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## Abstract

Traceability systems offer strong incentives to livestock and meat exporting countries by altering their productive and industrial processes in order to access premium meat markets globally. Kenya, whilst acknowledged as one of the countries within the horn of Africa with a reasonably credible veterinary service, has very limited access to beef and livestock markets in importing countries due to perceived risk or suspicions of presence of trans-boundary animal diseases (TADs) such as Rift Valley Fever (RVF) and Foot and Mouth Disease (FMD), lack of capacity to prove the absence of TADs and absence of an effective traceability system that acts as proxy for quality assurance. The objective of this study was to report on the processes through which a model traceability system was designed for pastoral production systems of Northeastern Kenya.

The study reports that industry-wide consultation is a critical ingredient in the design process that encompassed simple drop down menus, low price and phased process of implementation. The use of a single central database reduced considerably the cost of implementation and minimized response time for impact analysis.

**Key words:** Design, electronic traceability systems

## 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). Such system are developed using guidelines of the Office international des epizooties (OIE) with key factors to be considered in the identification and implementation of appropriate traceability models suitable for countries and regions that have populations practicing various forms of pastoralist production systems such as transhumance and nomadism (OIE 2009).

The guidelines 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, record all the related processes and analyse all the information required to meet specific objectives, such as the prevention of disease and the acquisition of health

certificates amongst others (Barcos 2001). Overall, such systems should conform to international standards by defining the objectives and scope of the system as well as the organizational arrangements (consistent with the geographical, environmental and cultural circumstance within which it is designed), 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 2008). In addition, traceability systems developed specifically for third world countries ought to be of low cost, simple and implemented using a phased approach. Other related issues that affect design are 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) and a benefit-cost analysis (OIE 2008).

This paper 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.

## Materials and methods

### Study design

The first step in the design process was 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:

#### Literature review

A review of relevant documents including export certificates, livestock surveillance and disease notifications reports, no objection and movement permits, laboratory and OIE notification reports and models operating in other countries (Botswana and Namibia) was conducted. This information was used to prepare background papers and guiding principles that formed a basis of discussion at a stakeholders' workshop.

#### Stakeholder workshop

A participatory stakeholders' workshop was subsequently organised in Garissa - a key town within the selected market chain. This workshop formed the main entry-point for developing a model for LITS to both public and private sector stakeholders including the veterinary and animal production departments, provincial administration, political leaders, the traders' association and their officials. During the workshop, participants were introduced to the available Radio Frequency Identification Devices (RFID) technologies and the different models applicable. The importance and implications implementing a livestock traceability system was also emphasised. The purpose of this exercise was to bring each participant to an equal footing with regard to livestock traceability, contribute to the selection of the preferred RFID tools to be used in the traceability model; identify opportunities for involvement; assign roles and identify key

responsibilities while implementing the system. Finally the workshop was used to develop and clarify a study implementation plan.

Subsequently, the traceable requirements for each stakeholder were established in the course of a comprehensive needs analysis.

#### Analysis of stakeholders' traceability requirements

Traceability requirements (needs analysis) for each stakeholder were established through consultations with the stakeholders at various levels. These 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).

A combination of key informant interviews, focus group discussions and expert opinions were used beginning from the headquarters (centre) and ending up at the periphery (district level). All the information gathered during stakeholder needs analysis was consolidated into a Statement of User Requirements (SOUR).

#### Strategy meeting

After the needs analysis was complete, a strategy meeting was held with senior technical experts (Subject Matter Specialists) at the Department of Veterinary Services headquarters in Kabete. The purpose of the meeting was to confirm and 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 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 Standard Operating Procedures (SOP's) were also defined.

