A FRAMEWORK TO DEFINE THE IMPACT OF SUSTAINABLE ICT FOR AGRICULTURE PROJECTS: THE NAMIBIAN LIVESTOCK TRACEABILITY SYSTEM

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ABSTRACT
Namibia expanded its livestock traceability system to include data of the Northern communal farmers, with ear-tagging starting in 2010, and full functionality added in 2014. The new technology enables them to export safe meat products to previously-excluded overseas markets. In this article, the complexities of a livestock traceability system are explained to provide one with a sense of the lengths countries like Namibia went through to successfully implement such a system. Next, a new framework is proposed to apply to agricultural development projects, called the Impact-for-sustainable agriculture framework, with all the facets of the framework explained. Finally, the framework is applied to the Namibian Livestock Identification and Traceability System (NamLITS), with the focus on the Northern Communal Areas (NCAs). NamLITS is an example of a successful agricultural development project, and it is hoped that this new framework can be applied to other agricultural initiatives.

KEYWORDS
Livestock Traceability, Namibia, Sustainability, ICT for Agriculture, Impact Assessment Framework

1. INTRODUCTION

The United Nations Educational, Scientific and Cultural Organisation (UNESCO) lists seventeen Sustainable Development Goals, the first of which is to ensure "no poverty" and the second "zero hunger" (UNESCO, 2015). It is against this backdrop of poverty and hunger that the world is aiming to supply enough food for future generations. But consumers want assurance that the food products they buy are safe for human consumption, hence the need for traceability. Traceability is defined as the ability to "track" food products (Germain, 2003; Schwägele, 2005); Storøy et al., 2013). Traceability forms the basis of modern-day food safety systems (Ekuam, 2009) and has become increasingly important to consumers. Traceability partners must identify the supplier and the consumer of any food product (GS1, 2010) while differentiating between the external traceability of trading partners and the internal traceability within a company's own operations. As part of an integrated supply chain, a traceability system should include product traceability, as well as process, disease, genetic and measurement traceability (Opara, 2002). The GS1 Global Traceability Standard, widely used in fresh product markets, has to ensure that if any food products are unsafe for human consumption, they can be recalled by the accurate backward tracing of the contaminated food products (GS1, 2010). In terms of livestock tracking, it is done through a detailed food label, reflecting the animal's history captured on a traceability system, also identifying the country of origin, place of birth, place of slaughter and where the meat was processed (Hobbs, 2003).

Traceability includes "tracing" food products backward (Germain, 2003; Schwägele, 2005; Storøy et al., 2013) from the consumer to the retailer, the distributor, the processing company and back to the producer. The transparency of the process enables the retailer and

distributor to identify meat products from specific producers in the event of a food safety crisis (Hobbs, 2003). Figure 1 has been adapted from (Schwägele, 2005) where tracking sends information forward from primary producer right to the consumer and tracing sends the same information backward from the consumer to the origin of the animal:

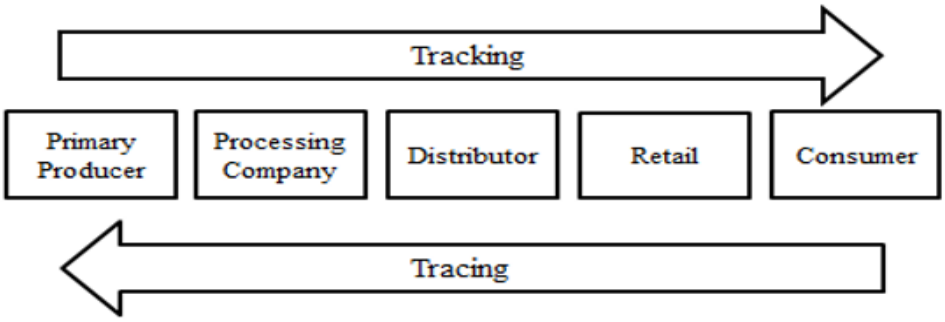

Figure 1. Tracking and Tracing Along the Food Chain (Source: Schwägele, 2005)

As a result of this process highlighted in Figure 1, imported meat products have the label showing the country of origin, as shown in Figure 2, clearly indicating the origin of the animal as being from Namibia. The slaughter- and packaging dates are also specified, and the rest of the animal history can be found by scanning the barcode.

Figure 2. An Example of a Label Showing Namibia as the Country of Origin (Source: Engelbrecht, 2012)

Livestock traceability is difficult to implement because of all its strict requirements, except in European Union (EU) countries, where the livestock industry is predominantly well-developed and the veterinary services in place (OIE, 2014).

In Africa, commercial farmers can benefit because of favourable exchange rates. Africa has a large number of communal farmers, but the poverty and hunger in rural communities often lead to low input, low output farming systems with little veterinary support (OIE, 2014). Namibia implemented their Namibian Livestock Identification and Traceability System (NamLITS) in 2006, ensuring that it adheres to all the requirements to export safe meat to the EU and other countries, however, the system only targeted the commercial farmers.

In 2010, the ear-tagging of the communal farmers' cattle started, and in 2014 the previously-excluded communal farmers were incorporated into the NamLITS database (Fourie, 2013). The communal farmers are now in a position to gain economically from traceability, and the way in which communal farmers can benefit is discussed in terms of a proposed framework.

There are three main research questions discussed in this paper: (1) What are the different components of a livestock traceability system? (2) How was the expansion of NamLITS implemented in the previously excluded Northern Communal Areas (NCAs)? (3) What framework is proposed to ensure that the expansion to include communal farmers can lead to future sustainable ICT for agriculture projects?

2. METHODOLOGY

Livestock traceability is explained by means of a narrative study, firstly broad, then specifically in terms of Namibia. An inductive research approach is used to create a generic framework, with the qualitative data collection process involving the gathering all the necessary data, including interviews, observations, official documents, media articles and websites. Three interviews were conducted during two separate visits to Namibia, where the use and functionality of NamLITS were discussed, both from a system development perspective and end-user point of view. Members of the Namibian Meat Board were also asked to give their views on the legislative requirements of NamLITS and use in the NCAs. A farm was also visited where cattle were dehorned, branded and castrated, and the NCAs were visited where animal technicians attended a regional meeting.

