ENHANCING DISEASE SURVEILLANCE AT THE SITE OF OUTBREAK USING MOBILE PHONE TECHNOLOGY: THE CASE OF NGORONGORO DISTRICT ARUSHA, TANZANIA

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CERTIFICATION

We, the undersigned, Prof. Esron D. Karimuribo and Prof. Lughano J. M. Kusiluka, certify that we have read and hereby recommend this research thesis for acceptance by the Open University of Tanzania a thesis titled: *"Enhancing Disease Surveillance at The Site of Outbreak Using Mobile Phone Technology: The Case of Ngorongoro District Arusha, Tanzania"* in partial fulfillment of the requirement for the degree of Master of Science in Zoology of the Open University of Tanzania.

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Date: ……/……./2013

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DECLARATION

I, Kuya L. Sayalel**,** declare that, this thesis is my own original work and it has not been submitted for the award of a degree in any other University.

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Date

DEDICATION

This work is dedicated to my family, especially my beloved wife Jane Kuya, my daughters, Ruth and Severa, and my son Moringe who really missed my company for a long time and whose care and untold support with encouragement propelled me to accomplish my studies.

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ABSTRACT

A study was carried out to assess the status and performance of human and animal health disease surveillance systems in Tanzania using Ngorongoro district in Arusha region, Tanzania as a case example. The acceptability and reliability of the use of Android mobile phones in the “one health” community- based surveillance system was assessed. The evaluation of the performance of the surveillance systems through visiting and retrieval of disease surveillance forms submitted from the village health facilities to the district medical office (DMO) and district veterinary office (DVO) in Ngorongoro was carried out. A total number of 14 wards of Ngorongoro district were visited and all livestock field officers (LFO) were interviewed. The study also collected data from 13 health facilities, representing approximately 62% of all health facilities in Ngorongoro district. It was further observed that there is poor surveillance in both human and animal health sectors as evidenced by less than 50% submission of reports to DMO/DVO. Major symptoms identified by the Community Health Reporters (CHRs) included Diarrhoea (66.7%), coughing (50%), sores in the mouth (44.4%) and headache (39%). In livestock, the major signs were coughing (61%), lameness and sores in the mouth (33%), and swollen of lymphnodes (31%). The acceptability of android phones was 57%, 77.8% and 75% for the communities, human health officials and LFOs, respectively. Infrastructure problems, lack of reliable transport and remoteness of livestock and human health facilities were mentioned as the major challenges in disease surveillance in the study area. It can be concluded that android mobile phones have the potential to improve surveillance systems under ‘one health’ approach.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
AU- IBAR	African Union Interafrican Bureau for Animal Resources
CAS	Community- based active surveillance
CAHW	Community Animal Health Workers
CBPP	Contagious Bovine Pleuropneumonia
CHRs	Community Health reporters
CSM	Cerebral spinal meningitis
DHST	District health supervisory team
DMO	District Medical Officer
DPS	District- based Passive Surveillance
DPT	Digital Pen Technology
DVO	District Veterinary Officer
EAC	East African Community
ECF	East Coast Fever
EIDs	Emerging and re- emerging Infectious Diseases
FAO	Food and Agricultural Organisation of the United Nations
FMD	Foot and Mouth Disease
GPS	Global Positioning Systems
IDSR	Infectious Disease Surveillance and Response
IDWE	Infectious Disease Week Ending
JTC	Joint Technical Committee
LFO	Livestock Field Officers

MBDS	Mekong Basin Disease Surveillance
MCF	Malignant Catarrhal Fever
MoHSW	Ministry of Health and Social Welfare
MUHAS	Muhimbili University of Health and Allied Sciences
MLFD	Ministry of Livestock Development and Fisheries
NCA	Ngorongoro Conservation Area
NIMR	National Institute for Medical Research
OH	One Health
PDAs	Personal Digital Assistants
PPR	Peste Des Petits Ruminants
PVP	Predictive Value Positive
RVF	Rift Valley fever
RMA	Rural Medical Aid
RMO	Regional Medical Officer
SACIDS	Southern Africa Centre for Infectious Diseases Surveillance
SADC	Southern African development Community
SUA	Sokoine University of Agriculture
TADs	Transboundary Animal Diseases
TAWIRI	Tanzania Wildlife Research Institute
VIC	Veterinary Investigation Centre

CHAPTER ONE

1.0 BACKGROUND INFORMATION

1.1 Introduction

Ngorongoro district is one of the five districts of Arusha region in the United Republic of Tanzania. The district is bordered to the north by Narok and Kajiado districts of Kenya, to the north east by Longido district, to the east by Monduli district, to the south by Karatu district, and to the west by Meatu district of the Shinyanga region (Figure 1). The district covers an area of 14,036 km² and is located between longitudes 34.5^{o} and 36^{o} E and latitudes 1.5^{o}S and 4^{o} S. The human population in the district according to the 2002 national census was 129,776 (Tanzania National Census, 2002).

Administratively, the district is divided into three divisions namely, Ngorongoro, Loliondo and Sale, and there are 21 wards and 55 villages. The district is also well known for its abundant diversity of wildlife, fossil remains dating back to the earliest period of human evolution and other natural, cultural and scenic values (Charnley, 2005; Lithgow, 2004). The famous Ngorongoro Conservation Area (NCA) occupies half of the southern part of the district which is approximately 60% of the district landmass and much of the remaining part of the district is designated as a Game Controlled Area.

The Maasai pastoral community constitutes 85% of the human population in the district and the remaining 15% comprises the Batemi (Sonjo) and Tatoga who are agropastoralists, and the Hadzabe, a small tribe of hunters and gatherers (Hanby,

2004). Livestock animals kept by the Maasai include cattle, donkeys, sheep and goats (Homewood *et al.,* 1997). In 2002, the livestock population in Ngorongoro district was estimated to be 431,965 cattle, 878,078 sheep and goats (Tanzania National Census, 2002).

The pastoral community has a wealth of indigenous knowledge that has been used for many decades in disease treatment and control, food storage and environmental protection (Briggs, 2005). Indigenous Knowledge (IK) refers to a distinctive body of knowledge and skills including practices and technologies that have been developed over many generations outside the formal educational system, and that enables communities in their specific environments to survive (Mascarenhas, 2004). A broader definition is that indigenous knowledge is the knowledge used by local people to make a living in a particular environment (Johnson, 1992). For instance, traditional communities use plant parts as local herbs in the treatment of diseases and for other purposes as a means of survival (Anand, 2005). Saray (2001) reported that in most African countries, traditional medicine is used by approximately 70-80 percent of local populations to deal with their basic health care needs. A study by Karimuribo *et al*., (2006) reported that the majority of sick animals are attended to by owners and community- based animal health workers before they referred to the field officers. This knowledge can be used to improve surveillance and especially in areas that are remote and difficult to reach.

Ngorongoro district has few human health as well as veterinary facilities, contributing to poor human and animal health services. During 2010, Ngorongoro

district had 20 human health facilities which included 12 dispensaries owned by the District Council, two hospitals owned by the Roman Catholic Church, one dispensary owned by Ngorongoro Conservation Area Authority (NCAA) and five dispensaries that are owned by private entities. There are also 15 Livestock Field Offices in the district (Karimuribo *et al.,* 2010). Because of the few human and animal health facilities, inadequate funds and remoteness of this area, Ngorongoro has a history of being an entry point for devastating infectious diseases of livestock, wildlife as well as humans.

