

Type of customers	(a.) Did you sell animals to this customer type (Insert code)	(b.) Nature of business relationship with the customer (Insert code)	(c.) In case of established long term relationship, what is the basis of the relationship (Insert code)	(d.) Nature of payment (Insert code)
1 Butchers	[___]	[__][__]	[___]	[__][__]
2 Livestock producers buying for breeding purposes	[___]	[__][__]	[___]	[__][__]
3 Private consumers	[___]	[__][__]	[___]	[__][__]
4 Restaurant owners	[___]	[__][__]	[___]	[__][__]
5 KMC	[___]	[__][__]	[___]	[__][__]
6 Specific buyers in foreign countries	[___]	[__][__]	[___]	[__][__]

7 Any buyer in foreign countries	[__]	[__][__]	[__]	[__][__]
8 Exporters	[__]	[__][__]	[__]	[__][__]
9 Others (specify)	[__]	[__][__]	[__]	[__][__]
10 Others (specify)	[__]	[__][__]	[__]	[__][__]

Codes

Did you sell to this customer type
0= No
1= Yes

Nature of business relationship with the customer
1= One time sale
2= Buyer with whom you have a long term business relationship
3= As a sub-agent of the small-scale trader

Basis of the long term relationship
1= Friendship
2= Kinship
3= None
4= Others (specify) ________________

Nature of payment
1= Cash on the spot
2= In kind
3= Cash after the animal is sold by the buyer
4= Cash after a short while
5= On credit
6= Others (specify) ___________

A13. Does any of the buyer listed above request for records or history (age, vaccination, place of birth, among others) of an animal before purchase 0=No 1= Yes [__]

1. If YES, which buyer (Give names)
   ____
2. How do you keep such records while servicing this buyer? Give details____
   ____
   ____

A13. Do you know of any buyer (in Kenya or export countries) to whom you would wish to sell your livestock but currently unable to because they require longer history about individual animals than you are currently able to provide 0=No 1= Yes [__]

1. If YES, which buyer (Give names and country)
   ____
2. Would you be willing to contribute to a livestock identification and record keeping system so that you are able to sell to this buyer? 0=No 1= Yes [__]

3. If YES, how much in KShs would you be willing to contribute for every animal you sell? [__________] KShs

B. Membership to Livestock Traders Associations and Groups

B1. Are you a member of any livestock traders association? 0=No 1=Yes [____] (Insert code)

If the trader is a member of a livestock traders association ask questions B2 to B4 and if not go to question B5

B2. What is the name of the association

____?

B3. Is there any annual membership fee and what is the amount?

Is there any annual membership fee? 0=No 1=Yes (Insert code)	Amount paid as annual membership fee (KShs)
[____]	

B4. What are the main benefits you get from the association? [____] [____][____] (Insert code)

Codes
1= Increased bargaining power
2= Improved buyer supplier relationship
3= Strength in lobbying
4= Increased income
5= Technical and financial support
6= Better access to information
7= Others (specify)

____

____

Are you a member an informal group of livestock traders? 0=No 1=Yes [____] (Insert code)

If the trader is a member of an informal group ask questions B6 to B7 and if not go to section C

B6. Is there any annual membership fee and what is the amount?

Is there any annual membership fee? 0=No 1=Yes (Insert code)	Amount paid as annual membership fee (KSh)
[____]	

B7. What are the main benefits you get from the group? [____] [____][____] (Insert code)

Codes
1= Increased bargaining power
2= Improved buyer supplier relationship
3= Strength in lobbying
4= Increased income
5= Technical and financial support
6= Better access to information
7= Others (specify)

____

____

C. Sources of market information

C1. What is/are the source(s) of your information on price, supply and demand conditions in your purchase markets? [____][____][____](Insert code)

Codes

1= Personal observation	7= Radio
2= Speaking with regular customers and suppliers in those markets	8= TV
	9= Trade association
	10= No source
3= Speaking with brokers	11= Fellow traders
4= Speaking with relatives	12= Others (specify)
5= Friends	____________________
6= Newspapers	

C2. Are you always satisfactorily informed about prices and also demand and supply conditions in your purchase markets? 0= No 1= Yes [____] (Insert code)

If you are sometimes not satisfied, explain the reason

____

____

____

Thank you very much for your time and willingness to provide information.

Appendix 6: Opportunity cost avoided by implementing a traceability system

Year	1	2	3	4	5	Total (US$)	
CBPP cost of vaccination control	7,654,500	6,494,078	6,441,262	6,622,673	6,726,775	33,939,288	Thompson (2003)
Cattle deaths	234090	234090	234090	234090	234090	1,170,450	Tambi *et al.* (2006)
beef	251910	251910	251910	251910	251910	1,259,550	
Milk	375300	375300	375300	375300	375300	1,876,500	
Draught power	66690	66690	66690	66690	66690	333,450	
RFV socioeconomic impact	100000000	100000000	100000000	0	0	300000000	Kasiiti (2009)
Other costs	0	0	0	0	0		
Meat (20,237,829 kg)	6420046.667	6420046.667	6420046.667	0	0	19,260,140	
Milk(21,134,520 litres)	1138012.667	1138012.667	1138012.667	0	0	3,414,038	
Business	11897436	11897436	11897436	0	0	35,692,308	
Vaccination	1025641	1025641	1025641	0	0	3,076,923	

Year	1	2	3	4	5	Total (US$)	Year
Export losses avoided	3056657.436	3056657.436	3056657.436	3056657.436	3056657.436	0	FAOSTAT 2008
Human related loss of income	604757.7107	604757.7107	604757.7107	0	0	0	Authors computation
Foreign Exchange	2062000	2062000	2062000	2062000	2062000	10310000	GoK (2004)
Local Cost	884000	884000	884000	884000	884000	4420000	
(i) Disease Control Campaigns	4780000	4780000	4780000	4780000	4780000	23900000	
Tick Control Programme	4360000	4360000	4360000	4360000	4360000	21800000	
Laboratory Services and Surveillance	540000	540000	540000	540000	540000	2700000	
Clinical Services	1200000	1200000	1200000	1200000	1200000	6000000	
Pilot Trials -	60000	60000	60000	60000	60000	300000	
Management and Studies	320000	320000	320000	320000	320000	1600000	
Transboundary diseases	146,931,041.4807	145,770,619.4807	145,717,803.4807	24,813,320.436	24,917,422.436	132,473,409	

Author's compilation