3. FINDINGS: NARRATIVE STUDY OF A LIVESTOCK TRACEABILITY SYSTEM

3.1. Requirement of a Livestock Traceability System

There are several aspects one has to keep in mind to implement a livestock traceability system successfully. Authors such as Greene (2010), Regattieri et al. (2007), Siena et al. (2008) and Verbeke (2001) agree that a traceability system has various facets to address when it is implemented, such as unique identification of an animal and meat products, processing information, animal movements and animal health. Figure 3 below is a summary of the goals of a traceability system, as illustrated by Greene (2010) where the animal health is monitored by combining certain criteria, and together with the movements, ensure safe meat to export markets.

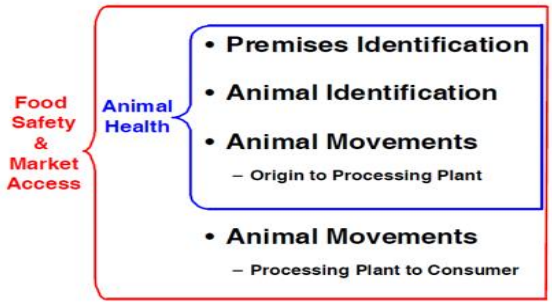

Figure 3. Animal Identification Goals with Traceability (Source: Greene, 2010)

3.1.1. Tracking Animal Movement

The red meat value chain is more complex than one tends to think. Animals need to be tracked from the original farm to the feedlot and then the abattoir, but all meat products from the animal, including the processing of the meat, hides and skins must be tracked from the abattoir to the wholesaler, retailer and finally the consumer. Importers should also keep track of the imported meat, until finally reaching the overseas consumer (SAFA, 2003) as is illustrated in Figure 4.

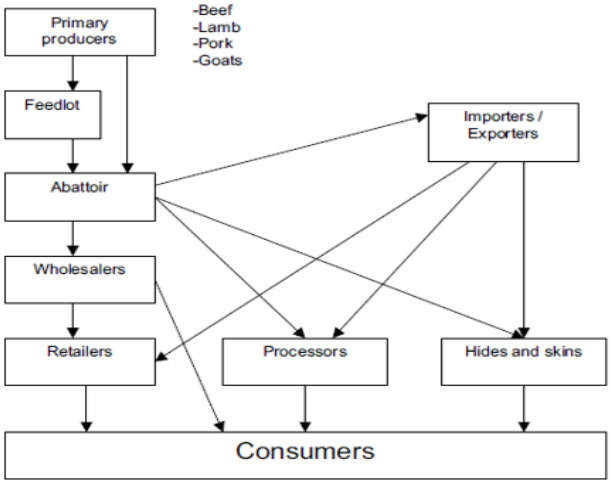

Figure 4. The Red Meat Value Chain (Source: SAFA, 2003)

The data of the movement of the animal is kept in the traceability system, and is updated as movements occur. The following needs to be in place when moving an animal, before it is slaughtered (Fourie, 2013; SAFA, 2003):

- Whenever an animal is moved from the original farm to the new farm, the documentation, including the movement permit and the updated movement register, must accompany the animal. This is also the case if moving an animal from the original farm to a livestock auction. The movement register must reflect if the animal is sent to a feedlot or an abattoir from the primary producer, as seen in Figure 4.
- The tracking of animal movements is very important to comply with the 90/40 day rule. The 90/40 day rule is enforced when animals are moved. This rule implies that an animal cannot be slaughtered within 90 days after entering the country, or 40 days since its last move from farm-to-farm, farm-to-auction or farm-to-abattoir.
- All the information is stored in a centralized database for auditing purposes and to comply with the set requirements. Proof of compliance is required in cases of EU audits.

3.1.2. Unique Identification of Animals

For effective traceability, all animals must be uniquely identifiable. The animal's owner must also be identifiable with either a unique farm identifier, or area identifier such as a crush pen area. The various ways of identifying a farmer or region differ among traceability systems. Today, popular methods include inserting a rumen bolus, conventional RFID ear-tags and hot iron branding, although various other forms of animal identification exist. Animal branding started more than 3 800 years ago where valuable animals such as horses were marked (Bowling et al., 2008).

In Namibia the farm is uniquely identified through the branding of the animal, where every farmer uses a hot iron to brand his or her farm identifier on the animal's hind leg. Hot iron branding is a method by which an iron, with identifying symbol or combination of symbols is heated, and then held on the skin of the animal to cause a scar. Brand irons are usually made from mild steel alloys (Caja et al., 2004), no more than 4 mm wide, with a smooth, flat surface. Animals are branded at a young age, from about three to six months. The ear-tag used in Namibia has the number of the specific animal and region, as well as the

Namibian symbol, making the animal brand the only way of identifying ownership, as shown in Figure 5 below:

Figure 5: An Example of a Namibian Ear-Tag
(Source: Engelbrecht, 2012)

The animal itself needs to be uniquely identified, not only to prove ownership, but also to control disease outbreaks by isolating infected animals (Moreki et al., 2012).

3.1.3. Monitoring Animal Health

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

3.1.4. Disease Control

Namibia is at high risk of FMD outbreaks, due to exposure from Zambia and Botswana, where buffalo cross the borders and are the carriers of FMD (Schultz, 2013). As Schultz (2013) pointed out, the exposure to buffalo is very difficult to control, with the area above the Namibian Red Line, also known as the Veterinary Cordon Fence (VCF), at high risk of exposure. The Red Line acts as an imaginary line where the communal farmers north of the Red Line could previously not export beef because of the risk of exposure to FMD (Kumba, 2003). If a buffalo is spotted in the North East of Namibia, that area is quarantined for twenty-one days. If the disease is transmitted to other game or livestock, the area can be quarantined for up to six months (Fourie, 2013).

