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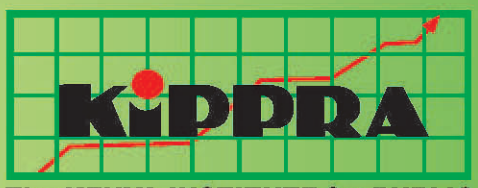

The KENYA INSTITUTE for PUBLIC POLICY RESEARCH and ANALYSIS

Application of Radio-Frequency Identification Technology in Livestock Management in Botswana: Lessons for Arid and Semi-Arid Lands in Kenya

Adrian W. Matofari and Vivian M. Omariba

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THE KENYA INSTITUTE FOR PUBLIC POLICY RESEARCH AND ANALYSIS (KIPPRA)

YOUNG PROFESSIONALS (YPs) TRAINING PROGRAMME

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Kenya Institute for Public Policy Research and Analysis

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Abstract

In Kenya's Arid and Semi-Arid Lands (ASALs), livestock management is a pivotal aspect of sustenance and livelihood for the locals. Recognizing the significance of efficient livestock management, this study delved into the potential application of Radio-Frequency Identification (RFID) technology as a transformative tool for livestock management in Kenya's ASALs. The focus of the research was influenced by a comparative analysis, specifically drawing insights from Botswana's Animal Identification and Traceability System (BAITS) where RFID- based Livestock Identification and Traceability System (LITS) has been successfully implemented. Against the backdrop of challenges in livestock management faced by Kenya's ASALs, the study aimed to unravel the determinants that contribute to the effective implementation of RFID technology. Utilizing a case study methodology, the research focused on three critical dimensions: communication channels, technology considerations, and the socio-environmental which were extracted from the Diffusion of Innovation Theory. The study drew lessons from Botswana LITS and highlighted the policy implications for Kenya in enhancing livestock management using RFID technology. Key findings underscored the role of communication channels in facilitating information dissemination among stakeholders. The choice of appropriate and reliable technology emerged as another determinant crucial for successful implementation. Moreover, a favorable social environment, characterized by a culture of adoption and compliance, significantly contributed to the effectiveness of RFID technology in Botswana's BAITS. Moreover, the study found out even though there are benefits that came as a result of the implementation of the technology, there were some challenges as well. Some include poor network coverage, limited ICT skills, workforce adaptation and privacy/security concerns. The study, while anchored in the context of Botswana, extended its impact to the Kenyan scenario by outlining policy implications for the enhancement of livestock management. Valuable lessons were drawn, emphasizing the importance of stakeholder engagement and collaboration. Continuous technological innovation and infrastructure development were highlighted as prerequisites for sustained success. Additionally, the study emphasized the crucial role of robust regulatory frameworks to ensure compliance and safeguard data security.

Abbreviations and Acronyms

ASALs	Arid and Semi-Arid Lands
BAITS	Botswana Animal Identification Traceability System
DOI	Diffusion of Innovation
DVS	Directorate for Veterinary Services
EU	European Union
ICT	Information Communication Technology
LITS	Livestock Identification Traceability System
MOALFC	Ministry Agriculture, Livestock, Fisheries and Cooperatives
RFID	Radio- Frequency Identification

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1. Introduction

This section will discuss the history of animal identification, the problem statement and why RFID technology can be an innovative solution to effective livestock management and the objectives that the study.

Livestock management refers to the process of overseeing and controlling the care, breeding, feeding and general well-being of domesticated animals. It involves the application of various practices and techniques to ensure the optimal health, productivity of the animal, as well as efficient utilization of resources. The livestock sector is a critical component of the Kenyan economy, accounting for 10 percent of the national GDP and employing over 50 percent of the agricultural labor force. It is also a major source of food and nutrition for the country's population, providing over 30 percent of the animal protein consumed, MoALFC, (2022).

The livestock sector is particularly important in the ASALs of Kenya, which make up over 80 percent of the country's landmass and are home to over 30 percent of the population. The ASALs are characterized by low rainfall and poor-quality soils, which make crop production difficult. However, they are well-suited for livestock production, as they provide extensive grazing areas for animals. The main types of livestock raised in the ASALs are cattle, goats, sheep, and camels. These animals are adapted to the harsh climatic conditions and can survive on low-quality feed. Livestock production provides pastoralist communities in the ASALs with a number of benefits, including a source of food and nutrition, source of income means of saving and investment as well as a social and cultural symbol.

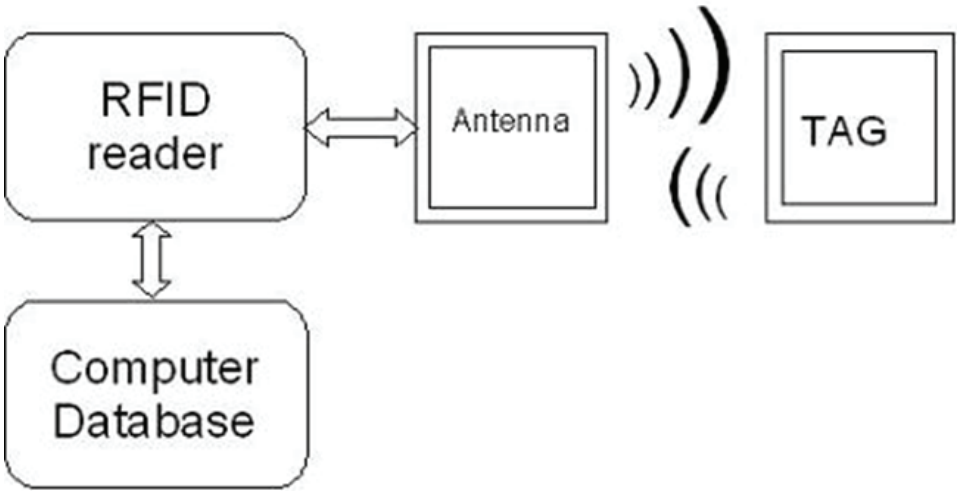
Despite the importance of the livestock sector in the ASALs, there are several challenges that face livestock producers in this region. The ASALs are particularly vulnerable to climate change, which is leading to more frequent and severe droughts and floods. These extreme weather events can cause widespread livestock losses and damage to grazing land, Odongo et al, (2021). In addition, overgrazing, deforestation, and unsustainable agricultural practices have led to the degradation of natural resources in the ASALs. This has made it more difficult for livestock producers to find adequate feed and water for their animals. Moreover, livestock in the ASALs are susceptible to several diseases, including foot-and-mouth disease, Rift Valley fever, and lumpy skin disease. These diseases can cause significant livestock losses and reduce productivity, Mbae et al, (2020).

Radio frequency identification (RFID) technology can be a solution to livestock management in Kenya. RFID technology is a wireless system that uses radio waves to identify and track objects. Siror et al, (2011), define Radio Frequency Identification Technology as a contactless identification technology which consists of a transponder, that is located on the object to be identified and an interrogator or reader. This technology can be used to address several of the challenges facing livestock management in the ASALs of Kenya, including, monitoring the movement of livestock during droughts and floods occasioned by climate change thereby helping to reduce livestock losses. For instance, RFID tags can be used to track the movement of livestock within a pasture, allowing farmers to identify areas that are being overgrazed and take steps to protect them. In addition, RFID technology

can be used to track the spread of livestock diseases and identify infected animals. RFID tags can be used to track the movement of livestock between different farms and markets, helping to prevent the spread of diseases (M.H. Ariff et al, 2014)

A typical RFID system includes three components: an antenna or coil, a transceiver (with decoder) and a transponder (RF tag) electronically programmed with unique information, Doumdouzis et al (2006). Antennas establish the communication between the tag and the transceiver. The transceiver is responsible for the data acquisition. The reader decodes the data which are encoded in the integrated circuit of the tag and the data can then be transferred to any computer system for processing. Figure 1.1 below shows the representation of a typical RFID system.

Figure 1.1 A typical RFID system



Source: MBA Knowledge Base 2021

Although the livestock sector is a key element in the ASALs of Kenya, existing livestock management systems in these regions grapple with inefficiencies, ranging from inadequate data accuracy to suboptimal disease control mechanisms and limited technology adoption. This not only hampers Kenya's ability to tap into lucrative markets such as the European Union, which adheres to OIE standards, but also impedes access to key export destinations, including the UAE, Bahrain, Saudi Arabia, South Sudan, and Kuwait. The consequences of subpar livestock management extend to diminished productivity, profitability, environmental repercussions, and the pervasive issue of cattle theft.