#### System design and development

Briefly, system design entailed a detailed architectural set-up, configuration and customization of content management software into relevant modules. 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. The traceability database was then designed based on the relational data model following all of the related agents and operations. Agents who have to submit animal traceability information to the database are the department of veterinary services, the department of livestock development, municipal and county market levy collectors and operators, animal holding grounds and quarantine stations, slaughterhouses, food quality assurance organizations, distributors, and exporters

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 stakeholders 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 by fixing the gaps;
- Design and documentation parameters;
- 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 (UAT) Planning;
- Test parameters setups and test cases designs;
- User Acceptance Testing;
- 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 Department of Veterinary Services;
- User and administrators training sign off.
- Migration of system to end 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.

Subsequently, data dictionary containing all necessary data to be recorded and registered in the database with codification and format [numeric, alphanumeric, length, address and International Standards Organisation (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.

## Results

#### Selection of RFID tags

The stakeholders opted that both RFID ear button tags and rumen boluses be tested under pastoral production systems of northeastern Kenya in Kenya.

Ear button tags were chosen, being the most commonly used tags worldwide, while rumen boluses have worked well in Botswana. Need for comparison of the two technologies warranted technical evaluation at field level.

#### Organisational mapping (stakeholders and their role at implementation)

The roles of the key stakeholders during implementation of the study were established (Table 1).

**Table 1**. Suggested roles of the key stakeholders in LITS

| Stakeholder | Role in LITS | |
|---|---|---|
| **Department of Veterinary Services** | - | Control/custodian of the central data base; |
| | - | Validation and verification of market data; |
| | - | Engineering policy change to the branding of Stock Act; |
| **Headquarters** | - | Provision of access to market infrastructure; |

| | |
|---|---|
| | - Provision of required human resource;<br>- Explore opportunities to expand traceability to the rest of Kenya;<br>- Provision of livestock IDs (registrar of brands);<br>- Ensuring compliance with veterinary procedures;<br>- Sensitisation and awareness to the community;<br>- Recovery and recycling of rumen bolus from slaughterhouse. |
| **Department of Veterinary Services**<br>**District level** | - Recruitment and registration of traders;<br>- Compliance with market related veterinary procedures;<br>- Movement permit.<br>- Physical mouthing of animals for FMD.<br>- Serological testing for CBPP (P-1).<br>- Hot iron branding.<br>- Application of ear tags and RFID devices to consigned cattle;<br>- Collection, entry, validation and verification of market data; and<br>- 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<br>- Sensitisation and awareness |
| **AU-IBAR** | - Cross-border policy harmonisation, dialogue and information exchange<br>- Audit of the traceability system<br>- Explore possibility of up-scaling the system regionally (IGAD, COMESA) |

**Stakeholder traceability requirements**

The stakeholders' traceability requirements were subsequently consolidated into a Statement of User Requirements (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 practices); 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 Foot and Mouth Disease (FMD), Rinderpest, Rift valley Fever (RVF), Contagious Bovine Pluropneumonia (CBPP) and Bovine Spongiform Encephalitis (BSE); the disease control measures implemented (vaccination, isolation and quarantine) and finally consolidated trend reports.

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

**The traceability blueprint**

The strategy meeting with SMS 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 that credible data sources and information pertinent to such reports were incorporated and effectively protected in the event of system failures. Moreover, the system was designed to protect the privacy and confidentiality of individual information, 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 of traceability**

The On-trace (2007) definition was preferred and adopted by the Department of Veterinary Services: This 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).”*

**Scope**

The initial species selected for traceability was cattle at individual animal level; however, the framework for the designed model 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 province through which cattle for export were grazed.

**Objectives 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 and control 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, Arid and Semi Arid Lands, African Union-Inter-African Bureau of Animal Resources (AU-IBAR), Kenya Livestock Marketing Council (KLMC) and Livestock Traders Marketing Society of Kenya (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.

**System design and development**

The design process took approximately three months for the software solution, database, screens and reports. It involved applying a clearly defined and phased approach. 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 model 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 an Internet Service Provider (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 process of software design and architectural specialist knowledgeable in the software infrastructure.