Communal farmers need to contain disease outbreaks effectively to minimize the quarantine area. The outbreak area will be the focal point, as seen in Figure 6. With the help of Google Maps and NamLITS, the areas in direct contact with the focal point can be traced back or traced forward, where they typically share resources such as drinking water, the second area shown in Figure 6. In this way the contamination radius is identified and the areas of contamination can be quarantined. If areas beyond the traced areas have been exposed, it will lead to a bigger area being quarantined, where a game fence will typically serve as the boundary of the contamination. If it goes beyond the game fence, the entire

country will be quarantined. Figure 6 shows how the radius of the disease outbreak is determined and Figure 7 illustrates how forward and backward tracing is used to contain the infected area when the disease is spreading.

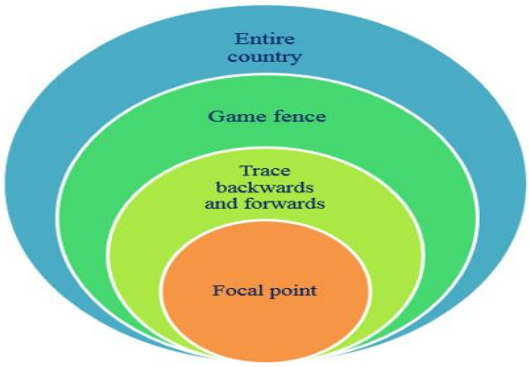

Figure 6. Managing Disease Outbreak Events (Source: Field Data)

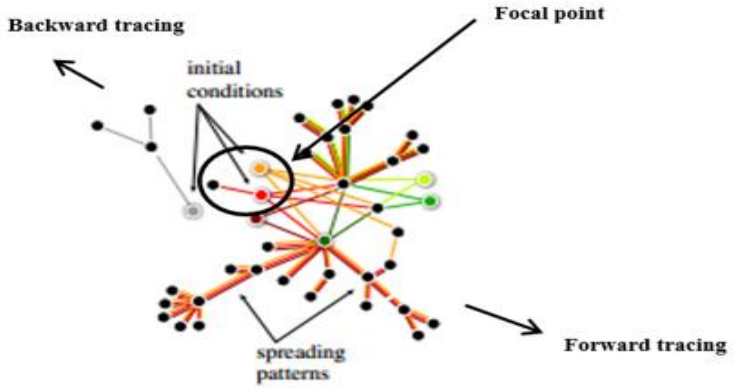

Figure 7. A Disease Outbreak Showing Spreading Patterns (Source: Bajardi, Barrat, Savini & Colizza, 2012)

3.1.5. Managing Nutrition and Yield

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

Protozoa causes diseases in animals and humans. However, the EU is regulating the use of antibiotics by means of the Council Regulation (EEC, 1990) as explained by Andrée et al. (2010). Unregulated use of antibiotics results in antibiotic-resistance and increased allergies (Toldrá & Reig, 2006).

Growth promoters are illegal because they remain present in all products derived from the animal and lead to poorer quality meat products, which lead to health risks (Toldrá & Reig, 2006).

Andrée et al. (2010) list a number of vulnerabilities where inadequate traceability can lead to insufficient documentation regarding the animal or animal product, faulty ear-tag information, a lack of identifying all animal contaminants and a lack of information regarding

the detection of contaminants. In the light of all the health risks to animals and humans, the feed of animals needs to be nutritional, yet safe for human consumption, leading to the need to identify animals uniquely. The next section discusses a new framework that is used to measure the sustainability of an agricultural project by linking the different factors through three layers, leading to determining the impact of the project on the beneficiaries.

4. THE EXPANSION OF NAMLITS TO THE NCAS

The NamLITS system was expanded in 2010 to allow communal farmers' cattle, north of the red line, to be ear-tagged and captured on the NamLITS database. This paved the way for the previously excluded communal farmers to be able to export to overseas markets, not only to markets in Namibia and South Africa.

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

Once a buffalo is spotted in the North East of Namibia, that area is quarantined for 21 days. If the disease is transmitted to other game or livestock, the area can be quarantined for up to six months (Fourie, 2013). The southern areas are known as free zones where cattle can move and be sold without restrictions. Just below the VCF there is a surveillance zone and above it is the buffer zone, where animal movements are more restricted and diseases are more accurately tracked and monitored. The infected zone, the Caprivi, is the zone where exporting is not allowed because of the constant exposure of cattle to buffalo that may potentially spread FMD seen in Figure 8 below.

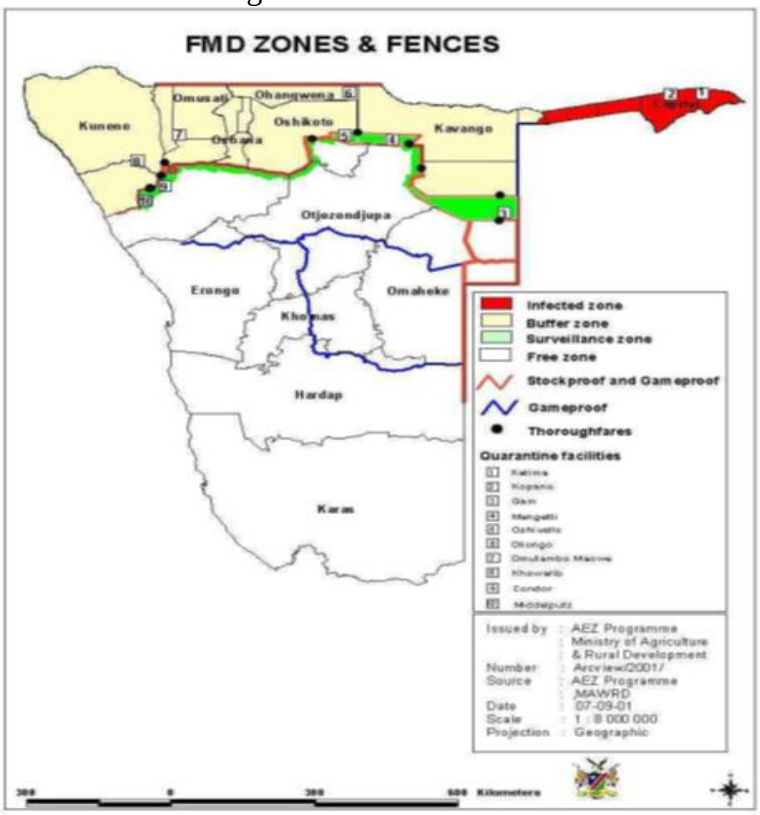

Figure 8: Namibia's Foot-and-Mouth Disease Zones and Fences (Source: Kumba, 2003)