Recognizing the need for transformative solutions, the exploration of innovative technologies like Radio-Frequency Identification (RFID) becomes imperative. Botswana emerges as a compelling model for this endeavor, boasting a track record of success in leveraging RFID technology to revolutionize agricultural practices and foster economic development. Botswana's proactive use of innovation and commitment to sustainable resource management position it as a pioneer of

efficient livestock tracking and management using RFID in Africa.

Furthermore, Botswana's environmental structure, characterized by arid landscapes and diverse livestock ecosystems, align closely with the challenges encountered in Kenya's ASALs. By centering on Botswana's achievements, this study extracts insights that are directly applicable to the distinct context of Kenya's ASALs. The strategic emulation of RFID technology from Botswana holds the promise of addressing inefficiencies in Kenya's livestock management systems, thereby unlocking opportunities for market access, meeting international standards, and catalyzing positive impacts on productivity, profitability, and overall sustainability. In essence, adapting the Botswana system becomes not just a choice but a strategic imperative for Kenya to usher in a new era of efficient and sustainable livestock management.

The broad objective is to explore the application of RFID technology in livestock management in Botswana and leverage lessons learnt for livestock management in the Arid and Semi-Arid Lands (ASALs) of Kenya. The specific objectives of the study are to:

(i) Examine the determinants for effective implementation of RFID technology in the Botswana Animal Identification and Traceability System (BAITS).

(ii) Draw lessons for Kenya from the implementation of RFID technology in Botswana Animal Identification and Traceability System (BAITS)

(iii) Outline the policy implications of integrating RFID technology into Livestock Identification and Traceability System (LITS) to enhance livestock management in Kenya.

2. Situational Analysis

This section will discuss the history of adoption of RFID technology, RFID technology in Kenya and the policy and legal frameworks available in Kenya to support its adoption and the gap analysis in the implementation of these policies.

2.1 History of Animal Identification

Animal identification through markings on their body's dates to around 3,800 years ago, with various ancient civilizations like the Greeks and Chinese utilizing hot-iron branding to uniquely identify valuable animals, particularly horses. The practice of branding became essential in these societies, not only for distinguishing individual animals but also for safeguarding their value. In addition, the emergence of diseases like rabies among cattle heightened the need for effective animal identification and monitoring methods. This historical context underscores the enduring significance of animal identification techniques, which have evolved over the centuries to address various practical and health-related concerns, as noted by Blancou (2001).

Today, animal identification still uses some of the same methods used in ancient times to mark animals for identification such as tattooing and hot-iron branding. Coincidentally, the reasons for animal identification have remained unchanged as well, with issues of public health, animal management, trade among other reasons featuring as the major reasons for animal identification. However, the technology used in modern animal identification has evolved significantly, allowing for more precise identification of individual animals and for the tracing of those animals throughout their lives from birth until they are purchased by a consumer, Bowling et al, (2008).

These technologies encompass mechanical, electronic, and biometric methods, as highlighted by Marchant, (2002). Mechanical methods include traditional techniques like tagging, branding, and tattooing, which physically mark the animal for identification. Electronic methods utilize devices such as ear tags, ruminal boluses, and injectable transponders that provide automated and electronic means of tracking and identification. Biometric methods, on the other hand, rely on unique physical characteristics of the animal, such as nose prints, DNA profiling, iris scanning, and retinal scanning, to establish individual identity.

Countries around the world have effectively used electronic methods such as RFID for livestock management. For instance, Australia and New Zealand have made it mandatory to use RFID technology to track specific types of livestock. This is done to ensure the safety of consumers and to protect the export of meat and other animal products. Canada has also effectively utilized RFID technology for livestock management. In response to a mad cow disease scare, Canada mandated the replacement of the existing bar-code system with RFID for the cattle industry by the end of 2009. The unique identification numbers on these tags are linked in a database with the movements of each animal covering its life shelf. The EU also makes it mandatory for use of RFID tags on livestock for disease control under

Regulation EC1760/2000 of the European Parliament. In Africa, Botswana, Namibia and South Africa have been efficient in the use of RFID technology in efforts to control diseases, improve food safety, enhance market access, improve animal identification and support export opportunities.

2.2 History of adoption of RFID technology.

RFID technology was started in the 1940s during World War II and has been in existence for several years. During this time, the British and German armies developed Radio Detection and Ranging (RADAR) systems which used radio waves to identify aircraft from a distance. After the war scientists like Harry Stockmann from Sweden started exploring the technology further in 1948 through his works such as his paper, "Communication by means of Reflected War." RFID was not very common in the early stages because it was expensive and available chips could not store large amounts of data. However, in the late 1990s and early 2000s it incorporated higher frequencies making it efficient for users. Firms started using it in cargo, pharmaceuticals, bookshops, transport, and animals.

2.3 Use of RFID- Based LITS in Botswana

The study uses Botswana a case study due to a number of reasons. Firstly, Botswana started the implementation of this technology way earlier hence they have more experience using it. Secondly there are similarities in both Kenya and Botswana in terms of reliance of on livestock as a significant economic sector. Thirdly, Botswana faced a myriad of successes and challenges while implementing the technology. Therefore, their experiences can be used as lessons to understand the technical aspects, infrastructure requirements and potential benefits of implementing the technology in Kenya. Fourthly, studying Botswana's experiences in disease control and its impact on international market access can inform Kenya's strategies to enhance livestock health and ensure product quality and safety.

According to OIE (2006), animal identification involves the process of combining and connecting the individual identification and registration of an animal with a unique identifier. It further defines animal traceability as the capability to monitor and track an animal or a group of animals throughout all stages of their lives. In addition, OIE defines an animal identification system as a comprehensive framework that includes and links various components. These components may involve identifying establishments or owners, specifying the individuals responsible for the animals, recording movements, and maintaining other essential records in conjunction with animal identification.

Table 1.1.2 below illustrates the evolution of animal identification in Botswana since the early 1900s.

Table 1.1 The evolution of animal identification in Botswana

Year	Method	Identification techniques
Before 1907	Ear notching	Identification using family line details.
Issuing of manual permits.		
1907 to late 1990s	Branding	Identification of herd belonging to farmer.
Zonal /territorial identification (1964).		
Issuing of manual permits.		
2001 to 2012	LITS	Individual cattle identification with RFID reticular bolus.
DVS oriented.		
Issuing manual and electronic permits.		
2012/2013	Transition from LITS to BAITS	Linkage of bolus to analogue ear tags.
DVS oriented.		
Issuing of electronic permits.		
2012/2013 and beyond	Use of BAITS	Individual animal identification with RFID analogue and electronic tags.
Farmer oriented.		
Issuing of electronic permits.		
Web based.		

Source: Evolution of Botswana Animal Traceability. Modisa (2015)

Electronic livestock identification in Botswana started in the early 2000s after the outbreak of foot and mouth disease which made the European Union (EU) come up with new regulations for all its exporters of beef. Botswana exports about 71 per cent of its beef products hence they had to comply with the regulations to access the potential EU market. This also applied to other countries that were exporting to EU including Namibia and South Africa.

The Ministry of Agriculture in Botswana uses the Livestock Identification Trace-back System (LITS), an RFID based animal identification technology to capture data on individual cattle and stores this data in a central database, Moreki et al, (2012) LITS uses rumen boluses with embedded RFID microchips to trace animals

with each rumen bolus coded with the owner's name, a personal identification number, the sex of the animal, the hide colour of the animal and the location of the animal.

This data is then uploaded to an extension officers' computer and stored on a central database in the capital city of Botswana, Gaborone. This puts Botswana one amongst the most technologically advanced systems in the world that utilize RFID tags in the ear or the rumen of animals to allow for traceability throughout the production chain.

Using of RFID- Based LITS in Botswana has led to a myriad of benefits for livestock sector. Some of the benefits include adequate sensitization of community members on the use of technology which led to acceptability and adoption by stakeholders in the livestock industry. This led to widespread understanding of its significance in livestock management hence creating a marketing edge for Botswana beef especially in the EU. Further, the technology led to accurate livestock Census information, linking each animal to its owner. Also due to improved traceability, the technology enabled the farmers to improve on their record keeping, monitor the animal feeding habits and develop disease control mechanisms.

Although there are several benefits that were recorded during the implementation of RFID technology for livestock management, a number of challenges were also encountered. For instance, there was limited communication infrastructure particularly in remote areas where issues such as media coverage made it difficult passing information through media. Also, inadequate computer skills were an issue because the country did not have enough technical experts in RFID systems. This made it difficult for Botswana to find and train a sufficient number of qualified professionals to handle the deployment, maintenance and troubleshooting of RFID systems. For the workforce also, the staff found it difficult to adopt to a new electronic system as they were used to traditional methods of identification.