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

**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 1 shows the animal health module. This window allows reporting on the procedures (health tests, examinations, manipulation, vaccinations and treatment) carried out by the veterinary officers.

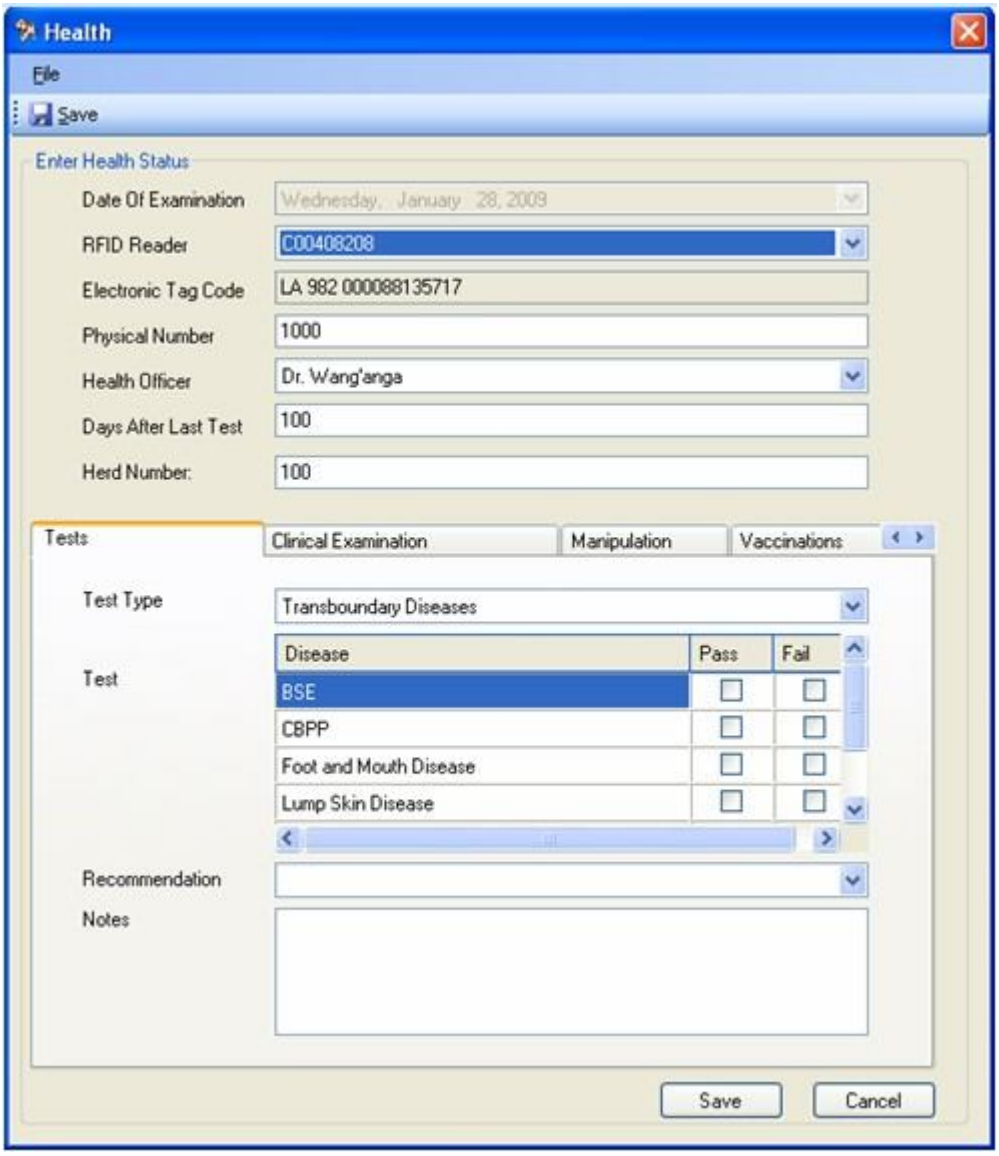



**Figure 1.** Animal health window

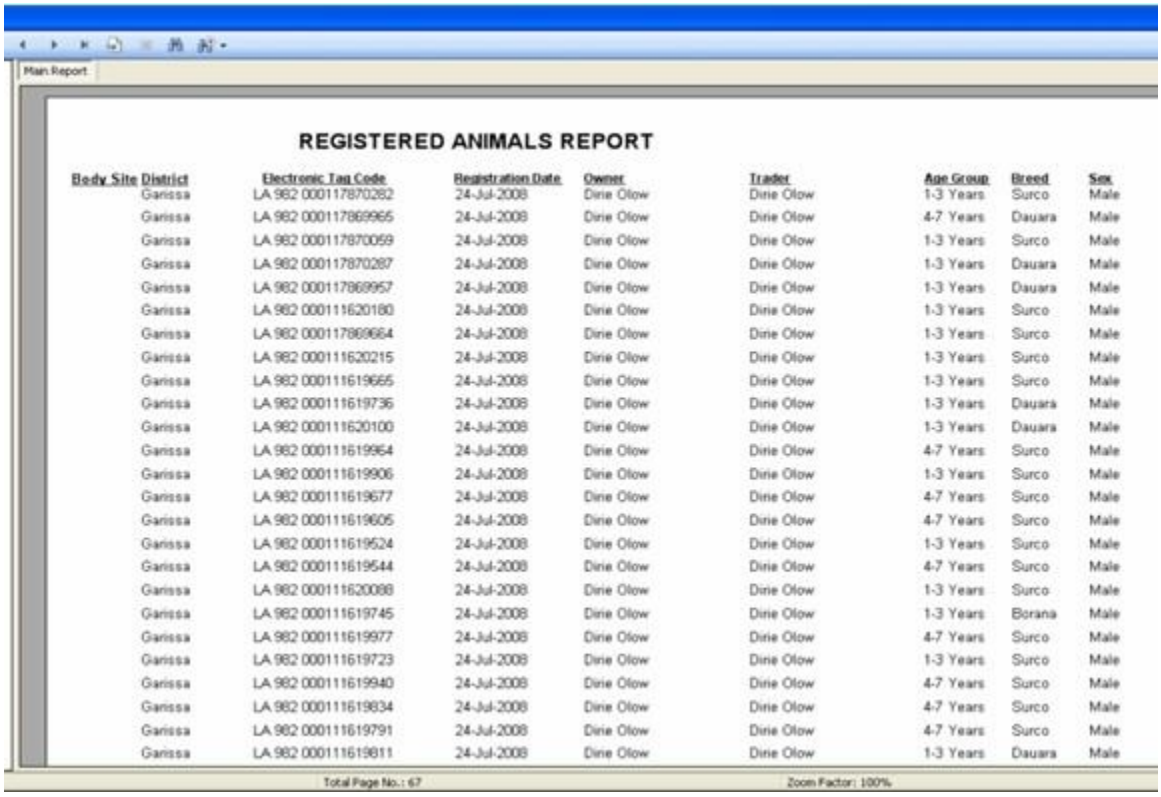
Simple drop down menus opened to the various categories of health tests that were to be performed. Under each specific category, the health officer was able to mark (checked) the specific system of the animal examined such as integumentary system. The health module also reported on the manipulations 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 2).



REGISTERED ANIMALS REPORT

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

**Figure 2.** 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 a sample master report 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.