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

An outbreak of foot-and-mouth disease in 2015 in the NCAs had a devastating effect, but the NamLITS system provided information on animals and geographical areas that helped to contain the disease. The NCAs recovered much more quickly from the outbreak, and are again able to export their meat products. Namibia exports about 950000 tons of beef to Norway, a number that can double now that the NCAs also have sufficient traceability in place. Namibia can also infiltrate new markets with its higher export capacity.

5. THE IMPACT-FOR-SUSTAINABLE-AGRICULTURE FRAMEWORK

A new framework is proposed to put sustainable agricultural projects in context with an impact assessment framework as a means of explaining how an impact assessment framework relates to a more sustainable project. To summarize the overall framework briefly, as seen in Figure 9, the framework places the Political, Economic, Social, Technological and Legal (PESTeL) components at the foundation of sustainability, linking with the Communication-for-Development (C4D) framework, together with the three pillars of sustainability to form the information and pre-knowledge needed to build the framework. The PESTeL components and the pillars of sustainability should be seen as describing the background of an agricultural project, forming the initial building blocks of the overall framework. The second layer or building block, is that of the introduction of new technology to bring about certain behavioural changes, with the ultimate goal of highlighting developmental impacts. Finally, the third component or layer is the various impacts on the communal farmer, depicted in the order of Maslow's Hierarchy of Needs (Prinsloo, 2017). Considering the three layers, in that specific order, can lead to more sustainable agricultural initiatives.

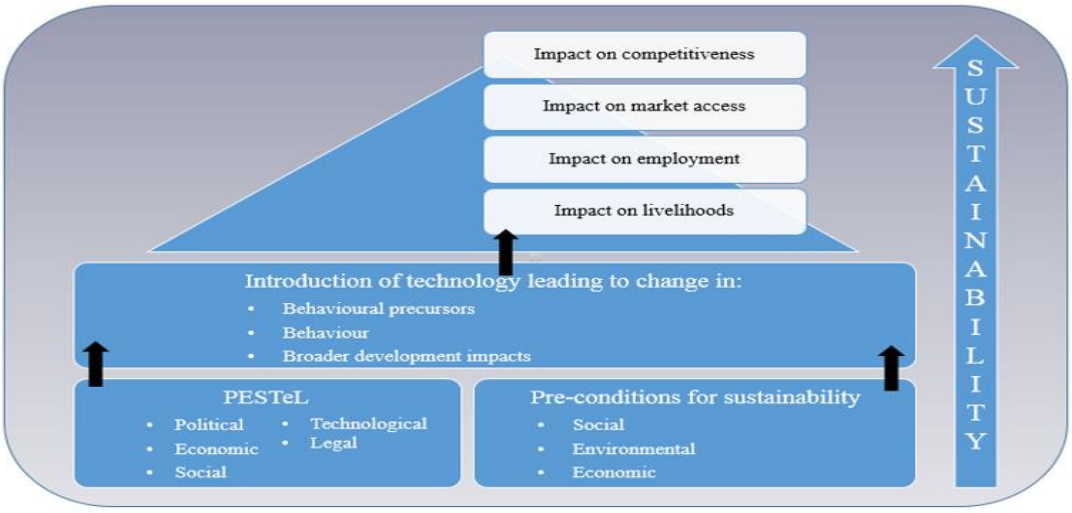

Figure 9: The Impact-for-Sustainable-Agriculture Framework

5.1. The Three Pillars of Sustainability: The First Building Block of the Proposed Framework

Three main dimensions, also referred to as pillars, arose from sustainable development, and are still widely used today by authors such as Köhler (2014), Roy et al. (2013) and Opp and Saunders (2013). Sustainable development needs to focus on social, environmental and economic aspects. The three pillars of sustainability are first referenced as part of Agenda 21 and Kahn (1995) describes sustainable development as resting on three conceptual pillars: "social sustainability", "environmental sustainability" and "economic sustainability". Stephen (1996) briefly explains the role of the ecology or environment, and to live within its capacity, the role of the economy provides us with a means to maintain a standard of living and the role of society ensures that we set values for people that they can aim to achieve.

Reasons why Information and Communication Technology for Development (ICT4D) projects fail are ample, and literature suggest high costs and lack of government planning (Masiero, 2016), capable people being scarce, with technology only as successful as the capable people driving the project (Marais, 2015), cultural differences (Harris, 2016), failure to address real challenges (Qureshi, 2015), and people not assuming the appropriate responsibility (Qureshi, 2015), to name a few. There are, however, several universally accepted success factors as outlined by Pade et al., (2009). Pade et al. (2009) briefly discuss nineteen such factors, but a few are of particular interest to this study, and are listed below:

(1) Simple and clear project objectives
(2) Using ICT to enhance existing rural development activities
(3) Cultivating an influential project champion
(4) Incorporating socially excluded groups
(5) An understanding of the local political context
(6) Focusing on local needs
(7) Appropriate training
(8) Focusing on self-sustainability
(9) Encouraging local ownership
(10) Choosing the appropriate technology
(11) Building local partnerships
(12) Building on existing facilities
(13) Ongoing monitoring and evaluation of the project

All sustainable success factors of rural ICT projects are incorporated to form part of the background, and summarizes the evidence to support all the layers of the framework as a whole, showing that one starts with understanding the local context and challenges, building a strong case study and summarising the evidence in a table illustrating the developmental impacts that took place. Next, one adds the third layer to illustrate the direct impact on the communal farmer, and the picture is complete, as seen in Figure 8.