Cultural and social acceptance was an issue also especially to the pastoralist communities and local farmers who had to adopt to a new technology. Furthermore, privacy and security concerns were a pertinent issue because RFID technology involves the use of radio waves to transmit and collect data raising concerns about privacy and data security. There were issues on who is authorized to safeguard sensitive information from misuse and access.

Botswana still faces these challenges but due to support from government financially, politically and through civic education and capacity building the country has been able to overcome these challenges and advance the usage of this technology. For livestock management.

2.4 RFID Technology in Kenya

In Kenya, this technology has not been adequately explored and implemented. However, it is existent and is being used in several sectors such as library services, tracing of shipments, pharmaceuticals and automotives. The frequencies of tags being used in these items vary from passive, semi-passive to active tags. Some

companies and institutions have also started producing this technology locally instead of outsourcing it from other countries. An example of an institution that is exploring the production of this technology is Dedan Kimathi University Technology (DeKUT).

For the case of use of RFID to tag livestock in Kenya, animal tagging using RFID-based LITS started with a pilot study between 2007 and 2008. About 130,000 heads of cattle were tagged in Northern Kenya (ILRI,2014). Another pilot study was done in 2018 at Laikipia County tagging about 70,000 heads of cattle belonging to 702 owners. The project was funded by KCB Foundation to provide insurance to farmers and guarantee the financial access such as loans. About 381 farms were coved by this project (MOALF,2018)

2.5 Kenya's Institutional Legal and policy framework for livestock management and gap analysis.

Kenya has a myriad policy and legal frameworks to support livestock management and consequently, support of livestock identification and traceability. Some of these frameworks are discussed below:

2.5.1 Animal Identification and Traceability Strategy (ANITRAC) 2020 to 2030

The objective of this policy is to establish a robust system to identify and trace animals from "farm to fork". This system aims to enhance animal health, food safety, market access and overall animal management to ensure accurate information about individual animals and their movement within the country throughout their lifecycle. The policy also aims to implement a standardized and technologically advances animal identification system, establish a centralized database, enhance animal health monitoring and disease control, facilitate market access and international trade, strengthen livestock management and productivity, and raise awareness to all stakeholders in the livestock industry through capacity building.

While this strategy attempts to implement an efficient system of tracing animals throughout their lifecycle, so far there hasn't been much done three years since its inception. One of the major objectives was to open Kenya to international trade in livestock but this makes it impossible to access markets such as the EU which observe strict animal tracing standards from farm to fork. It is also important to note that most stakeholders have not been sensitized about this policy, hence they are not aware of it and its importance.

2.5.2 Draft National Livestock Policy, 2019

The Objective of this policy is to contribute to food and nutrition security and improve livelihoods while safeguarding the environment. Its specific objectives are to improve the management of livestock, feed, and rangeland resources, promote social inclusion and environmental resilience, enhance livestock marketing, research, extension, and food security. Other objectives include

Cross-border Disease Management where national government will collaborate with neighboring countries to strengthen disease surveillance, monitoring, and control. It also emphasizes a rapid response to disease outbreaks. The policy also shall enhance community involvement with county governments institutionalizing community involvement in planning and developing range and pasture rehabilitation programs.

From the analysis of the implementation of this policy, it is noted that coordination and collaboration between national and county governments is an area requiring attention. There seems to be inadequate collaboration between the two levels of government. Further, the policy emphasizes community involvement in range and pasture rehabilitation programs at the county level. However, the mechanisms for ensuring effective coordination in the two levels of government on livestock management are not explicitly outlined, potentially leading to fragmented implementation and inefficiencies.

2.5.3 National Livestock Policy (Sessional Paper No. 2 of 2008, Revised 2014)

This policy outlines, guides, and controls operations in the livestock sector and industry. It proposes measures to support rangeland management and feed availability. Its key measures include encouraging appropriate grazing management strategies promoting fodder and pasture conservation, encouraging the production of irrigated forages and mitigating the effects of pests and diseases.

However, weak monitoring and evaluation has hindered the implementation of this policy hence it becomes difficult to track the progress of the key measures outlined by the policy. Furthermore, a more explicit focus on sustainable and climate-resilient livestock management practices would address the growing challenges posed by climate change in the region. Social-political and cultural factors such as traditional practices, land tenure systems and cultural beliefs have causes livestock management inefficiencies such as cattle theft, over-grazing, utilization of land not allocated to livestock farmers, among others. This makes it difficult to implement due to the inter-community tensions that come as a result of these inefficiencies.

2.5.4 Veterinary Policy 2015

The broad objective of this policy is to professionally safeguard animal health and welfare, increase animal production and productivity, and promote trade in animals and animal products for sustainable food security, food safety, and economic prosperity. It identifies the use of an electronic Animal Identification and Traceability System which will support efficient record keeping of livestock. Further, it highlights that the national government, in collaboration with stakeholders, will support the establishment of this system to comply with international standards.

While this policy acknowledges the importance of an electronic system, there is a need for a clear roadmap and concrete measures to establish and implement it across the country. This gap hinders effective disease control, trade facilitation, and overall livestock management.

2.5.5 Animal Diseases Act (Cap 364)

This act provides for matters relating to animal diseases and empowers the Director of Veterinary Services with various sanitary measures. Some of the provision there in include declaration of areas infected by notifiable diseases, prohibition of importation of animals, direction for the slaughter and disposal of diseased carcasses, prohibition of the use of vaccines or drugs, among other measures.

Nonetheless, the challenge that faces the implementation of this policy is limited enforcement of the act. The effectiveness of the measures outlined in these policies rely heavily on comprehensive enforcement mechanisms, and any deficiencies in this regard could undermine the intended outcomes of disease control, land use regulation, and livestock management.

2.5.6 Crop Production and Livestock Act (Cap 321)

This act empowers local authorities to make by-laws related to the regulation and control of livestock within their jurisdictions. One of its provisions include prohibition of keeping or grazing livestock on agricultural land, regulation of the numbers and kinds of livestock on agricultural land, requirements for male livestock castration, licensing of male breeding livestock, compulsory reduction of livestock numbers and collection of grazing fees.

Just like the Animal Disease Act (Cap 364) discussed in 2.3.5 above, enforcement is a gap when it comes to implementation of this Act. There also seems to be limited capacity, inadequate resources, technical expertise and staffing to implement the Act In the community level.

2.5.7 Branding of Stock Act (Cap 12)

This act provides for the registration of brands of stock and includes provisions on how brands are to be imprinted. Its provisions include registration of stock brands, imprinting of registered brands, publication of registered brands, compilation of a brand directory, inspection of areas where stock is kept to compare with branding certificates and offenses related to the use of unregistered brands or defacing brands. The Act also aims to identify and link livestock to their owner.

This Act however has not been adequately implemented since Kenya still has a challenge accessing the international trade market for livestock. This is due to insufficient methods of tracing these livestock from their owner to the market. The sanitary requirements for exportation are very high hence Kenya has not been

able to penetrate the international market due to inadequate implementation of this policy.

3. Literature Review

This section discusses some of the studies that have been done previously about RFID- based LITS, the lessons learnt from the countries that used the technology for livestock management and a comparison between Botswana and Kenya in terms of the dynamics related to livestock management.

3.1 Empirical Literature

Different methods of animal identification and traceability exist among various countries. According to the Australian Department of Agriculture, Fisheries, and Forestry (DAFF), (2006), Australia introduced the National Livestock Identification System (NLIS) in 1999. The NLIS is implemented and enforced by each individual state or territory in the country. In Australia, individual animal identification is mandatory, and it is achieved by using NLIS-approved devices that are either placed in the animal's ear or administered as a rumen bolus. These devices utilize radio-frequency identification (RFID) technology with encoded microchips, allowing for comprehensive "whole-of-life" tracking of bovine animals. This means that cattle can be traced from their birth property through every subsequent property they are transported to until their eventual slaughter. During livestock transportation, the National Vendor Declaration is required and serves as a formal assurance that the livestock are being moved with the owner's permission. Upon arrival at a new property, each animal's RFID tag is scanned, and the information is recorded and linked to the RFID device. All animal movement data is stored in the central NLIS database, ensuring accurate and efficient tracking and management (DAFF, 2006).

According to the Meat Board of Namibia, (2002), the stringent regulations imposed by the EU have necessitated the implementation of bovine animal identification and traceability programs in Namibia to ensure continued access to their primary export markets. In response to these requirements, the Namibian government introduced the Farm Assured Namibian Meat Scheme (FANMS) in 1999. The FANMS program is administered by the Meat Board of Namibia and maintains a comprehensive database. This database includes information on livestock brands, FANMS member details, livestock traceability data, as well as records of meat imports and exports. As part of the program, it is mandatory for all animals to be identified using FANMS-approved devices before they leave their property of birth. Additionally, producers are required to complete an exit register for each animal before it departs from their premises.