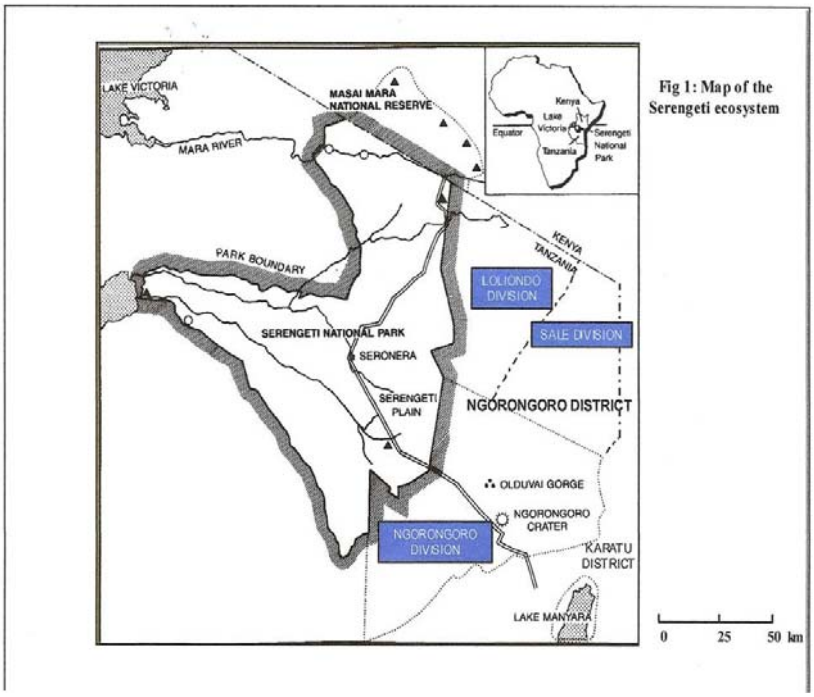

Figure 1.1: The Map of Ngorongoro District showing its Administrative Divisions
***Source*: Cleaveland *et.al.*, (2001)**

Ngorongoro district is well known for having a great diversity of wildlife, which interacts with livestock in the same ecosystem in search of pastures, water and salting (Lithgow, 2004).

Under this coexistence, adverse natural disasters such as prolonged drought and unexpected heavy rains also provide a favourable condition for spread of disease organisms including the endemic, emerging and re -emerging diseases such as foot and mouth Disease (FMD), malignant catarrhal fever (MCF), Contagious Bovine Pleuropneumonia (CBPP) and Rift Valley fever (RVF) [Field *et al*., 1997]. An emerging disease is a disease that had never been recognized before, while re-emerging diseases are those that have been around for decades or centuries, but have come back in a different form or a different location (Fineberg, 2010). Emerging infectious diseases in animals and humans are being identified more frequently, many of them in low income tropical countries (Robinowitz, 2008). Due to the fact that approximately 75% of these emerging diseases in humans originate from animals, there has been increasing interest in employing animal health surveillance for prediction of human health risks (Greger, 2007; Robinowitz, 2008; Taylor, 2001). Some of the infectious emerging and re-emerging diseases that have been reported in Ngorongoro district include CBPP in early 1990s, Rift Valley fever in 2006-2007 and peste des petits ruminants (PPR) in 2008 (Bölske *et al*.,1995; Breiman *et al*., 2007; Swai *et al*., 2009). The actual disease situation in wildlife is not well known and this poses a great risk for the circulation of disease pathogens in the ecosystem and also spread to other regions. This is because, by their nature, wild animals tend to camouflage and therefore, most of the diseased animals may be unnoticed or not reported.

Ngorongoro district is one of the areas in Tanzania with very few professional health personnel and the majority of workers are of the paraprofessional or auxiliary cadres

working in livestock field offices or medical Health facilities with no or limited equipment. This makes detection of disease at source, reporting and monitoring of disease outbreaks difficult or inaccurate. Because of the poor roads to reach the remote areas of the district one requires a four wheel drive vehicle, which must be in good working condition especially during the rainy reason. The distance covered before reaching a health facility can range from 50 km for a dispensary to about 100 km for a health centre. Due to the difficult conditions and high living costs in remote areas qualified staff in both private and government sectors are reluctant to work in such areas and most of them prefer to work in urban areas (Karimuribo *et al*., 2010). The recent development and access to second generation mobile devices which have the advantage of collecting data which can be verified by an expert at a distance, offer a new opportunity for disease surveillance and prevention (Despont *et al.,* 2005). The field workers (clinical officers and livestock field officers) can then be referred to information on the hand set memory in the local language on suitable biosecurity measures to adopt. The mobile phones now have accurate geospatial sensing, which enables accurate tracking of the location of the outbreak and linking to text, image and data (Forster and Snow, 1992).

The present study aimed at improving the disease surveillance at site of occurrence using mobile phones by reporting near to real time disease events. As opposed to the Digital Pen Technology (DPT) which is used by trained extension officers to report disease events, this study will assess the potential of using community- based health workers who live within the community. Currently, the people involved in detection and reporting of disease events occurring within communities based in remote areas

include livestock keepers, livestock extension agents, veterinarians, community-based health workers (CBHWs), tour drivers, park rangers or researchers/tourists who notice unusual things in wildlife or domestic animal populations.

The information on disease events is usually reported to the relevant government authorities such as representative of human health and/or veterinary departments. With training, members of the community can expand facility-based surveillance by detecting and reporting cases that may go undetected by the health facility/livestock field officers. A standard case definition was developed to guide the community members to detect and report the disease outbreak. Symptoms/signs of disease that are more specific for disease condition can assist community health workers to detect and report the outbreak to the relevant authority. The approach used in this study, intend to compliment the conventional human and animal health disease surveillance system by involving the community animal health workers as the first line of information source about disease events in humans and animals.

1.2 Justification

Due to poor infrastructure, lack of diagnostic equipment, inadequate professional staff and the vast area of the Ngorongoro district, the reporting of disease outbreaks and events in the district is usually delayed. Logistical difficulties of travel and communication, which are common in developing countries, constrain the conventional surveillance system that relies on epidemiologists visiting sites to discover and investigate cases, particularly in rural areas. This contributes to a delayed investigation, confirmation and response from institutions responsible for

offering human and animal health services. The delay contributes to losses and negative impacts of diseases on the health, welfare and livelihoods of people and animals inhabiting Ngorongoro district.

Delays in intervention, have previously contributed to development of epidemic status of some diseases and favoured wide spread of infectious diseases to other parts of Tanzania and neighbouring countries as was the case with CBPP (Kusiluka and Sudi, 2003), RVF and PPR (Swai *et al.*, 2009; Karimuribo *et al*., 2011). Other challenges include community members' lack of knowledge about the possible link between human and animal cases of disease, failure to access to health care facilities because of long distances, low number of the facilities and qualified staff as well as cultural beliefs that promote seeking the assistance of local healers before consulting a professional nurse or physician (Shayo, 2003). The quality of surveillance in developing countries can improve if a community-based approach is adopted. Such a system has been used successfully in Niger during smallpox eradication and guinea worm control campaigns (Ndiaye *et al*., 2003).

In order to address the challenges of delayed reporting and response to disease outbreaks in Ngorongoro, there was a need to develop and employ a system which should be able to capture as well as transmit information related to occurrence of disease events in remote areas of the district. This study aimed at assessing the use of mobile technologies to capture, store and transmit near to real time disease-related events occurring within remote communities in Ngorongoro district in supporting the reporting system. This will help to inform appropriate organs, that is, human and

animal health control authorities responsible for disease investigation and rapid response to contain diseases. Rapid response will reduce mortalities and loss of income and other negative impacts such as failure to perform production activities, low production of animals as a result of infectious diseases in human and animal (wild and domestic) populations.

1.3 Objectives

1.3.1 General Objective

The general objective of the present study was to enhance human and animal disease surveillance at the point of outbreak in Ngorongoro district, using mobile phone technology.

1.3.2 Specific Objectives

The specific objectives of the study were:

(i) To collect baseline information on the performance of the human and animal health surveillance and reporting systems in Ngorongoro district.