5.2. Sustainable Livelihoods

In the sustainable livelihood (SL) approach, the main emphasis is on people, helping them to reach their potential, but also looking at other factors such as legislation and policies, different institutions and new trends (Carney, 2003).

For the farmers, SL can assist in increasing their income and generate a regular stream of income (Tacastacas, 2011). The sustainable livelihood framework was first illustrated by the Institute for Development Studies (1996), but was adapted and later published by Adato and Meinzen-Dick (2002), who added the agricultural technologies component, as illustrated in Figure 10 below. Certain vulnerability contexts link to policies, institutions and processes by taking into account the different forms of capital, also known as livelihood assets, forming

in turn livelihood strategies and livelihood outcomes. The livelihood assets are H: human capital; N: natural capital; F: financial capital; P: physical capital; and S: social capital.

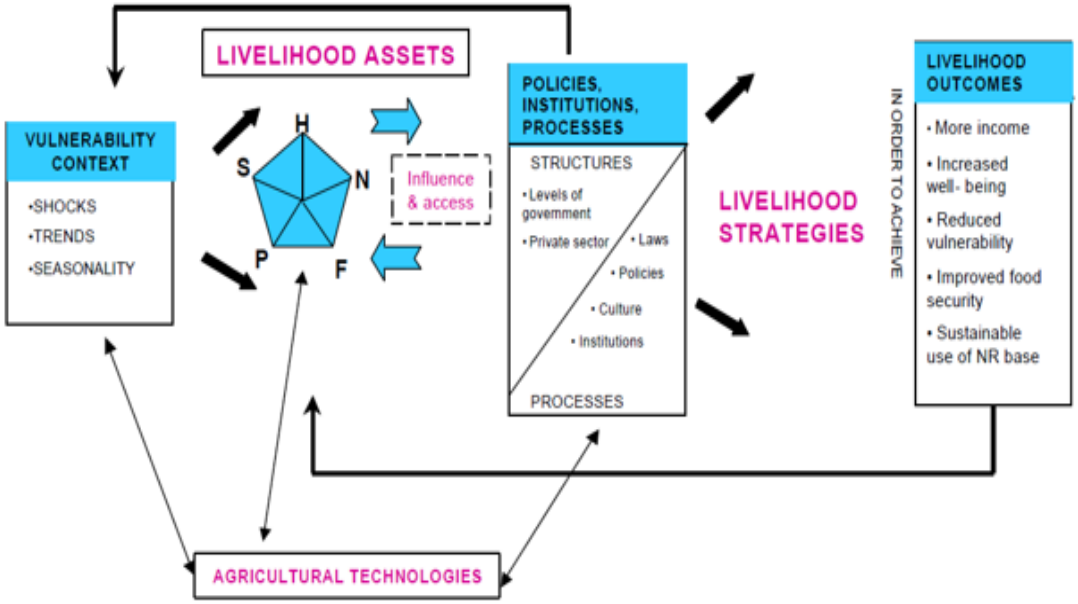

Figure 10: The Sustainable Livelihoods Conceptual Framework with Agricultural Technologies
(Source: Adato & Meinzen-Dick, 2002)

The livelihood outcomes as illustrated in Figure 9, is of importance in this case, as it is posited that, for a development project ultimately to reach sustainability, a true impact must be seen by the people or communities whom the development project was intended for, the actual beneficiaries. If one is to dissect the sustainable livelihoods framework, the vulnerability context, policies, institutions and processes, and the livelihood outcomes all link to some extent to the framework proposed in the study; however, the different forms of capital, consisting of human, social, political, financial and natural capital, are not used as inputs.

A different method of data gathering is used, because of the meaning of the different forms of capital. In studies where different forms of capital are at the heart of the research, individuals are studied as explained by Putnam (2001), Ellison et al. (2007), Colombo et al. (2015) and Hewitt-Dundas and Burns (2016), to name a few. In the cases presented in this paper, the individuals could not be reached, reasons being that communal farmers do not speak English in most cases, and the farmers live in remote areas not easily accessible.

The first point of access to the farmers are the animal technicians in Namibia, and summarized data was collected through them to apply to the case studies.

The above-mentioned framework is of value, and is considered as one form of input, but the more simplistic pillars of sustainability, together with other frameworks, are seen as providing the crux of sustainability, and are used instead.

5.3. The Communications-for-Development Model as an Impact Assessment Framework: The Second Building Block of the Proposed Framework

A very comprehensive study was conducted by Heeks and Molla (2009) to combine the most-

used impact assessment frameworks of ICT4D development projects in a compendium. The compendium lists a total of eleven frameworks, and the C4D framework, the livelihoods framework and the cultural-institutional framework are considered as a means of explaining the impact of the project on communal farmers. The livelihoods framework is not suitable, due to its different forms of capital studied at individual level, as well as its poor linkages to information (Hoque & Sorwar, 2015); the cultural-institutional framework focuses very strongly on the roles of the different institutions, and how it affects the behaviours of the ICT4D users as a means of cause-and-effect in a given context (Heeks & Molla, 2009).