Upon the arrival of these animals at a new property, an arrival register has also to be completed. One crucial aspect of this process is ensuring that the ear tag numbers of the animals match the information provided in the exit register, which accompanies the cattle during transportation. These measures collectively contribute to the traceability and accountability of livestock in Namibia, aligning with EU regulations and safeguarding access to crucial export markets (Meat Board of Namibia, 2002).

In Japan, each bovine animal is assigned an individual identification number at birth, and the date of birth, gender, parents' individual identification numbers, and the breed of the animal are recorded. Cattle are identified on the farm by 2 ear tags that are imprinted with a 10-digit number and a bar code. Animal movement records are required both for outgoing and incoming cattle, and the individual animal identification number, date of the transfer, and both parties involved in the transfer are required to be recorded in the database. In 2003, Japan implemented the Beef Traceability Law that requires animal identification and traceability from "distribution to consumption, Ministry of Agriculture Forestry and Fisheries, (2003).

In Uruguay, a highly organized system of farm registration known as the "Direccion de Controlar de Semovientes" (DICOSE) assigns a unique 9-digit number to every farm. This number serves to precisely identify and categorize each agricultural property within the country. The first two digits of the DICOSE number correspond to the geographical location of the farm, with the subsequent two digits designating the specific police district within that area. The final five digits are reserved for identifying the individual producer who owns the parcel of land. To enhance traceability and management, Uruguay implemented the National Livestock Information System (SNIG) on September 1, 2006. This system mandates the individual identification of all livestock animals before they reach six months of age or before they are transported from their property of birth, contributing to a comprehensive and efficient livestock tracking and management framework (NLIS, 2007). All cattle have to be identified with a RFID device, either on the ear or in a rumen bolus. The RFID tag codes only for the individual animal identification number.

The notification of livestock movements in Uruguay is a controlled process facilitated through registered operators or authorized individuals or companies within the National Livestock Information System (SNIG). These registered entities possess the necessary equipment, software, training, and security clearance to access the SNIG database. When cattle need to be moved, it is the responsibility of these operators to electronically notify the SNIG database regarding the specifics of the movement. Termination records, which mark the endpoint of an animal's journey, are meticulously documented in the SNIG database by technicians belonging to the Animal Industry Division of the Ministry of Livestock, Agriculture, and Fisheries. These technicians utilize handheld devices to read the RFID tags affixed to the animals. Following this process, they oversee the secure destruction of the RFID tags. The SNIG database plays a pivotal role in storing crucial information, including the date and location of harvest for each individual animal, ensuring the accuracy and reliability of livestock traceability data in Uruguay's robust system (NLIS, 2007).

3.2 Link between animal identification and traceability in enhancing sale of livestock produce: Lessons from other countries

Animal identification and traceability systems play a pivotal role in enhancing the sale of cattle produce by ensuring transparency, safety, and quality throughout the supply chain. These systems have been successfully implemented in various countries worldwide, providing valuable lessons and insights for other countries such as Kenya who are looking to improve their cattle industry. In this discussion, the study will explore the link between animal identification and traceability and its impact on livestock produce sales, drawing lessons from countries that have effectively leveraged such systems to boost their cattle produce sales.

According to the IGAD Center for Pastoral Areas and Livestock Development report on LITS experience in Namibia, (2015), Namibia's implementation of the Namibian Livestock Identification System (NamLITS) is an example of a comprehensive approach to livestock identification, registration, and traceability. This system, based on the Animal Identification Regulations, aligns with international standards, and demonstrates Namibia's commitment to ensuring the health and safety of its livestock, particularly in regions facing the threat of transboundary animal diseases. The key elements of NamLITS, including the use of RFID ear tags, maintaining up-to-date registers, movement control through veterinary permits, and a central computerized database, collectively contribute to effective surveillance, disease control, and eradication efforts. This not only safeguards Namibia's livestock but also facilitates access to high-value markets like the European Union, where traceability and food safety are paramount.

Namibia's largest feedlot, operated by Meatco, further underscores the country's dedication to quality in its red meat production. The rigorous disease surveillance and control measures managed by the Directorate of Veterinary Services (DVS) and the collaboration with private laboratories for sample analysis demonstrate a commitment to ensuring that the meat produced meets stringent health and safety standards. Further, the utilization of Total Mix Ratio (TMR) for animal nutrition on the farm emphasizes efficiency and productivity in the livestock sector. The farm's practices, such as monitoring weight gain and feed quality, showcase Namibia's dedication to maximizing the quality of its beef products. This system has allowed Namibia to meet the strict traceability requirements of the European Union, one of its primary beef export markets. As a result, Namibia has increased its beef exports and sales to the EU.

Argentina's Sistema de Identificación Nacional de Ganado y Carnes (SINIGAN) has contributed significantly to the country's commitment to modernizing its cattle industry and elevating the quality of its beef products. This national animal identification and tracking system relies on state-of-the-art electronic ear tags to meticulously monitor cattle movements throughout their lifecycles.

The significance of SINIGAN extends far beyond domestic borders, as it has played a pivotal role in bolstering Argentina's beef exports. It has facilitated access to key markets like China and the United States, where strict traceability measures are critical. By ensuring the traceability and quality of its beef products,

SINIGAN has not only opened doors to lucrative export opportunities but has also bolstered Argentina's reputation as a reliable and quality-focused beef producer on the global stage. This, in turn, has contributed to the growth and success of Argentina's beef industry, positioning it as a major player in the international beef market.

Japan's Livestock Identification Association is a comprehensive animal identification and tracking system that monitors cattle from birth to slaughter. The system includes RFID tags, health records, and movement tracking. This ensures the safety and quality of beef, a vital factor in maintaining consumer trust. Japan's stringent traceability requirements have allowed it to establish itself as a high-quality beef producer, leading to increased sales both domestically and internationally. Japan is known for its premium beef, particularly the highly prized Wagyu beef, which is renowned for its exceptional marbling, tenderness, and rich flavor. Japanese beef, including Wagyu, is in high demand worldwide, and Japan exports its beef to several key markets such as the United States and Asia.

Uruguay's Sistema de Información Ganadera (SIG) is an animal identification and traceability system that promotes the country's reputation for producing high-quality, grass-fed beef. The implementation of SIG has been particularly advantageous in facilitating Uruguay's beef exports to prestigious markets such as the European Union and the United States. These markets place a premium on traceability, animal welfare, and adherence to stringent standards. Uruguay's commitment to these principles, as reflected in SIG, has not only gained it access to these lucrative markets but also helped it meet the discerning demands of consumers seeking premium beef products.

Brazil's Sistema Brasileiro de Identificação e Certificação de Bovinos e Bubalinos (SISBOV) system tracks cattle movements and ensures compliance with environmental and sanitary regulations, particularly in the Amazon region. In emphasizing the traceability and adherence to stringent traceability standards, SISBOV has significantly bolstered Brazil's reputation as a reliable source of high-quality beef products. Access to markets like China, with its soaring demand for meat, has been facilitated by Brazil's commitment to maintaining traceability and complying with international sanitary requirements. Additionally, SISBOV has been crucial in addressing environmental concerns, assuring consumers, and importing nations that Brazil is committed to sustainable and responsible beef production.

3.3 A comparison of livestock management in Botswana and Kenya

Kenya and Botswana share a lot in common when it comes to weather conditions. Just like most Kenyan ASALs which constitute approximately 80 percent of Kenya's land mass, about 70 percent of Botswana is covered by the Kalahari Desert. In both countries drought is a problem and when the rain comes, it causes sporadic floods leading losses especially in the agriculture sector. Botswana mainly depends on livestock agriculture where about 85 per cent of Botswana’s

agricultural output is derived from livestock production, mainly beef with a cattle population of about 2.2 million.