(ii) To identify, train and assess the performance of community-based health workers in the use of mobile phones for disease surveillance in human, wild and domestic animal populations.

(iii) To assess the criteria for and level of acceptance of application of mobile technologies within pastoral and agro-pastoral communities inhabiting the Ngorongoro district.

(iv) To develop and test application of android phones in the application of ‘One Health’ community-based disease surveillance system.

1.4 Research Questions

The study tried to answer the following questions:

(i) What is the performance of the current disease surveillance systems in human and animal health sectors?

(ii) How can the use of community health workers complement to the performance of the conventional surveillance systems

(iii) What are the causes of the poor performance of the conventional surveillance systems?

(iv) What determinants do community members use to access health services and to provide disease information to the conventional surveillance system?

(v) How can the human and animal surveillance systems be improved by using mobile phone technologies?

CHAPTER TWO

2.0 LITERATURE REVIEW

This section describes key concepts and principles of disease surveillance, 'one health concept', participatory epidemiology and mobile technologies used to improve surveillance in animal and human populations.

2.1 Disease Surveillance

Disease surveillance is commonly defined as an ongoing systematic collection, analysis and interpretation of data essential to the planning, implementation and evaluation of disease management practice, closely integrated with the timely dissemination of these data to those who need to know (Mboera, Rumisha & Kitua 2001; Thacker & Berkelman 1988). Effective disease surveillance is required to ensure freedom from emerging and re-emerging infectious diseases (EIDs) or timely intervention in order to reduce risks and impact on animal and human populations. Although the purpose and objectives of disease surveillance may differ between different health sectors, it is generally agreed that surveillance is useful for rapid detection of new and/or foreign diseases, provides evidence of freedom from diseases within a defined geographic area or population, accurately delineates the distribution and occurrence of diseases relevant to disease control and provides evidence required to assess progress and success of disease control or re- dedication (FAO, 2004).

2.2 Human Health Surveillance System in Tanzania

Up to 1998, the Ministry of Health of the United Republic of Tanzania used five separate surveillance systems to monitor infectious diseases. These systems were

Health Management Information System (HMIS); Infectious Disease Week Ending (IDWE); Tuberculosis (TB)/Leprosy; Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome (HIV/AIDS); and Acute Flaccid Paralysis (AFP)/ Poliomyelitis) (Nsubuga *et al.*, 1998).

In order to improve disease surveillance, the Ministry of Health and Social Welfare of Tanzania (MoHSW), adopted an Integrated Disease Surveillance and Response Strategy (IDSR) in 1998. The IDSR was developed by World Health Organization, Africa Regional Office (WHO-AFRO). The aim of this strategy was to assist health workers to detect and respond to diseases of epidemic and public health importance and those targeted for eradication and elimination (Rumisha *et al.,* 2007). Under this strategy each facility in- charge is supposed to submit a weekly epidemic prone disease report to the DMO and at the same time is obliged to submit a monthly report at the end of each month on those diseases that are of public health importance or those that are aimed for eradication. (see table 1). The IDSR focal person in the DMO's office reports to the Regional Medical officer and the Regional Medical Officer (RMO) reports to the Epidemiology and Disease control section of the Ministry of Health and Social welfare. International bodies such as East African Community and WHO get the surveillance report from this section.

However, performance of this strategy in most parts of the country has not been as effective as was expected (Mboera *et al.,* 2005). In the human health sector, the timely submissions of weekly and monthly reports have been reported to be only 8% and 24%, respectively (Rumisha *et al.,* 2007). The problem of poor timely reporting

is mainly attributed to the paper-based transmission of data coupled with the poor infrastructure and communication networks especially in rural areas.

Table 2.1: A List of Priority Disease under the IDSR in Tanzania (IDSR Technical Guide Version, 2001)

Category	Disease
Epidemic prone diseases	Cholera
	Bacillary dysentery
	Plague
	Measles
	Yellow fever
	Cerebro-spinal meningitis
	Rabies / animal bite
Disease targeted for Elimination/Eradication	Acute flaccid paralysis
	Neonatal tetanus
Diseases of Public Health Importance	Malaria
	Typhoid fever
	Diarrhoea in children under 5 years
	Pneumonia in children under 5 years

***Source*: IDSR technical guide, (2001)**

2.3 Animal Disease Surveillance System

According to World Organisation for Animal Health (OIE) *Terrestrial Animal Health code* (OIE, 2011) each country is required to have a fundamental animal disease data in order to engage in international livestock trade. To fulfill this requirement, the Ministry of Livestock and Fisheries Development designed livestock disease surveillance report forms and meat inspection forms that are supposed to be filled by Livestock Field Officers (LFOs) and submitted to the

District Veterinary Officer (DVO) any time the LFO encounters disease outbreak. In addition, at the end of each month the LFO is required to submit a written report to the DVO. In developing countries, it is difficult to achieve this to cover all the areas and therefore community Animal Health Workers are used to complement the surveillance system (Catley *at el.,* 2004). The DVO compiles the surveillance reports from field officers and submit to the zonal Veterinary Investigation Centres as well as to the Regional Veterinary office where the latter report to the Epidemiology unit of the Ministry of Livestock Development and Fisheries.

2.4 'One Health Concept'

"One Health" has been defined as "the collaborative effort of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals and the environment (Kahn *et al.,*2009). It is a global initiative to promote collaborative efforts between different natural and social science professionals.

The One Health concept is a worldwide strategy for expanding inter-disciplinary collaborations and communications in all aspects of health care for humans, animals and the environment. In recent years, reports have shown that infectious diseases account for over 40% of human disease burden in respect to morbidity and mortality especially in developing countries (Jones *et al*., 2011). Of these diseases, about 7% is attributed by zoonoses and nearly 13% are those claimed to have emerged from animals. It is also documented that 60% of emerging and re emerging pathogens are zoonotic and 72% of them originates from wildlife (Atlas, 2011). Contact of human to wildlife has increased tremendously due to factors like increase in human population, encroachment to wildlife corridors, climate change and other related

factors such as tourism. The need to integrate surveillance for human and animals is highly suggested to successfully control the emerging and re- emerging infectious diseases and more so in resource poor countries (Cleaveland *et al.*, 2001). The collaboration between the two professions gives rise to multidisciplinary approach rather than single approach in disease control.

2.5 Surveillance System Evaluation Guidelines

The purpose of surveillance evaluation guidelines is to promote the best use of public health resources through the development of effective and efficient surveillance systems. The attributes measured includes: Simplicity, Flexibility, Acceptability, Sensitivity, Predictive value positive, Representative and Timeliness (Douglas *et al.*, 1998).

2.5.1 Simplicity

The simplicity of a surveillance system refers to both its structure and ease of operation. Surveillance systems should be as simple as possible while still meeting their objectives. The flow of information and the lines of response in a surveillance system can help assess the simplicity or complexity of a surveillance system. An example of a system that is simple in design is one whose case definition is easy to apply and in which the person identifying the case will also be the one analyzing and using the information.

2.5.2 Flexibility

A flexible surveillance system can adapt to changing information needs or operating conditions with little additional cost in time, personnel, or allocated funds. Flexible

systems can accommodate, for example, new diseases and health conditions, changes in case definitions, and variations in reporting sources.

2.5.3 Acceptability

Acceptability reflects the willingness of individuals and organizations to participate in the surveillance system. In terms of evaluating a surveillance system, acceptability refers to the willingness to use the system by: persons outside the sponsoring agency, such as those who are asked to do something for the system and persons in the sponsoring agency that operates the system. To assess acceptability, one must consider the points of interaction between the system and its participants, including persons with the condition and those reporting cases.