The main focus in the study is not on the users of the traceability systems, but rather on the farmers, involved in a secondary role only, and not primarily a system user. The only remaining framework left to consider, is the C4D framework, as illustrated below in Figure 11:

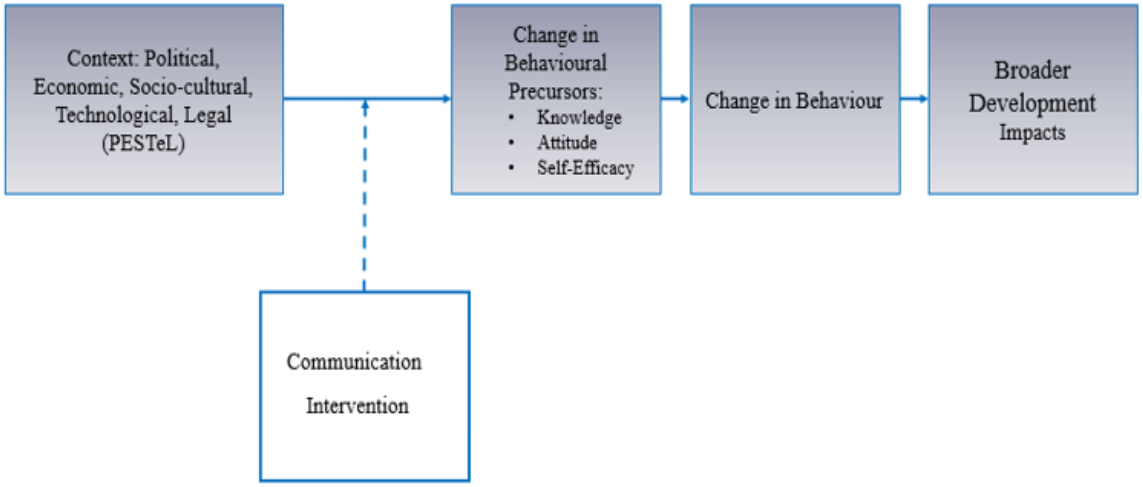

Figure 11: Communications-for-Development Framework (Source: Heeks & Molla, 2009)

In Figure 11, the C4D framework sketches a strong background picture by looking at the various PESTeL facets; all of these facets feed into the final framework to provide context.

The changes in behavioural precursors, leading to a change in behaviour, and leading to developmental impacts round off the subsequent framework very well. However, in figure 10, the communication intervention is replaced by a technological change, causing a slight adaption of the framework in the traditional sense. It is not uncommon for researchers to adapt frameworks to their desired contexts, as is illustrated by Burton et al. (2002), Briner et al. (2012) and Shortall et al. (2015), to name a few. The emphasis is not so much on how communication has led to change, but rather how the introduction of the traceability system - the technology - has led to changes.

5.4. The Four Objectives of the Agriculture-for-Development Framework: The Third Building Block of the Proposed Framework

The World Development Report of 2008 focuses on agriculture, and Sub-Saharan Africa is lacking in agricultural development in various aspects such as failed agricultural opportunities, not creating economic growth and increased rural poverty (de Janvry & Sadoulet, 2009).

The four policy objectives and their different effects, transitions and demands are applicable to a vast number of contexts, including urban development and countries in transition, as stated in Chapter 10 of the World Development Report (World Bank, 2007), but the simplified model, looking only at the four main objectives, was applied to an agricultural context to narrow the focus in the context of this study, shown in Figure 12. The four objectives are grouped in a specific order, from the most basic human need to the need for self-actualisation, and use Maslow's hierarchy of needs.

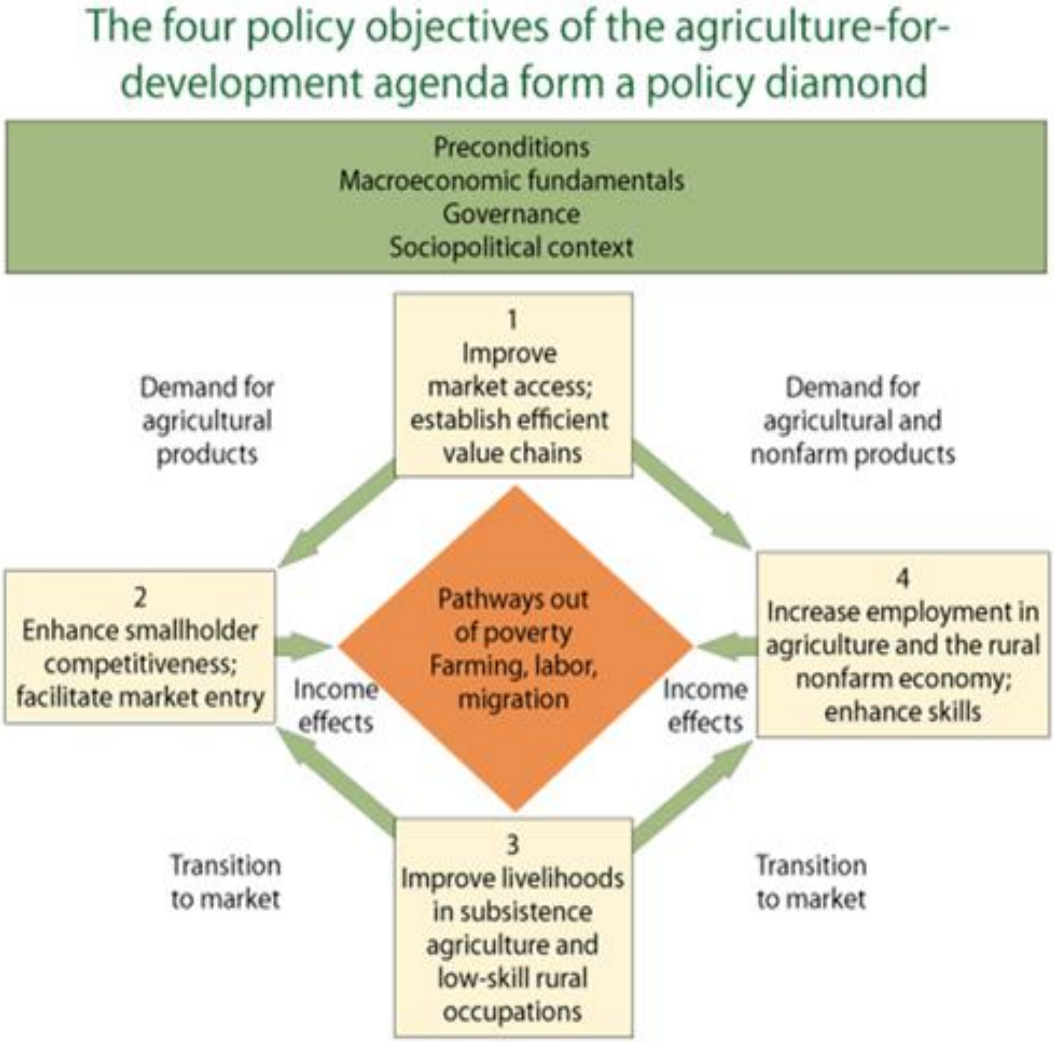

Figure 12: The Four Policy Objectives of the Agriculture-for-Development Agenda form a Policy Diamond (Source: World Bank, 2007)