In both countries, the ASALs are dominated by pastoralists whose main economic activity is livestock keeping. Even though pastoralists dominate the ASALs, both countries have private ranches for livestock production owned by farmers. (FAO,2017). In Kenya, pastoralism is common in the Rift valley and Northern Kenya. In Botswana, pastoralism is common in Ngami-land, south of the Okavango Delta. The Ovaherero and Ovambanderu ethnic communities are known for pastoralism in Botswana. The two communities share a number of cultural elements that relate to social organization, preferred economy, epistemology, and spatio-political organization. The two communities speak the same language, both live a pastoral way of life and practice the same pattern of land and livestock management (Almago, 1980). Other nomadic communities in Botswana include the Ovahimba, San and Khomani. In Kenya the communities known for the pastoral lifestyle include the Maasai, Samburu, Somali, Borana, Turkana and Pokot. In both Kenya and Botswana, the pastoralism landscape has been shaped by dynamics such as livestock diseases, human-wildlife conflicts, and droughts. Both countries also have policies that guide land management, particularly for grazing. In Botswana, the country's traditional livestock farming system is subdivided into two: first, the traditional livestock farming system based on small herds or so-called cattle posts: secondly the traditional livestock farming system, under the Tribal Grazing Land Policy (TGLP) of 1975 based on relatively large cattle herds being managed under the communal grazing system but operating on a commercial basis (Gosalamang et al. 2012). As for commercial livestock, this comprises of fenced ranches and feedlots, which are highly specialized, employing modern animal husbandry practices and strategic feeding to produce high-value beef animals. In Kenya, the National Livestock Policy, 2019 aims to improve the management of livestock. The policy spells out that this can be achieved by monitoring rangeland resources, promoting social inclusion and environmental resilience. For both countries, agriculture is the main source of livelihood. In Botswana agriculture contributes to 2.3 per cent of the GDP, out of which about 70 to 80 per cent is attributable to cattle production. 80 per cent of cattle can be accounted for by the traditional system while 20 per cent can be accounted for by the commercial system (BEDIA, 2007). In Kenya, agriculture contributes to about 21 percent of the national GDP with livestock contributing to about 10 percent of the GDP. Even though there is a number of similarities between Kenya and Botswana when it comes to livestock management, there are also differences between the two countries. To start with, Botswana's implementation of the RFID-based LITS by use of ear tags and micro-chips is in its advanced stages. Kenya is still in the inception stage of adopting an electronic system with two pilot studies being done in the year 2008 and 2018. The traditional visual identification methods such as tattooing, era notching and tattooing are still dominant.

Secondly, when it comes to the scope Botswana has implemented a centralized and standardized livestock identification system across the country which covers a wide range of livestock species. The scope in Kenya varies across regions and communities. The areas with commercial livestock production have more

organized identification systems while others in remote or pastoralist regions rely more traditional methods of identification.

Thirdly, the population of livestock in the two countries determines how livestock is managed in each country. For instance, Kenya has a population of more than 20 million cattle, while Botswana has about 2.2 million cattle. This makes livestock management in the two countries different in terms of grazing and pasture management, disease control and veterinary services, identification and traceability, market value chain management and breeding improvement.

4. Methodology

In this section, the paper uses the Diffusion of Innovation Theory to illustrate the determinants of implementation of BAITS in Botswana to address the first objective. To address the second objective on the lessons learnt from Botswana's RFID-based LITS, the study explores various using literature using desktop review from Botswana BAITS and other literature. For the third objective, the study discusses the policy implications for integrating RFID-based LITS to Kenya based on the findings in objective one and two.

4.1 Theoretical framework

4.1.1 Diffusion of Innovation Theory

The theory of innovation diffusion, formulated by E.M. Rogers in 1962, offers a valuable framework for understanding how contemporary technologies are embraced and disseminated across societies. This theory posits that the uptake of a new technology is influenced by pivotal factors, encompassing the attributes of the innovation itself, the communication channels used to propagate information about the innovation, the prevailing social system, technology and the individual characteristics of potential adopters. In the context of this study, the theory of innovation diffusion will be applied to elucidate the potential adoption of RFID technology to bolster efficient livestock management in the ASALs of Kenya. By applying this theory, we can gain insights into the factors that shape the acceptance and potential adoption of RFID technology in the context of livestock management. Moreover, the theory of innovation diffusion underscores the significance of communication channels in shaping the adoption process. Effectively functioning communication channels, like informative campaigns and educational initiatives, play a pivotal role in disseminating knowledge about RFID technology. Through leveraging these channels, stakeholders can raise awareness and enhance understanding among cattle farmers, law enforcement entities, and other pertinent stakeholders. This, in turn, can foster the adoption of RFID technology in advancing comprehensive livestock management practices.

To address the first objective, the table below illustrates the analytical framework of the determinants for the implementation of RFID technology based on the broad areas of communication, technology, and social environment. The framework further demonstrates the variables and indicators that determine the adoption of RFID for each factor.

Table 4.1 Analytical framework for examining the determinants for implementation of RFID technology

Area	Variable	Indicator(s)
1. Communication Channels.	Public awareness/ Create awareness	Sensitization workshops and community events held to sensitize stakeholders on use of RFID technology. Media (Tv, Radio, Print media, social media) Training materials Online resources e.g., helpline
	Channels used	Workshops Community events Media Expert knowledge
	Materials	Articles printed or shared on mainstream media to sensitize stakeholders. Booklets/Brochures/ Manuals Roadshows
	Experts	Extension officers, veterinarians,
2. Technology	Infrastructure access Distribution connectivity	Mobile units Network coverage/communication towers
	Database Scanning	Data Management system, scanning facilities, data storage.
	Policy technology Level of adoption	Policy documents Act/ Laws Regulations Database for policy advise
	Database	Data collection (type of data collected, Data updates (system used) Data access (access codes, who has permission) Data analysis Data security
3. Social Environment	Stakeholders	Government (incentives provided) Farmers (herders, subsistence/largescale, farmer associations) RFID Vendors Community leaders Veterinarians Security personnel (Police, agencies) Non-governmental services
	Cultural Factors	Beliefs and value systems (Perceptions of adopters/ Non adopters) Traditions (Decision makers e.g., in the family)

	Scope of use of the technology	Health purposes Security purposes Tracing and tracking purposes
	Level of adoption	Those using old technologies for tracking and tracing (plastic dangles, hot iron branding, tattoos, markings) Those using new technologies for tracking and tracing (RFID tags, RFID chips
	Enforcement system	Fines Bans Sanctions

4.2 Discussion of the determinants of RFID technology implementation; Botswana LITS approach.

4.2.1 Communication

The indicators for this variable include sensitization workshops and community events held to sensitize stakeholders on the use of RFID technology. Botswana employed multiple communication channels to facilitate the implementation of RFID technology. Sensitization workshops and community events were organized to educate stakeholders on the benefits and utilization of RFID technology. One approach involved conducting workshops where the government informed farmers about the significance of RFID tagging and the advantages of traceability. In 2017, for instance, the Ghanzi Department of Veterinary Services held a workshop to certify communal farmers, enabling their access to the European Union market.

In addition, various media platforms such as radio, television, and print media were utilized to raise awareness about the Livestock Identification and Traceability System (LITS), effectively reaching a broader audience. To ensure effective training, dedicated facilities were established, equipped with teaching materials, demonstration areas, and hands-on training tools, enabling workshops and training sessions to be conducted seamlessly. The government also offered continuous support by establishing helplines and online resources for farmers to seek assistance and clarification as they continued to use the system.

4.2.2 Technology

In Botswana, various indicators were considered to assess the technology variable. These indicators encompassed infrastructure access, distribution, connectivity, database, scanning, mobile units, distribution centers, network coverage/ communication towers, data management system, scanning facilities, and data storage. To ensure that farmers in remote areas were not left behind, Botswana implemented the use of mobile training units. These units were deployed to reach isolated farming communities and provided on-site training and support to farmers. For efficient tracking and identification of cattle, distribution centers were strategically positioned across the country. Equipped with the necessary

equipment, these centers facilitated the attachment of RFID ear tags to cattle, improving the monitoring process.

Recognizing the importance of connectivity, special efforts were made to enhance network coverage, particularly in areas with limited connectivity. This initiative aimed to enable real-time data transmission between scanning points and the centralized database, ensuring timely and accurate information. Scanning facilities were established at key locations, such as markets and checkpoints, to monitor the movement of livestock. By implementing these facilities, Botswana enhanced its ability to track and manage livestock, contributing to improved overall management and control.

On Policy Guidelines, the indicators that Botswana used to measure the implementation of RFID-based LITS include policy documents, acts/laws, regulations and database for policy advice. Botswana implemented BAITS, which is supported by policy documents, such as the Animal Health Act of 2011 mandating electronic identification using RFID tags for livestock. Botswana's vision 2036 outlines the government's objective to establish a sustainable, technology-driven, commercially viable agricultural sector that is disease-free and able to optimize land and other resources.