2.5.4 Sensitivity

The sensitivity of a surveillance system can be considered on two levels. First, at the level of case reporting, the proportion of cases of a disease or health condition detected by the surveillance system can be evaluated. Second, the system can be evaluated for its ability to detect epidemics. A surveillance system that does not have high sensitivity can still be useful in monitoring trends, as long as the sensitivity remains reasonably constant.

2.5.5 Predictive Value Positive

Predictive value positive (PVP) is the proportion of persons identified as having cases who actually do have the condition under surveillance. In assessing PVP, primary emphasis is placed on the confirmation of cases reported through the

surveillance system. At the level of an individual case, PVP affects the amount of resources used for case investigations. A surveillance system with low PVP and therefore frequent "false-positive" case reports--would lead to wasted resources.

2.5.6 Representativeness

A surveillance system that is representative accurately describes the occurrence of a health event over time and its distribution in the population by place and person. Representativeness is assessed by comparing the characteristics of reported events to all such actual events. Although the latter information is generally not known, some judgment of the representativeness of surveillance data is possible, based on knowledge of population characteristics.

2.5.6 Timeliness

Timeliness reflects the speed or delay between steps in a surveillance system. The time interval linking any two of the steps in this figure can be examined. The interval usually considered first is the amount of time between the onset of an adverse health event and the report of the event to the public health agency responsible for instituting control and prevention measures. Another aspect of timeliness is the time required for the identification of trends, outbreaks, or the effect of control measures.

2.6 Application of Mobile Technologies in Disease Surveillance

The use of mobile technologies in disease alerts and surveillance is not a new concept in Africa. In early 2000s, the FAO piloted the use of Digital Pen Technology (DPT) in southern African countries including Malawi, Mozambique, Namibia,

Tanzania and Zambia (FAO, 2011). The beneficiaries were the Epidemiology Units of Departments of Veterinary Services of participating countries and surveillance personnel in the field.

The main objective of the project was to contribute to the SADC Transboundary Animal Diseases (TADs) project's goal of improved food security and wealth creation (FAO, 2011). The DPT has an integrated digital camera, an advanced image microprocessor and a mobile communications device for wireless connection.
The digital pen captures, stores and then securely sends the handwritten report using special paper. When writing, the digital snapshots of the pattern on the paper are automatically taken. Every snapshot contains enough data to determine the exact position of the pen and what it writes or draws, including the time each pen stroke was made as well as which particular paper form was written on. All this data is then retained in the pen's memory as a series of coordinates (Schreiner, 2008).

Other mobile facilities such as Personal Digital Assistants (PDAs) and other mobile phones have been used in disease surveillance in humans, domestic animal and plant populations in different countries (Shirima *et al.,* 2007). PDAs are used to store information that can be accessed at anytime and anywhere. PDAs in Africa are also used in car kits and are fitted with differential Global Positioning System (GPS) receivers to provide real-time automobile navigation, checking market prices of crops and transferring money. Africa has the world's highest mobile phone growth rate and as such, this technology has great potential for supporting human development (Winters and Toyama, 2009). A study on social impact of mobile

phones in Tanzania showed that mobile phones are used to maintain social networks and provide access to information on socio-economic opportunities (Goodman, 2005).

Such applications of mobile technologies offer opportunities for improved detection and reporting of disease events in remote areas of Africa which have many problems including poor transport and communication facilities and lack of enough resources required for offering medical and animal health services. The PDA is best suited in situations where the user is fairly technical and is able to navigate complex menus and record data in small fields on a small screen. The digital pen is more suited to situations where a large amount of data is being sent back to the office such as surveys data.

As a field service solution, the digital pen is ideal in that, completing a larger detailed form is straightforward because it is simply written on paper with a pen, but complicated and extremely time consuming using a PDA. However, the advantage of the PDA is that it can store information in it like a personal computer and can also be used as a phone and for e-mail communications. This also means that battery life become critical because the use of the screen for searching information and recording information combined with the use of the radio for data transmission and phone calls consumes a lot of power such that the PDA will require recharging during the work day. The main advantage that digital pen and paper technology has over the PDA, is the redundancy factor. If the user loses or breaks the PDA or is unable to connect to the internet due to technology failures, the work stops and data is lost. However, if the same events occur with a digital pen user, no such loss happens because data is

recorded on paper, and in the worst case scenario, the user sends the data in the paper form. Therefore, there is a 100% failsafe system of data collection with the digital pen (Geo-informatics, 2007).

The recent introduction of android phones that utilizes open source android operating system and mobile phone software, EpiCollect, is suitable to be used by epidemiologists, ecologists and for community data collections (Aanensen, 2009). Data collected by multiple field workers can be submitted by phone, together with GPS data, to a common web database and can be displayed and analysed, along with previously collected data, using Google Maps (or Google Earth). Similarly, data from the web database can be requested and displayed on the mobile phone, again using Google Maps.

2.7 One Health Project Description

The One Health (OH) surveillance strategy was developed as a result of a participatory and consultative process designed in collaboration between SACIDS with other institutions within the country like Ministry of Health and Social Welfare (Epidemiology unit), Ministry of Livestock and Fisheries Development (Epidemiology section), Muhimbili University of Health and Allied Sciences (MUHAS), Sokoine University of Agriculture (SUA) and National Medical Research Institute (NMRI) and outside the country such as in the United Kingdom (Royal Veterinary College and Imperial College London) while those in South-East Asia (BIOPHICS, Ministry of Public Health Thailand, MBDS and InsTEDD, Cambodia) assisted in the improvement of the OH surveillance system developed by SACIDS.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Study Area

The present study was carried out in Ngorongoro district of Arusha region Tanzania. The district headquarters is Loliondo town, which is located in the north-eastern part of Ngorongoro district and is about 400 km from Arusha where the nearest Veterinary Investigation Centre (VIC) is based. The area occupied by Ngorongoro district is 14,036 km^2. The livelihoods of the majority of residents in the district depend on livestock keeping. Ngorongoro district is made of three divisions namely Ngorongoro, Sale and Loliondo. The residents of the district are either staying within the Ngorongoro Conservation Area (NCA) in Ngorongoro division or outside the NCA in Sale and Loliondo divisions. Humans and livestock in the district co-exist with wildlife in the protected areas.

Over 80% of total area of the Ngorongoro district is under the jurisdiction of wildlife protected area. The co-existence of wildlife, livestock and humans pose a great risk for transmission of infectious diseases between the species and hence, the area is suitable for the 'One Health' research approach on emerging and re-emerging infectious diseases such as Rift Valley fever, highly pathogenic avian influenza and ebola.

3.2 Selection of Study Sites

The study sites were purposively selected based on the information obtained during discussions with key informants who included members of the pastoral and agro-

pastoral community, livestock extension officers and human health personnel within the district. The selection criteria for the study sites were: (i) livestock abundance, (ii) human settlement, (iii) land use zone, (iv) wildlife abundance and (v) accessibility by road. Thirteen (13) villages were selected based on the above criteria, namely Arash, Endulen, Esere, Kakesio, Malambo, Nainokanoka, Naiyobi, Ngaresero, Olbalbal, Oldonyosambu, Oloirobi, Samunge and Soitsambu. All these villages possessed animal and human health facilities except Naiyobi which lacked a human health facility.

3.3 Research Design and Data Collection

The research was executed in inter-dependent phases adopting qualitative methodologies of data collection. Initially, the research proposal was submitted to the Tanzania Wildlife Research Institute (TAWIRI) for clearance on wildlife research issues and permission letter was granted with reference number TWRI/TST/65/Vol.VI/85/27. Ethical clearance was sought and provided from the National Institute for Medical Research (NIMR) for collection of human health data (Ref. no NIMR/HQ/R.8a/Vol. IX/885). In order to make the process participatory, the project objectives were introduced to key stakeholders including the Ngorongoro Pastoral Council, National Institute for Medical Research, Ngorongoro District Council, Epidemiology Units of Ministry of Health and Social Welfare as well as the Ministry of Livestock and Fisheries Development.