Agriculture can lead to economic growth, and has done so in India, Chile and Vietnam in the past (de Janvry & Sadoulet, 2009), where 10% of public spending is routed to agricultural development, compared to between 3% and 4% in Sub-Saharan Africa. It is in this context that the World Development Report of 2008, specifically the emerging national agenda for agriculture, is of importance to provide an agriculture-for-development agenda in the form of a diamond (World Bank, 2007), stating the following four main objectives:

(1) To improve market access.
If one is able to improve access to markets to small-scale, rural farmers, one opens up possibilities, new revenue and ultimately economic development.
(2) To enhance smallholder competitiveness.
Rural farmers now compete on a bigger scale, becoming role-players who can then influence market prices.
(3) To improve livelihoods in subsistence agriculture.
Once rural farmers compete on a larger scale, they earn an income, leading to better living conditions.
(4) To increase employment in agriculture.
Better living conditions, with more money at rural farmers' disposal, lead to growing businesses, enabling more employment. This paves the way for less poverty at the centre of the diamond, as shown in Figure 11.

Three interviews were conducted during two separate visits to Namibia, where the use and functionality of NamLITS were discussed, both from a system development perspective and end-user point of view. Members of the Namibian Meat Board were also asked to give their views on the legislative requirements of NamLITS and use in the NCAs. A farm was also visited where cattle were dehorned, branded and castrated, and the NCAs were visited where animal technicians attended a regional meeting. Questionnaires were used as an additional method, and served to describe attitudes of people, and the practical use of the traceability systems. Thirty-nine questionnaires were completed by animal technicians in the NCAs and used to derive various aspects of the use and value of NamLITS. Specific aspects such as the use of NamLITS to ensure better animal health, controlling disease outbreaks and managing cattle vaccinations accurately were determined in the questionnaires.

6. A DISCUSSION OF THE RESULTS

The NamLITS case study, specifically the communal farmers of the NCAs are discussed in terms of the three different layers of the proposed impact-for-sustainable-agriculture framework.

6.1. The First Layer of the Framework

The first layer takes a closer look at PESTeL, sketching the context and the pre-conditions in the form of the pillars of sustainability.

6.1.1. PESTeL

At 825 418 km² Namibia is the world's thirty-fourth largest country and after Mongolia, Namibia is the least densely populated country in the world with 2.56 inhabitants per square kilometre (World Bank, 2015) because of the vast Namib desert spanning most of the country. Namibia has a population of 2.1 million people and a stable multi-party parliamentary democracy, a form of governance where the citizens of the country vote in a free and fair election, voting for their choice of political party (Melber, 2015). The South West African People's Organisation (SWAPO) has been the governing political party since its independence from South Africa in 1989 (de Visser, 2013), with the first president of Namibia, Dr Sam Nujoma, popularly referred to as the "Father of the Nation" (Melber, 2003). Dr Nujoma was president for three consecutive terms from 1990 until 2005, followed by Hifikepunye Pohamba for two five-year terms until 2015, and Hage Geingob, who is currently the president (Kössler, 2015).

In 2004 Namibia introduced a computerized system called NamLITS so that it could remain an exporter of meat to the European Union and other countries. It involves ear-

tagging as well as branding of the animal. This system enables users to prevent stock theft, enforces better movement control and allows for more efficient system governance (Deloitte, 2012). It is a very comprehensive system, and adheres to strict regulations, including the controlling of animal movement, monitoring animal health, controlling disease outbreaks, managing nutrition and identifying animals uniquely (Boy, 2013). The NamLITS system was expanded in 2010 to allow communal farmers' cattle, north of the red line, to be ear-tagged and captured on the NamLITS database.

6.1.2. The Pillars of Sustainability

6.1.2.1. Social

(1) Using ICT to enhance existing rural development activities
The NCAs are difficult to access, with roads in poor conditions, if there are any roads at all. The different tribes living there live a secluded life, and have their own traditions and religious customs.

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

(3) Incorporating socially excluded groups
NamLITS is now providing traceability to the entire Namibian farming community, creating opportunities and economic growth to the poorest communal farmers.

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

(5) Building local partnerships
A one-day trip was undertaken to the NCAs, where a general meeting of animal technicians was attended. It was necessary to observe how the workers worked in unison in the face of a crisis - the unthinkable outbreak of foot-and-mouth disease. The events witnessed showed how the people take ownership of traceability and banded together.

6.1.2.2. Economic

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

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

(3) Choosing the appropriate technology.

NamLITS is written in Progress OpenEdge with complex functionality. The developers support and maintain the system.

(4) Building on existing facilities
The expansion of NamLITS to include the NCAs uses the same system as the NamLITS as is the case in the southern regions. The system was expanded to incorporate the extra data.

(5) Ongoing monitoring and evaluation of the project
NamLITS is still expanding, the project is used throughout Namibia, and new challenges in the NCAs are addressed, such as accurate tracking of animal vaccinations, with and the project usefulness continuously monitored.

6.1.2.3. Environmental

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

(2) Focusing on self-sustainability.
NamLITS is sustainable, it receives funding from the government after initially being funded by the EU. NamLITS does not rely on any additional funding to continue.

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

6.2. The Second Layer of the Framework

The second layer combines the evidence of all the data collected by means of a case study, elaborate interviews, observations and documentation. The main findings are discussed as in terms of the adapted C4D framework, adapted to incorporate the introduction of a new technology, and first provides the context, second the change in behavioural precursors, third the change in behaviour and fourth the broader developmental impact, as shown in table 1 below.