The 2014 Revised National Policy on Agricultural Development, the 2020 Economic Recovery and Transformation Plan acknowledges that raising agricultural productivity is essential for job creation, the adoption of new technologies, enhancing self-sufficiency. Botswana's 2021 Food Systems Transformation Draft Pathway prioritizes (i) Value chain development with increased private sector participation; (ii) nutrition sensitive agriculture; (iii) climate smart agriculture, and (iv) technological development.

Regarding regulations, the Animal Information and Traceability System Regulations of 2018 provided a legal framework for traceability. The regulations sought to promote food safety, quality assurance, control animal diseases and promote market access for livestock farmers who adhered to the regulations.

Research Institutions played a pivotal role in providing technical expertise and conducting studies to assess the effectiveness of the LITS in achieving its goals. Their insights contributed to system improvements. Several public entities, such as the Botswana University of Agriculture and Natural Resources, are also geared to help the industry.

The type of information collected was pivotal for the implementation of LITS. In Botswana, the collection of information in the designated area involved various aspects. The data collected included animal identification, owner details, location, health records, and ownership changes. This was made possible through the use of RFID ear tags, which farmers attached to their cattle. For real-time updates, scanning facilities equipped with RFID tag readers were utilized. These facilities enabled the database to be updated immediately, capturing cattle movements and reflecting their current location.

On accessibility, authorized stakeholders such as farmers, veterinary services, and government officials were granted permission to access the database. They could

retrieve information pertaining to specific animals, including their movements and health history. To ensure the security of sensitive information and maintain data integrity, the database was protected using encryption and access controls. These security measures played a crucial role in safeguarding the collected data. Data analysis was also important for identifying trends, tracking disease outbreaks, and assess livestock management practices, informing decision-making and policy formulation.

4.2.3 Social Environment

Stakeholders

In Botswana's social environment, various stakeholders play crucial roles in the beef industry. These stakeholders include the government, farmers, RFID vendors, community leaders, veterinarians, security personnel, and non-governmental services. The Ministry of Agriculture (MOA) provides significant institutional support to the industry. In addition, parastatals such as the National Development Bank (NDB) and the Citizens' Enterprise Development Agency (CEDA) offer concessional finance to the sector.

In the context of Botswana's approach, the government implemented several initiatives. Firstly, they subsidized RFID ear tags for farmers, aiming to alleviate their financial burden. Secondly, farmers who complied with LITS regulations, which included proper tag attachment and accurate data input, became eligible for financial incentives. Thirdly, farmers who maintained accurate records of their cattle's health and movements received priority access to markets, enhancing their market access opportunities. Lastly, farmers attending training workshops and demonstrating their understanding of LITS were awarded training grants or vouchers, promoting knowledge and skill development within the industry. These measures collectively contribute to a supportive and thriving social environment for Botswana's beef industry.

In recognition of the importance of traceability and disease control, Botswana's approach includes acknowledging and rewarding farmers who consistently follow best practices in these areas. These farmers are recognized and awarded for their commitment to maintaining high standards of traceability and disease management within the livestock sector. Furthermore, as an incentive, farmers who demonstrate a strong commitment to traceability and animal health management are offered tax benefits or deductions. This serves as a tangible reward for their valuable contributions to the livestock industry. Furthermore, the Ministry of Agriculture collaborates closely with local farmers' associations to ensure that the implementation of LITS aligns with the specific needs and concerns of farmers. This partnership facilitates effective communication and understanding between the government and the farming community, fostering a cooperative and supportive environment for the successful implementation of LITS.

Cultural Factors

Cultural factors are essential considerations when examining the adoption of technology, particularly in the context of livestock identification and traceability systems. The beliefs and value systems held by individuals or communities can significantly influence the decision to adopt or reject such technology. For example, if there are traditional beliefs surrounding animal identification or resistance to new methods, these cultural factors can impact whether individuals or communities embrace the technology. In addition, traditions and cultural practices play a role in adoption decisions.

Decision-making within families or communities, often led by family heads or other traditional authorities, holds significant weight in determining whether the technology is adopted. The support or opposition of traditional leaders can sway the decisions of individuals or groups, reflecting the influence of cultural values and traditions on the adoption process. Understanding and respecting these cultural factors is crucial for the successful implementation of livestock identification and traceability systems, as it allows for tailored approaches that consider and address the specific cultural contexts in which they are being introduced. Through the workshops, Botswana involved the stakeholders by training them on the importance of an electronic identification system, continuous engagement, using education to create awareness and receiving feedback on the use of the electronic system from the farmers and all stakeholders in the livestock industry.

Scope of Use of the Technology

The scope of the technology used in livestock identification and traceability systems extends beyond cultural factors and encompasses various health-related purposes. Real-time health monitoring of cattle is made possible through the utilization of RFID tags and chips. This enables continuous tracking and monitoring of vital health indicators, ensuring the well-being of the animals. Moreover, the technology facilitates early detection of diseases among cattle, allowing for timely intervention and prevention measures.

In the event of disease outbreaks, technology provides a means for swift and targeted responses, aiding in the containment and management of the spread of diseases. Moreover, RFID technology plays a crucial role in managing vaccination records, ensuring that animals receive timely and appropriate vaccinations. These health-related applications of the technology contribute to improved animal welfare, enhanced disease control, and more effective management of livestock health within communities and the broader agricultural sector.

Security Purposes

In addition to its health-related applications, livestock identification and traceability systems using technology serve security purposes as well. The technology is employed for tracing and tracking livestock, enhancing security measures in multiple ways. This includes preventing theft by enabling the identification of stolen animals, monitoring the movement of cattle to ensure they remain within authorized areas, and controlling the spread of diseases by quickly identifying and isolating infected animals. The level of adoption

of these technologies can vary among different groups within the agricultural community. Adoption categories can be observed, with some adopters continuing to use traditional methods such as plastic dangles, hot iron branding, tattoos, or markings for cattle identification. These methods have been used for generations and may be deeply rooted in cultural practices or personal preferences. On the other hand, some adopters have embraced modern technologies, recognizing the advantages of advanced and efficient identification and traceability systems. These adopters utilize RFID tags and chips, which provide more reliable and accurate data, ease of use, and compatibility with digital systems for streamlined record keeping and data management. The adoption of new technologies in Botswana offered significant benefits in terms of efficiency, accuracy, and the ability to integrate with other digital systems. The varying adoption categories reflect the diversity of perspectives and preferences within the agricultural community, as well as the ongoing transition from traditional to modern technologies in livestock identification and traceability.

Enforcement System

To ensure adherence to regulations and promote widespread adoption of livestock identification and traceability technology, an enforcement system was implemented in Botswana. This system involved monitoring and inspection by government officials. Government oversight played a crucial role in monitoring the adoption of the technology, ensuring that farmers complied with the prescribed methods for cattle identification. Government agencies were responsible for enforcing regulations related to the use of RFID tagging. Periodic inspections were conducted to verify compliance and identify any instances of non-compliance. These inspections aimed to maintain the integrity of the system and ensure that the technology was being effectively utilized. To encourage farmers' compliance, penalties were established for those who did not adhere to RFID tagging regulations. These penalties could include fines or legal consequences. The imposition of fines or legal consequences served as deterrents, discouraging non-compliance and incentivizing farmers to embrace the technology. By implementing an enforcement system that included monitoring, inspection, and penalties for non-compliance, the government aimed to create a regulatory framework that promotes the proper use of livestock identification and traceability technology. This system provided accountability and helped maintain the accuracy and effectiveness of the technology in achieving its intended goals.

5. Lessons From The Botswana Animal Identification And Traceability System

The government of Botswana developed a farmer guideline for the successful implementation of its animal identification and traceability system. These guidelines were essential for ensuring the tracking and monitoring of cattle within the country using the BAITS system.

5.1 Communication

5.1.1 Ear Tagging

All cattle were required to be identified with ear tags within three months of birth. There are two types of ear tags that were used for identification: Electronic Ear Tag: This tag contains a Radio Frequency Identification Device (RFID) and is the primary identifier recognized in BAITS. Analogue Ear Tag: This tag complements the electronic tag.

(i) Traceability: The tagging system, particularly the electronic ear tag, enabled the traceability of cattle from birth to slaughter. This traceability was crucial for various purposes, including disease control, food safety, and market access.

(ii) Tag Acquisition: Farmers were responsible for purchasing the two tags (digital and analogue) for their cattle which were used for the identification process.

(iii) Data Submission: After tagging the animals, farmers were required to submit relevant data to the BAITS database. This included information such as the cattle's ID, birthdate, farmer details.

(iv) Movement Permits: Farmers were also required to request movement permits when their cattle were being transported. This ensured that the movement of cattle was regulated and monitored.