3.3.1 Collection of Baseline Data

Baseline data on the performance of the human- and animal health disease surveillance and reporting systems in the district were collected. Data collected

included the number of surveillance forms submitted per week (IDWE system of human health) and per month (IDSR monthly in human) by health facilities to the DMO. In the animal health sector, the number of livestock disease surveillance forms submitted to the DVO as well as monthly reports were recorded. Six years data were collected from both sectors that are from 2005 to 2010. Also data on the proportion of sick humans and animals reported every month, the proportion of human and animal health facilities reporting diseases, time taken to transmit disease report to the DMO and DVO or the Regional Medical Officer and Veterinary Investigation Centre, and finally, to the central data processing units at the Ministry of Health and Social Welfare and Ministry of Livestock and Fisheries Development, respectively were collected. Information on the availability and frequency of feedback from district authorities to village health facilities was also collected.

The livestock surveillance forms captured the following information: The location (ward and village), symptoms or deaths, and whether it was humans or animals affected or both humans and animals. How many were affected, whether they were domestic animals or wild animals. For domestic animals, information on the affected species (cattle, sheep, goats, dogs, cats, donkeys etc) was recorded. For those who died and it was possible to carry out postmortem examination, the pictures of the various lesions were taken to assist in the diagnosis. The dates and time of the observations were recorded and the names and designation of the reporting officers in the selected villages of Ngorongoro. Names of the livestock owners in the selected sample and herd sizes were recorded and total number of livestock amounted to 3,446. The status of the disease occurrences were continuing and/or ending, the names

of the owners of the affected animals were recorded as well. Livestock species that were of interest to the researcher was cattle, goats, sheep, chickens, dogs and cats. Wild animals that were of interest included wildebeest, buffaloes, gazelles, eland and giraffe.

The distance from the District Medical Office/District Veterinary Offices to each human health facilities and livestock field offices were assessed by the use of vehicle odometer.

Community members were interviewed to assess the readiness of using health services in their localities. Also baseline data on the prevailing health problems in both livestock and human were collected. Community attitudes on action taken to sick and dead wild animals were also collected as this has impact on both human and animal health. The community members interviewed was purposively selected from their household due to nature of movement of pastoralist where both women and men were interviewed. This study also assessed the distance covered by the community members to reach a human and animal health services at health facilities and livestock field office, respectively. This is because it was considered that this may have influence on the readiness to use the services provided by these offices. The time taken for the field medical and animal health staff respond to a reported event of sickness in humans or animals were also assessed.

3.3.2 Identification and Training of Community-Based Health Workers

Key informants such as Village chairpersons, local leaders in the Maasai community (Laigwanani), Livestock Field Officers (LFOs), Extension officers in villages with

no LFO or in-charge of heath facilities were consulted to identify community-based health workers who provide service related to human and animal health. The informants were also asked to mention key attributes used to select or define a Community-Based Health Worker's based on either previous experience or suggestions from members of the community.

After identifying the Community-Based Health Workers, a list of the individuals to be engaged in detecting and reporting disease events occurring in livestock, wildlife and human health sectors was established. The list of Community-Based Health Workers was used as a sampling frame to select those who were trained on how to use android phones for reporting disease events. Community health workers were categorized into two, those who were dealt with livestock delivery services known as Community animal health workers (CAHW) and the other category were dealt with human health delivery services in terms of mobilizing communities in Immunisation campaigns and provision of first aid services and are called Community based health workers or Community owned resource persons.

In order to conform to the existing government hierarchy in disease surveillance in the human and animal health sectors, responsible authorities were consulted for their opinion about the feasibilities of using community-based workers in disease surveillance and reporting under the 'One Health' concept. A sample of nineteen community members were consulted in villages within the study area to get their views on common health problems in both animal and human sectors, distance to from their home to Livestock field office and human health facilities, action taken

when human or animal (livestock or wildlife) get sick and how fast service delivery officials (Animal and human health sector) respond to reported cases.

3.3.3 Development and Testing of Application of Android Phones in Disease Surveillance

A system for utilizing android mobile phones in capturing disease events in remote areas of pastoral and agro-pastoral communities within the Ngorongoro district was developed and evaluated. This involved designing a disease surveillance form in a participatory manner, by involving professionals working with local communities. The form was designed using simple language that was easily understood by the local communities and data processors. The questions were written in English and translated into Swahili which is Tanzania's national language.

The form was approved by the Joint technical team and then uploaded on the android phones. The form was used for collection of disease information occurring in human and animal populations using clearly observable signs/symptoms that are highly suggestive of particular disease conditions and proxy indicators of disease conditions e.g. school abseentism due to hunger and attendance improved after provision of food.

As community health reporters were expected to have limited knowledge on diseases, disease signs and symptoms included in the questionnaires were as much as possible those which best describe the specific diseases e.g. diarrhoea, coughing, fever (defined by raised body temperature), haemorrhages, abortions etc, rather than specific disease conditions. Syndromic surveillance offer a useful adjunct to

diagnosis based surveillance of emerging infectious diseases in developing countries, where laboratory confirmation is not routinely used (Hennings, 2004).

Syndromes associated with diseases of public health importance such as influenza-like illness caused by multiple epidemic prone to tropical infections, could indicate outbreak requiring laboratory based investigation and control (Chretien, 2008). Where applicable, previous epidemics of infectious diseases were used to define signs and symptoms to be reported in the community e.g. Rift Valley fever, PPR, anthrax, FMD, brucellosis, etc.

After development of the forms, a 5-day training workshop for community-based health reporters and officials was organized at Karatu town from 25/11/2011to 30/11/2012. The trained officials were from 10 livestock field offices based at ward level and 10 medical staff from ten different health facilities. The health facilities that were involved included Endulen hospital, NCAA, Olbalbal, Sale, Samunge, Nainokanoka, Kakesio, Soitsambu and Arash as well as Malambo Health centre.

Most of medical staff were Clinical officers (6/10) and some of them were Nurses (3/10) and one rural medical attendants (RMA). The selection of medical staff was determined by their involvement in compiling and sending the IDSR weekly and monthly reports to the DMO. From 01/12/2012 to 06/12/2012 the training was conducted for the community health reporters. These were people earmarked for disease surveillance and reporting. The first three days of training focused on the basics of applications of android mobile phones in disease surveillance as well as simplified coverage of infectious disease occurrence and dynamics in populations.

This was followed by a 2-day fieldwork for pre-testing of the developed disease surveillance form uploaded on the android phones. The trainees were then provided with phones to start working in their respective communities. For the purpose of this Thesis, the term medical staff refers to personnel working in the human health facilities and Community health reporters (CHRs) refers to both categories of community health workers that provide services to the human and animal health sectors.

The community-based surveillance activities were linked to the official human and animal health disease surveillance and response systems. The primary (livestock field officers and clinical officers) and secondary responders (DVOs and DMOs) were provided with the phones and laptops, and then notified every time disease information is transmitted from the community for them to take appropriate action.

The disease data captured using android phones was transmitted to a central server at Southern African Centre for Infectious Diseases Surveillance (SACIDS) based at Sokoine University of Agriculture (SUA). Through a Joint Technical Committee meeting, SACIDS had been given a responsibility to receive and store surveillance data collected in this study on behalf of the Ministry of Health and Social Welfare as well as the Ministry of Livestock and Fisheries Development.