Table 1 summarizes the highlights of all the gathered evidence, and firstly sketch the Namibian context, secondly the changes in behavioural precursors, thirdly the change in behaviour, and finally the broader developmental impact of NamLITS as applied to the NCAs.

Context	Change in behavioural precursors	Change in behaviour	Broader developmental impact
1. Lack of knowledge of how the NCAs are affected by the introduction of NamLITS.	Two visits to Namibia, witnessing cattle being dehorned and branded, speaking to two NamLITS developers, one state veterinarian, three members of the Namibian Meat Board and a visit to the Ministry of Agriculture.	Gaining a better understanding of the NCAs through discussions.	Developing a deeper sense of the challenges the communal farmers face in the NCAs.
2. Lack of knowledge of the challenges the animal technicians face in the NCAs.	A visit to the NCAs, where a group of 39 animal technicians were meeting to discuss the containment of the recent FMD outbreak.	Examining the effect of FMD, talking informally to the animal technicians and learning about their fears and hearing success stories.	A new technology is examined to assist the animal technicians to contain the FMD outbreak.
3. Lack of NamLITS system knowledge and all its complexities.	Introduction to the NamLITS interface, an RFID reader and Toughbook.	Hands-on exposure to the NamLITS system.	Gaining a better understanding of what NamLITS is capable of doing for the NCAs.
4. Lack of knowledge of the cultural differences in the NCAs between different tribes.	A visit to the NCAs as well as research on cultures and traditions.	More knowledge is obtained.	The challenges, beliefs and traditions are better understood.
5. Lack of understanding of the on-going monitoring of the project.	Discussions and visits to key stakeholders to determine NamLITS overall effectiveness.	Better understanding of why monitoring and improvement of the NamLITS system is important and necessary.	Developing a deep appreciation of NamLITS.
6. The impact of a FMD outbreak.	Discussions and research done on the recent FMD outbreak.	The disease and its impact is researched.	The full impact of the disease, as seen through the eyes of the animal technicians and communal farmers in the NCAs is appreciated.
7. Lack of understanding of how the auctions work.	Documentation studied and discussions held with the NamLITS developers and livestock farmers.	A sense of all the different elements involved in administering an auction is achieved.	The reasons why Namibia relies on animal auctions are better grasped.
8. Lack of understanding of how the different animal movement zones function in Namibia.	Documentation studied and discussions held with stakeholders to explain the different animal zones - the infected buffer, surveillance and free zones.	Discussions lead to better insight.	A deeper understanding is achieved to appreciate the necessity of the different movement zones.
9. Lack of understanding of the measures involved in the quarantine of a specific region in Namibia.	Discussions with NamLITS developers and veterinarians on why certain areas are quarantined and how it is done.	The reasons for the quarantine measures are better understood.	Why and how quarantine is enforced and understood.

Table 1. Concluding the Second Layer of the Framework by Summarising the Main Results

6.3. The Third Layer of the Framework

The third and final layer takes the impact of the new technology, and explains its different impacts on the communal farmer.

(1) Impact on livelihoods
- Communal farmers in the NCAs finally included in NamLITS can gain from traceability.
- The different tribes in the NCAs, whether nomadic or part of the Ovambu tribe, are empowered by traceability.
- Communal farmers benefit from ear-tagging and traceability, leading to new opportunities and revenue streams.
- The animals are easily identified, simplifying cattle ownership disputes and helping curb stock theft, ensuring that farmers' cattle are accurately documented.
- Cattle vaccinations are better documented, leading to better measures to prevent diseases from spreading, as well as assisting in rapid disease outbreak prevention measures.

(2) Impact on employment
- Communal farmers can now make money from selling their animals, leading to better opportunities. This in turn leads to a sense of pride in owning cattle.
- One cannot quantify any jobs that are created, except to say that communal farmers now also have a sustainable revenue stream.

(3) Impact on market access
- Communal farmers can access the cattle export market.
- Traceability ensures trust in meat products, opening new markets.
- Communal farmers see the value of NamLITS and feel proud of how NamLITS assisted in the recent FMD outbreak, ensuring that it is adopted fully, making more traceable meat available for the export market.
- More markets open up to Namibia.

(4) Impact on competitiveness
- The more export markets available to the Namibian farmer, especially the communal farmer, the more potential for growth the economy.
- Disease outbreaks are better addressed, controlled and monitored, making the meat safe for export to Europe and many other emerging markets.
- Namibia is a competitor to other African markets, especially by doubling their cattle capacity with the inclusion of the more than 2 000 000 cattle in the NCAs.

7. CONCLUSION

Namibia's recent expansion of NamLITS to the NCAs enables communal farmers to export safe meat to Europe and other parts of the world. The complexities of a livestock traceability system are explained to provide one with the background to appreciate the effort Namibia went through to achieve a functioning livestock traceability system.

The main findings are:

(1) The implementation of a livestock traceability system is complex, needs to adhere to strict regulations and need to store various aspects of the animals.

(2) The expansion of NamLITS led to the previously-excluded communal farmers to also benefit economically from traceability.

(3) ICT4D projects can be more sustainable if the layers of the proposed framework are followed and applied to specific contexts.

As part of creating sustainable agricultural initiative, a new framework is proposed to determine if the beneficiaries of the project, in this case the communal farmers, are more

likely to ensure that a project remains sustainable if they can feel a real impact of the initiative on their everyday lives. The framework is then tested on the NCAs, forming part of NamLITS. This paper makes a theoretical in terms of the new framework and a practical contribution where the framework is applied to a specific context.

Livestock traceability systems have to be in place exporting meat products to major international markets, but in many African countries the extensive nature of farming systems, particularly in communal systems makes implementation complicated. Future research could include a detailed study of the South Africa context, where talks are currently underway to bring such a system to this country. Further enhancements of the framework should also be considered, and the framework adapted as necessary. In future, the proposed framework also needs to be applied to a wider context, starting with other agricultural development projects, and later to developmental projects in general.

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