(v) Reporting: Farmers had to report departures, arrivals, and mortalities of their cattle. This reporting was essential for maintaining accurate records in the BAITS system.

(vi) Tag Replacement: If ear tags were lost or damaged, it was the responsibility of the farmer to report this and request tag replacements. This helped maintain the integrity of the identification and traceability system.

(vii) Forms: The guidelines included samples of forms to be used for various purposes, such as data submission, movement permit requests, and tag replacement reporting.

5.1.2 Registration and management of Brand Certificates

Brand certificates are official documents issued to livestock owners or keepers to identify and distinguish their animals from those owned by others. These certificates included a unique brand mark or symbol, often burned, or marked onto the animal's skin or hide using a hot iron or other appropriate methods. The brand mark serves as a permanent and visual identifier for individual animals or herds within a specific livestock operation.

These were the guidelines for the registration and management of Brand Certificates for the BAITS in Botswana.

(i) Eligibility: All livestock keepers were permitted to register for a Brand Certificate. This registration process could involve new registration, renewal, duplication, cancellation, or transferring a brand from one owner to another.

(ii) Application: The application for Brand Certificates can be completed at the nearest Department of Veterinary Services (DVS) office.

(iii) Fees: A fee of P50.00 was required for all processes related to Brand Certificates.

(iv) New Brand Registration: Required Documents: Applicants needed to present a valid keeper card/number and their national identity card.

(v) Renewal: Required Documents: To renew a Brand Certificate, individuals had to present a valid keeper card or keeper ID along with the expired brand certificate and their national identity card.

(vi) Cancellation: Required Documents: In the case of brand cancellation, applicants were required to present a valid keeper card, the brand certificate to be cancelled, a letter or document instructing the cancellation, and their national identity card.

(vii) Transfer: Required Documents: When transferring a brand from one owner to another, both the new and previous keeper IDs had to be presented, along with their national identity card.

Transfer Process: The transfer of brands could be executed with a signed letter, in the presence of both the current and new owners. If the current owner was unavailable or deceased, a letter of authority instructing the transfer and signed by a Commissioner of Oaths has to be presented.

5.2 Technology

5.2.1 Purchasing of Ear Tags

Ear tags approved for use in the Botswana Animal Information and Traceability System (BAITS) were available for purchase only at the Livestock Advisory Centre (LAC). The following guidelines were applicable to farmers in this regard.

(i) Eligibility to Purchase: To buy these ear tags from the LAC, the farmer was required to be a registered keeper and possess a valid keeper card.

(ii) Ear Tag Pairs: The ear tags were sold in pairs, consisting of an electronic ear tag and an analogue ear tag. Notably, the ear tags used for local animals were yellow in colour, while those for imported animals were red.

(iii) Registration to Keeper: Upon purchase, the ear tags were registered to the specific keeper. These tags could only be used by the individual who bought them for tagging their animals. If a keeper intended to allow another individual to use their tags, a transfer process within BAITS was necessary to assign the tags to the new keeper.

(iv) Analogue Ear Tag:

The analogue ear tag featured "BW" to denote Botswana and had a unique identification number. It was essential for the numbers on the analogue tag to match those on the electronic ear tag for accurate identification.

Figure 5.1: Example of the analogue ear tag used in BAITS.

(v) Electronic Ear Tag:

The electronic ear tag stored comprehensive information about the animal and could be read using a reader. It was crucial that the last 8 digits on the electronic tag matched those on the analogue tag for proper synchronization.

Figure 5.2: Example of the electronic ear tag used in BAITS.

Source: BAITS

(vi) Ministry Logo and Country Code: Both the analogue and electronic ear tags featured the ministry logo embossed on them and "BW," representing the country code.

These guidelines and practices ensured that the ear tags used in BAITS were correctly assigned to registered keepers, promoting accurate animal identification and traceability within Botswana's livestock management system.

5.2.2 Replacing ear tags

Ear tags had to be replaced in case of loss or damage. The Lost/damaged ear tags could only be replaced with tags bought from LAC or an authorized point of sale only.

Where the digital (button) ear tags had been lost, both tags had to be replaced. Where only the analogue ear tag was lost, replacement was only for the analogue ear tag. After tagging with the replacement ear tag(s), livestock keepers were required to ensure that the information captured was accurate. Returns for replacing ear tags had been submitted within 14 days after tagging either online or by submitting a completed form DVS

5.2.3 Cattle Tagging

(i) Mandatory Tagging: The law in Botswana mandated that all cattle had to be tagged within three months of their birth.

(ii) Proper Handling Facilities: To ensure the safe and effective tagging of cattle, proper handling facilities, such as crushes or chutes, were required. These facilities were essential for minimizing injury to both the animals and the individuals involved in the tagging process.

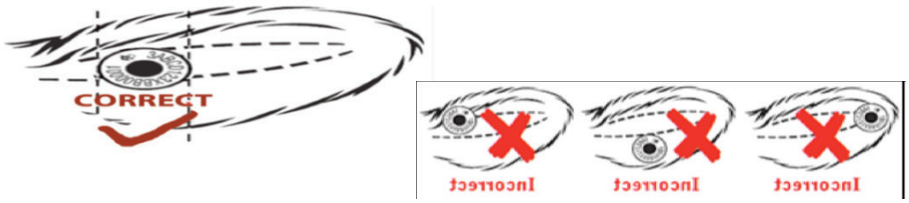
(iii) Compatibility of Ear Tag Applicators: It was necessary to use an ear tag applicator that was compatible with the specific ear tags being employed for cattle identification.

(iv) Source of Ear Tags: Only ear tags purchased from the Livestock Advisory Centre (LAC) were permissible for use in tagging cattle. These tags were likely the approved ones for use within the Botswana Animal Information and Traceability System (BAITS).

(v) Submission of Returns: Following the tagging process, returns containing relevant data were required to be submitted to BAITS within 14 days. These returns included information about the tagged cattle for proper record-keeping and traceability purposes. The following were guidelines required for submission of returns.

The holding must be registered / recognized in BAITS. The animals had to be properly tagged before this information can be submitted. Returns could be submitted either online or by a completed form which could be collected from DVS or downloaded from the government portal. The returns had to be submitted to DVS/BAITS within 14 days after tagging has been done. It was the responsibility of the keeper to ensure that the information submitted is accurate.

Figure 5.3 The correct method of tagging animals according to the BAITS system



Source: BAITS

5.3 Social environment

5.3.1 Registration of Keepers

In Botswana, a livestock keeper was considered as anyone who takes care of livestock at any given point and whose duty is to ensure that all legal requirements pertaining to livestock under their custody are met. To register as a keeper the following documents had to be provided.

- Citizens-A valid National Identification
- Non-Citizens- A valid Residence Permit
- For companies-A valid company registration certificate

- Associations/syndicates- Valid Registration Certificates
- Avail any information as may be required by Directorate of Veterinary Services (DVS).
- An application fee as set by DVS

5.3.2 Registration of a Holding

A holding refers to where animals are kept together under the same management. Holdings were an important component in animal traceability in Botswana as they enabled the Directory of Veterinary Services to tie an animal to a particular place at any certain time. In order for farmers to register a holding the following had to be in place:

- The applicant had to be a registered keeper
- The holding to be registered had to be fenced, have adequate water supply, and have adequate animal handling structures.
- The applicant had to provide location details including geo-coordinates for the holding to be registered.

5.3.3 Registering of arrivals

Arrivals referred to the confirmation of the location status of an animal which was a crucial procedure for the success of BAITS. Arrivals were required to be recorded for all animals that had been relocated to new locations or holdings, irrespective of whether the move was accompanied by a movement permit. To perform animal arrivals, individuals needed to be registered as keepers, and the animals in question had to be officially identified and registered within the Botswana Animal Information and Traceability System (BAITS). This process could be completed either online or by submitting a completed arrival form at any Department of Veterinary Services (DVS) office.

5.3.4 Cattle movement permit application

A movement permit was mandatory when relocating cattle between different zones, holdings, slaughter facilities, quarantines, or other areas as determined by the Director of Veterinary Services in Botswana. To apply for such a permit, the applicant had to be a registered keeper, and the animals intended for movement needed to be registered within the Botswana Animal Information and Traceability System (BAITS). Importantly, the animals and the holdings they originated from should not have been under any restrictions, and the brand certificate had to be valid for the cattle to be eligible for movement.

Furthermore, a keeper could only request a permit for animals that were registered under their ownership. The applicant was required to submit the movement

request at least two working days before the planned date of movement. Once the application was submitted, the applicant had to await approval from the Department of Veterinary Services (DVS) before proceeding with the cattle movement.