3.3.4 Assessment of the Acceptability, Reliability and the Impact of Application of Android Mobile Phones

At the end of the study, assessment of the acceptability, reliability and impact of android phones in enhancing the surveillance of human and animal diseases in the

study areas was undertaken. This involved focus group discussion and interview of individual community-based health workers and officials that were involved in the recording and transmission of disease events data. Community health reporters were asked to provide information on the perception of the surrounding community on the use of mobile phones to transmit disease information to the district authorities responsible for disease control. Support from the surrounding communities on provision of disease information to the CHRs any time they encounter a sick animal was supposed to increase in the number of reported cases and hence improved surveillance. Previous researchers reported poor IDSR weekly and monthly reports submission when the IDSR focal person is on leave or travel out of station (Rumisha *et al.*, 2007).

To address this problem the study aimed to know how staff at health facilities apart from the in-charge who was provided with a mobile phone perceived the idea of using mobile phones in disease surveillance. This study required to know the perception of working colleagues in health facilities as well as in livestock field office so that can provide information even if the IDSR focal person is not present. Due to limited number of mobile phone at the beginning of the study, some of human health facilities and LFOs were sharing phones with CHRs and therefore the time of active use of the phones may differ from one report to the other. This ranged from 2 to 7 months. A comparison of the number of disease event reports submitted from the village health facilities to the district authorities before and after the introduction of the use of android phones in disease surveillance was also made. The proportion of cases reported each month, the health facilities reporting cases and time taken for

transmission of disease event data from the village health facilities to district offices before and after the introduction of the android phone in disease surveillance. Opinions of the DMO and DVO on the reliability and impact of application of android phones in disease surveillance in the study area were also documented.

3.4 Designing 'One Health' Surveillance Strategy

An inception workshop for key stakeholders interested in OH surveillance was held during which selection of study sites as well as identification of appropriate mobile technologies and tools to assist surveillance were deliberated. The subsequent meetings of the National Centre for Infectious Disease Surveillance (NatCIDS) and the Joint Technical Committee (JTC) in August and September 2010 respectively, defined the OH surveillance strategy to be adopted in Ngorongoro. The meetings agreed that the strategy should consist of two complementing systems namely:

1. Community-based Active Surveillance (CAS) system which was designed to actively capture disease events in animal and human populations using simple case definitions of symptoms and syndromes occurring in communities. It was also agreed the CAS system would use community-based health reporters who would actively screen for the occurrence of disease events in human, wildlife and domestic animal populations. Data on these events would be recorded and transmitted through Android mobile phones using the Epicollect data capture application in near to real time.
2. District-based Passive Surveillance (DPS) system uses existing surveillance strategies in animal and human (IDSR) health sectors with enhanced performance through application of mobile technologies in transmission of near to real time data in the two health sectors.

Collaborating with other institutions in the United Kingdom (Royal Veterinary College and Imperial College London) as well as those in South-East Asia (BIOPHICS, Ministry of Public Health Thailand, MBDS and InsTEDD, Cambodia) assisted in the improvement of the OH surveillance system developed by SACIDS. The two systems (CAS and DPS) are linked together at the data analysis point. Data collected through CAS and DPS systems from pilot sites located in Tanzania are stored centrally on a server located at SACIDS headquarters. SACIDS acts as a custodian and stores data on behalf of the Ministry of Livestock and Fisheries Development and the Ministry of Health and Social Welfare who own the data. At SACIDS, data are analysed and summarised as reports that are shared with the two ministries and field-based disease management units at district headquarters. A similar model is proposed for dealing with handling data collected in the Zambezi River basin when data storage and analysis is expected to be undertaken by the University of Zambia Veterinary School (UNZA Vet) on behalf of respective ministries responsible for animal and human health.

Similarities in the current disease surveillance structure in animal and human health sectors provide opportunities for collaboration between the two sectors. For instance, under the current IDSR strategy, emphasis on disease management is placed in hands of district health facility levels (Franco, Setzer & Banke, 2006). Similarly, the MLFD demands the DVO to be in-charge of managing disease epidemics in animal populations. Because both the DMO and DVO work under the umbrella of the District Executive Officer, it is logical to work together in the management of disease epidemics in animal and human populations in their respective districts. This has been

happened in some instances during Rift Valley fever and anthrax outbreaks in Ngorongoro district between 2006 and 2009 (B.M. Miran, personal communication, 2010). It was also found that sometimes animal and human health officials in Ngorongoro district do share vaccine storage facilities during surge demand of resources. This usually happens during disease vaccination campaigns when teams of vaccinators camping in remote areas require storage facilities for proper handling of vaccines. This experience is not new to resource-challenged remote areas as reported in other countries where sharing resources such as transport logistics and equipment reduces costs (Schelling *et al.,* 2007). The current OH strategy designed by SACIDS where one person (community-based health reporter) actively searches for occurrence of disease events in human and animals is another good example of optimizing the use of limited resources.

3.5 Data Analysis

Different statistical procedures were used to analyse the data collected in the project and analysis was done using Epi Info statistical software version 7. Qualitative data were subjected to content analysis and presented as descriptive statistics. The critical probability of 95% was used to determine the level of significance.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Performance of Surveillance System in the Animal and Human Health Sector in Tanzania

4.1.1 Disease Surveillance Structure and Reporting

The surveillance structure between the animal and human health sectors in Tanzania was found to be similar (Table 4.1). The initial detection of disease events in both health sectors starts in the communities where sick individuals are located. The current official systems use cadres who are the LFOs (in animal health sector) and the health facility-based IDSR focal person (in human health sectors). These officials compile and transmit disease surveillance reports to the higher levels. The central coordinating level for disease surveillance and response in the district is at the DVO and DMO. The two offices are responsible for transmitting reports to higher authorities through the intermediate (zonal VICs and RMO) or sometimes directly to the central level in the ministry responsible for animal health and human health, respectively. The similarities in surveillance structures of the two health sectors offer opportunities for increased collaborations between veterinary and medical professionals with regards to disease surveillance and response.

With respect to frequency of reporting, the animal health sector demands submission of disease reports on a monthly basis using field and abattoir surveillance forms. In the case of notifiable diseases, the officials are required to report disease events immediately.

Under the IDSR system, officials are required to report diseases under surveillance on weekly (epidemic-prone conditions) and monthly (epidemic-prone, diseases of public health importance and those targeted for eradication) basis.

Table 4.1: Similarities between Disease Surveillance Structure in Animal and Human Health Sectors in Tanzania

Level	Sector	
	Animal health	**Human health**
Peripheral (Community)	Farmers and community-based animal health workers	Community based health workers or community-owned resource persons
Peripheral (Village and wards)	Livestock Field Officers and Ward Agriculture Extension Officers	In-charge or focal points for IDSR at health facilities (dispensaries, health centres or hospitals)
Intermediate (District)	District Veterinary Officers or District Agriculture and Livestock Development Officers	District Medical Officers
Intermediate (Region or zone)	Zonal Veterinary Investigation Centres	Regional Medical Officers
Central (Ministry)	National Epidemiology Section, Ministry of Livestock Development and Fisheries	Epidemiology and Disease Control Section, Ministry of Health and Social Welfare
Regional or international	Regional or international bodies (e.g. AU/IBAR, SADC, EAC, OIE)	Regional or international bodies (e.g. EAC, WHO)

***Source*:** Karimuribo *et. al.* (2010)

4.1.2 Surveillance Data for Years 2005 – 2010

The number of reports submitted to the DMO by the health facilities in selected villages in Ngorongoro district for the six years (2005- 2010) is indicated in Table 3. A total of 90 weekly reports were during the period submitted which is only 2.4% of the expected number of reports. The number of IDSR monthly reports submitted was

73 (7.8%) out of 936 expected by the District Medical Officer. In the animal health sector as shown in Figure 2, the LFOs were expected to submit 1008 reports during the six years of analysis, but it was found that only 113 (11.2%) had been submitted to the District Veterinary Officer. Generally these results show that there is a weakness in reporting system in both human and animal sectors.