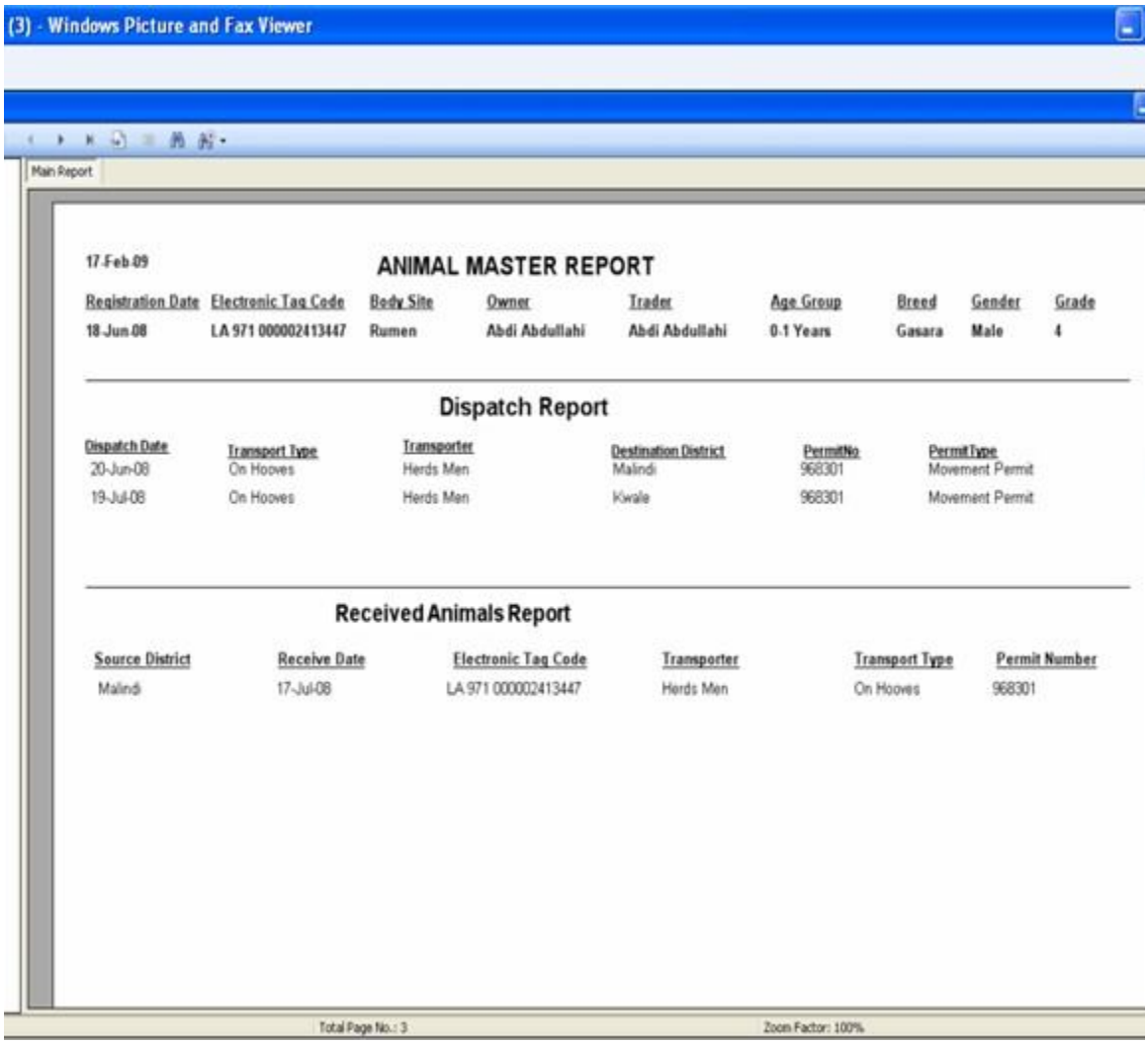



**Figure 3.** Master report

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.

The LITS database was 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 4).


**Figure 4.** 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.

## 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 here 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 2008). 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 and control 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 and control 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

## Conclusions

- The study noted that electronic traceability system is costly yet feasible in developing countries. Stakeholder education and private sector engagement within participatory workshop are part of the critical ingredients of success and sustainability. The use of IT-enabled systems such as RFID have been developed and introduced, thus reducing errors associated with manual data handling, thus making tracking more feasible.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