5.3.5 Transfer of ownership

This meant changing animal ownership from one registered keeper to another. Transfer of ownership. For the transaction to occur, both the current and the new owner have to be registered as livestock keepers. The brands used and to be used on the cattle had to be valid. The transaction could be done online, or a request submitted to DVS office. The animals to be transferred had to be identified and officially registered in BAITS.

5.3.6 Reporting animal mortality

It was crucial for livestock keepers to promptly report cases of animal mortality to the Department of Veterinary Services (DVS). This reporting obligation extended to all instances of animal deaths, whether due to slaughter for ceremonies, disease, or other causes. The reporting of animal mortality assisted in maintaining a comprehensive trace of the animal's life cycle from birth and ensuring an accurate animal census.

To be eligible for reporting, the animals in question had to be properly identified and officially registered within the Botswana Animal Information and Traceability System (BAITS). Additionally, it was a requirement that boluses from previously bolused cattle be returned to the nearest DVS office as part of the reporting process. Reporting could be done either online or through collecting a form from DVS.

6. Policy Considerations for Integrating RFID Technology into Livestock Identification and Traceability System (LITS) to Enhance Livestock Management in Kenya

6.1 Communication

6.1.1 Capacity Building and Training

A well-defined policy can prioritize capacity building and training to ensure that all stakeholders can effectively use and manage the Animal Identification and Traceability system.

Policy Considerations: Allocating resources for training programs, identifying target groups for training (e.g., farmers, veterinarians, government officials), Regularly updating training materials and curricula to keep pace with technological advancements, Promoting continuous learning and skill development.

6.1.2 Legal Framework and Legislation

Enact a robust legal framework that mandates and regulates the Animal Identification, Livestock, and Product Traceability system. This legal framework to be in line with organization for animal health (OIE) international standards, such as OIE Chapter 4.1 and 4.2 of the Code and CAC/GL 60-2006.

Policy Considerations: Defining the objectives and scope of the system in Kenyan law, establishing obligations for competent authorities and stakeholders, Prescribing penalties for non-compliance or fraudulent activities, ensuring data confidentiality and privacy, determining access rights to information, addressing funding mechanisms for system maintenance, Outlining reporting requirements for different stakeholders.

6.2 Technology

6.2.1 Technology and Infrastructure

The policy needs to address the technology and infrastructure requirements for implementing the system, ensuring that they are suitable for Kenya's unique conditions.

Policy Considerations: Evaluating available technologies and their affordability in Kenya, determining standards for data management and information systems, encouraging investment in technology infrastructure, especially in rural areas, Establishing guidelines for the procurement and maintenance of equipment.

6.2.2 Data Ownership and Access

Ownership and access to data generated by the system to be clearly defined in the policy. This is crucial for maintaining trust among stakeholders and ensuring data security.

Policy Considerations: Specifying who owns and controls the data (e.g., Veterinary Authority), Outlining the conditions under which data can be accessed by different stakeholders, Safeguarding data integrity and preventing unauthorized access, Providing guidelines for data sharing with international partners.

6.3 Social environment

6.3.1 Stakeholder Engagement

The policy can encourage and facilitate cooperation and collaboration among government agencies, private sector players, and other relevant entities.

Policy Considerations: Establishing mechanisms for regular consultation with stakeholders, encouraging information sharing and communication, Promoting private sector participation and innovation, Incentivizing compliance through partnerships and incentives.

6.3.2 Scope and Objectives

The policy to provide a clear direction for the system's goals, such as disease control, export certification, food safety, and fraud prevention.

Policy Considerations: Identifying priority diseases and health concerns in Kenya, setting performance criteria and measurable outcomes, aligning system goals with Kenya's livestock production and trade needs, regularly reviewing, and updating system objectives to adapt to changing circumstances.

6.3.3 Monitoring, Auditing, and Evaluation

The policy may consider establishing mechanisms for ongoing monitoring, auditing, and evaluation of the system's performance to ensure its effectiveness and compliance with standards.

Policy Considerations: Conducting regular audits and inspections by competent authorities, setting up an independent body for evaluating the system's impact on disease control, trade facilitation, and food safety, using feedback from audits and evaluations to make necessary improvements, ensuring transparency in reporting, and sharing results.

6.3.4 Trade and Export Certification

The policy to emphasize the importance of the Animal Identification and Traceability system in meeting trade and export certification requirements.

Policy Considerations: Ensuring that the system aligns with international standards and regulations, collaborating with trading partners to establish mutual recognition of traceability systems, Promoting the certification of Kenyan livestock products for export markets. Establishing mechanisms for addressing trade-related disputes and barriers

6.3.5 Financial Sustainability

The policy may consider address consider address the financial sustainability of the system, including funding mechanisms, cost-sharing arrangements, and revenue generation.

Policy Considerations: Identifying potential funding sources, including government budgets, user fees, and donor support, ensuring that the costs and benefits of the system are fairly distributed among stakeholders, establishing a transparent financial management system to track expenditures and revenues, Evaluating the economic impact of the system on the live.

7. Conclusion and Recommendations

7.1 Conclusion

The implementation of a National Animal Identification and Traceability System is not only a global necessity but a critical requirement for local and international trade in animals and animal products, as well as for ensuring food safety and the security of animal assets. However, in Kenya, the existing legal and regulatory frameworks have fallen short in adequately addressing the challenges associated with animal identification, registration, and traceability. Compliance with modern traceability requirements is essential for participating in global trade, and the absence of a robust LITS system places Kenya at a disadvantage.

In addition, in Kenya's case, the adoption of Livestock Identification and Traceability systems is not just a matter of compliance but also an opportunity to enhance the quality and safety assurance of food of animal origin, protect animal health, improve market access for Kenyan livestock products and overall effective livestock management in the country as stipulated in the Kenya LITS strategy of 2020 – 2030.

The study concludes that as Kenya moves forward with the implementation of its LITS programme, it can draw valuable lessons from Botswana's successful implementation of its BAITS system. Botswana's experience demonstrates the importance of clear policies, stakeholder engagement, advanced technology adoption, effective data management, and stringent compliance enforcement. In doing so, Kenya can establish an effective LITS system that not only safeguards animal health but also enhances its position in the global trade of animal products, benefiting both producers especially from the ASALS and consumers.

As noted by the study, Botswana faced multiple challenges while implementing this technology. Some of these challenges are similar to those faced by the ASALs of Kenya. However, regardless of these challenges, Botswana still managed to effectively implement this technology opening the country up for many economic opportunities and improved livestock management.

7.2 Recommendations

7.2.1 Communication channels

The Ministry of Agriculture, Livestock, Fisheries and Cooperatives to develop a targeted awareness and training program for livestock stakeholders on the benefits and correct usage of RFID technology for livestock management. This program can be tailored to the needs of different stakeholders, such as farmers, livestock owners, and government agencies. The program can also be conducted in a variety of languages to reach as many stakeholders as possible.

The Ministry of Agriculture, Livestock, Fisheries and Cooperatives may consider using more innovative approaches to communicate the usage of RFID technology on livestock management. This will enable more stakeholders to be sensitized on the use of RFID. This can be done by involving influential people in the community

such as those in the arts and media, renown farmers and industry experts. Their endorsement of this technology can significantly amplify the message and encourage others to adopt the technology.

7.2.2 Technology

The Ministry of Agriculture, Livestock, Fisheries and Cooperatives and the Ministry for Communications, Information and Digital Economy to collaborate in developing a comprehensive plan for enhancing the RFID infrastructure and technical capabilities required for effective implementation of the LITS system. This plan can include specific goals, timelines, and budgets. It can also identify the key stakeholders who will be involved in the implementation process.

The Ministry of Agriculture, Livestock, Fisheries and Cooperatives to work towards effective implementation by addressing gaps in the regulatory framework and policies that support the adoption and sustainability of RFID technology in livestock management. These gaps can be addressed in consultation with all relevant stakeholders. It can also be aligned with international standards and best practices.

7.2.3 Social environment

The Ministry for Communications, Information and Digital Economy, in collaboration with the Ministry of Agriculture, Livestock, Fisheries and Cooperatives may consider collaborating and partnering with countries such as Botswana, Canada and the European Union which have advanced in this technology to Fastrack the implementation of RFID in LITS management for Kenya.

The Ministry of Agriculture, Livestock, Fisheries and Cooperatives to use a multi-sectoral approach to involve all stakeholders from public and private sectors in the implementation of LITS. This will help to ensure that the system is designed and implemented in a way that meets the needs of all users. The Ministry can also work to address any cultural, political, or environmental factors that may hinder the adoption of LITS.

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