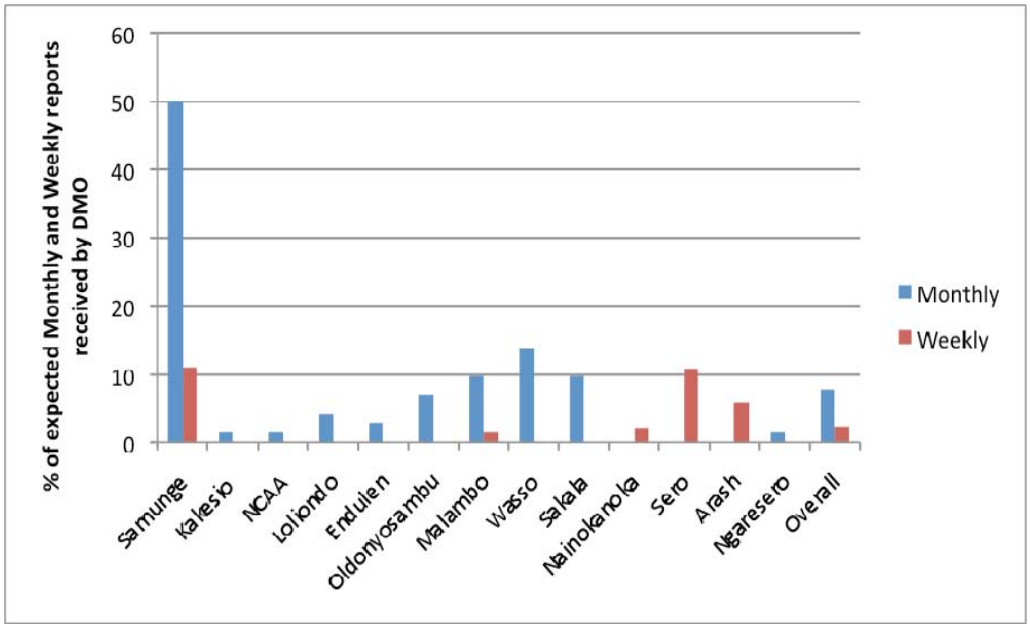

Figure 4.1: Expected and Actual Submission of Weekly and Monthly IDSR Reports from 13 Health Facilities in Ngorongoro District Between 2005 and 2010

The efficiency of reporting facilitates the control and provision of related services for improvement of humans' health. Between 2005 and 2008, the numbers of reports submitted were few reflecting poorly established disease reporting system in these remote areas. The trends, however, started to increase from 2008 to 2010 as shown in Figure 4.2. The findings above reflect inefficient surveillance systems in the

Ngorongoro district. These findings are in agreement with reports of poor surveillance performance elsewhere in the country (Mboera *et al.,* 2001).

Similarly Rumisha *et al.* (2007) reported that weekly and monthly IDSR reports submitted in the human sector was only 8% and 24% respectively. This problem mentioned to be attributed by transport problems in rural areas which lead to delay of report submission to the DMO or DVO. Facilities that are close to the district headquarters seem to submit their reports more regularly as compared with facilities that are more distantly located. There is also employees performance on submitted reports because the trends show that some facilities submit reports more frequently than others. The other factor attributed to poor performance of reporting is missing of key person responsible for receiving or send the reports. This was evidenced by looking on livestock data for 2008 and 2009 where there was no a single report submitted due to lack of a DVO. This situation was reversed in 2010 when the DVO was recruited. The poor performance of reporting due absence of reporting officers has also been reported by others (Rumisha *et al.,* 2007).

The observations show that of the 13 health facility that were visited in Ngorongoro district, Samunge dispensary was the most active with a total of 32 weekly reports followed by Wasso (10), Sakala (7) and Malambo (7). The reason for improvement of reporting trend in 2008 - 2010 is considered to be the appointment of a new District Medical Officer. During the period under study there was no DMO for one complete year. The DMOs who were posted to the district left due to remoteness of the district and moved to urban centres.

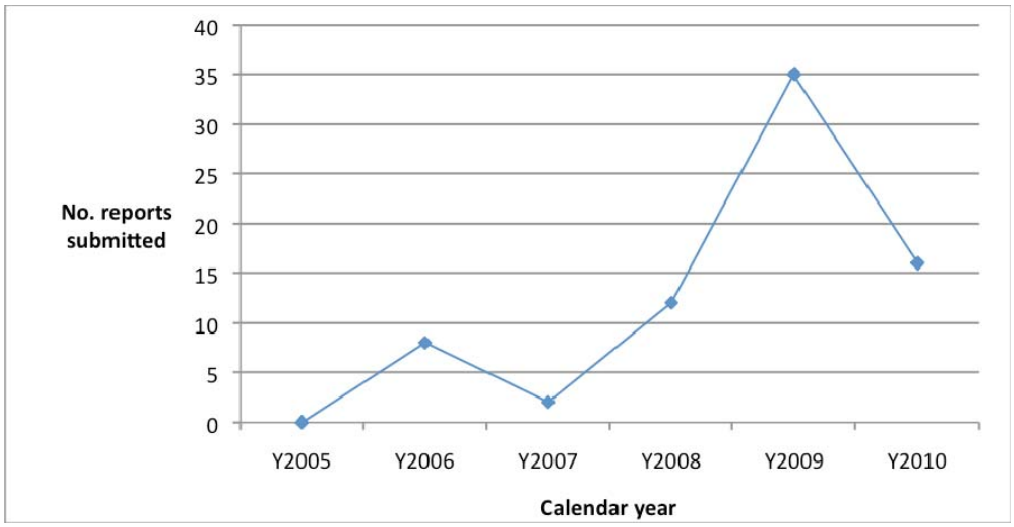

Figure 4.2: Trend of Monthly IDSR Reports Submitted Between 2005 and 2010

Figure 4.3 shows the proportion of veterinary field officers submitted reports to the District Veterinary Officer for the years 2005- 2010.

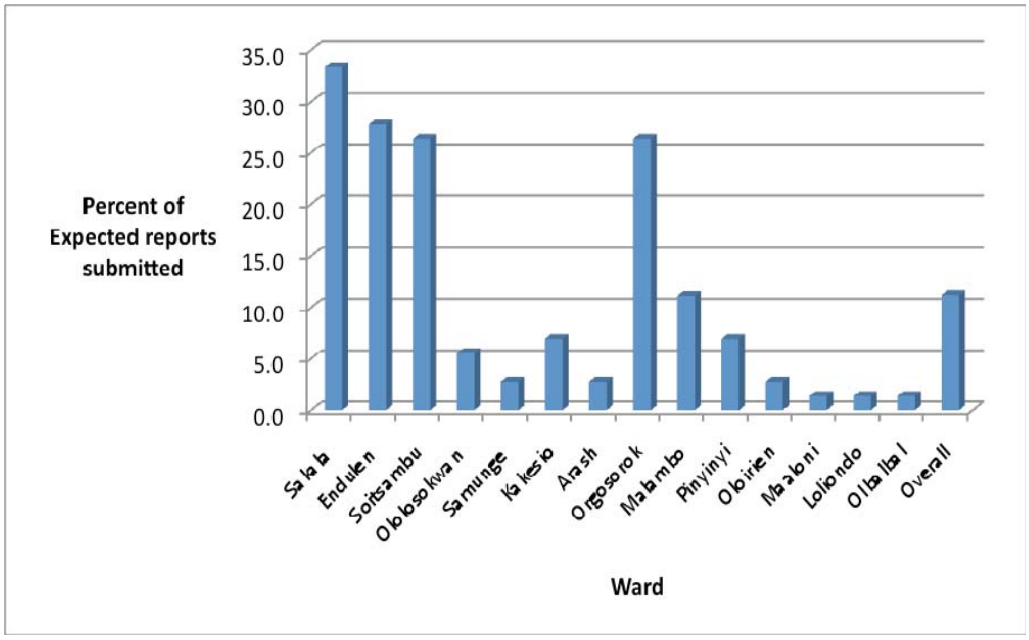

Figure 4.3: Reports of Animal Disease Surveillance Submitted to the District Veterinary Officer by Livestock Field Offices between 2005 and 2010

Sakala, Endulen, Soitsambu and Orgosorok offices seem to have performed better in terms of veterinary report submission (above 25%). These offices are closer to Loliondo which is the district headquarters. In addition to closeness, the veterinary staff in these stations mentioned to have regular visits to Loliondo for official and personal activities. This might have improved submission as compared to other livestock field offices that are closer to the DVO office such as Loliondo field office which submitted below five percent. The second category of stations that submitted between 5-10 reports included Ololosokwan, Malambo, Kakesio and Pinyinyi. The rest of veterinary offices submitted below five percent and most of them are those that are far from the district headquarters and with transport and road problem.

4.1.3 Distance from Health Facilities to the District Headquarters

The distance in kilometers from different facilities and means these facilities submit their report to the DVO is as indicated in Table 4.2. The effect of the distance from animal field offices and human health facilities to the district headquarters have been mentioned to have contributed to the poor submission of reports to the higher authorities.

The average distance was 83.3±70.5 and the closest facility for both human and animal health was 1.5 kilometres and the most remote was 237 kilometres. The interviewed staff mentioned distance and transportation problem as big challenges to submit reports to DMO/DVO on time. The recorded distances reflect that, as revealed by the human health and livestock field personnel, there is need for reliable transport to serve the different stations especially when disease incidences/outbreaks that require urgent reporting and quick responses occur.

Table 4.2: Means of Sending Reports to the DMO and Distance from Health Facilities to the District Headquarters

Name of facility	Category	Owner	Location, ward	Means of sending reports	Distance to the District Headquarters, km
Arash	Dispensary	Faith-based Organisation	Arash	1, 3, 6	52
Endulen	Hospital	Faith-based Organisation	Endulen	1, 2	166
Kakesio	Dispensary	District Council	Kakesio	2, 3	237
Loliondo	Health centre	District Council	Orgosorok	4	5
Malambo	Health centre	District Council	Malambo	1, 3, 2	92
Nainokanoka	Dispensary	District Council	Nainokanoka	2,	226
NCAA	Dispensary	Parastatal Organisation	Ngorongoro	1, 2, 3	178
Ngarasero	Dispensary	District Council	Pinyinyi	2, 3	122
Oldonyosambu	Dispensary	District Council	Oldonyosambu	1, 2 3, 5	93
Sakala	Dispensary	District Council	Sakala	3,4	3
Samunge	Dispensary	District Council	Digodigo	1, 3	65
Sero	Dispensary	District Council	Soitsambu	1, 2, 3, 5	43
Wasso DDH	Hospital	Faith-based Organisation	Orgosorok	4	1.5

***Source*: Own field data**

Key: 1. Public transport 2. Supervisory team, 3. Take physically 4. Walking 5. Radio call 6. Phones

The data on the available facilities both for human and animal (livestock and wildlife) treatment and disease control have been employed in the detection and reporting of disease cases to the relevant authorities for immediate responses in controlling the spread of infections. The distance from the district headquarters to facilities had impact on disease reporting because the trend indicated that facilities and livestock offices that were closer to the headquarters were better in submitting their reports as compared to those that were far away.

Another parameter assessed was the means by which reports were submitted from health facilities to the DMO or DVO. Results showed that there were several means of sending reports from health facilities to the DMO and DVO and they differed from one facility to another depending on the distance to the district headquarters (Table 4.3). Facilities that are based in Loliondo which is the district headquarters submitted their reports physically by just walking into the office of DMO/DVO. The in-charge of health facilities 8 (61.5%) mentioned the use of public transport to send their report. Most of them 3 (23.3%) also used this opportunity to go to the market which was scheduled every second day of the month. The rest of facilities especially that in Ngorongoro division 8 (61.5%) depended on the District Health Supervisory Team (DHST) to collect the reports or asked someone who was traveling to the district headquarters to submit the report. Time spent for the report to reach the DMO/DVO ranged from one day to 30 days depending on the distance and availability of transport. In addition, health facilities used mobile phones to send weekly disease information or use the radio calls 3 (23.3%). Unfortunately these data were not verifiable as the received information from radio call/phones were not recorded in a register.

Endulen and Wasso hospital served the largest population Figure 4.4. This is because these are hospitals and therefore health services are better as compared with health centres and dispensaries. The other facility with high population served is Nainokanoka. Despite being a dispensary, this facility receives patients from three wards named Nainokanoka, Alailelai and Naiyobi. There is no other health facility in these three wards. Malambo and Loliondo are health centres and the rest are dispensaries.

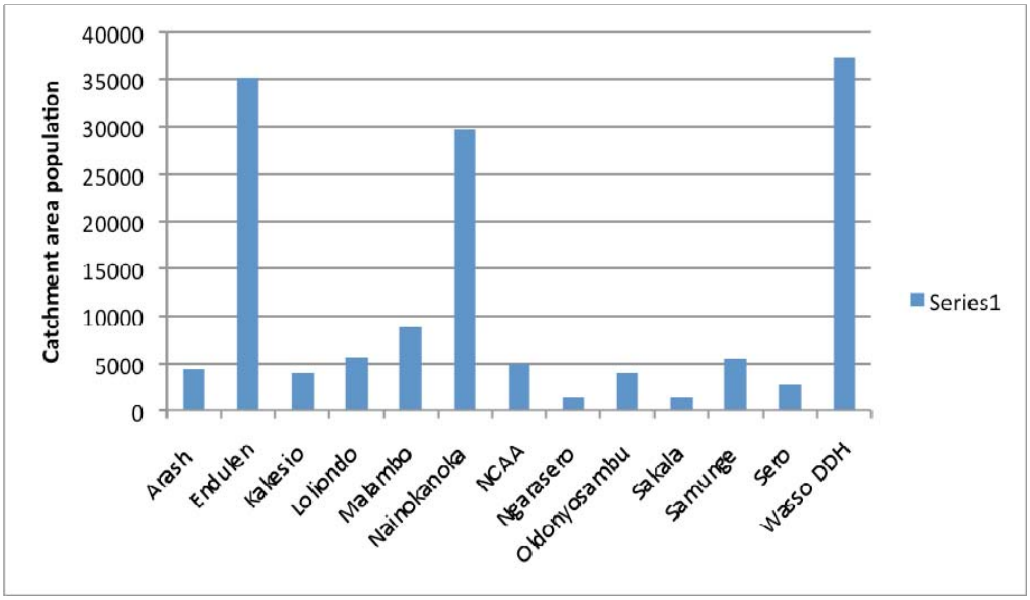

Figure 4.4: The Human Population in Ngorongoro District Served by the 13 Health Facilities Visited

Table 4.3: Means of Sending Reports by Health Facilities to the DMO

Means of sending reports	Number	Percent	95% Confidence limit
Phone	1	7.9	0.19- 36.03
Public transport	8	61.5	31.58- 86.14
Radio call	2	15.4	1.92- 45.45
Supervisory team	8	61.5	31.58- 86.14
Walking	1	7.7	0.19- 36.03

***Source*: Own field data**

4.1.4 Provision of Feedback by District Authorities

The study also inquired whether feedback was provided from the district authorities to the lower level facilities that submitted disease surveillance reports for both the

human and livestock health sectors. Forty six percent of the respondents in human health facilities reported that feedback was provided during meetings that were held after every three months or when the supervisory team visited their facilities while 31% responded that the feedback was provided but not always (Table 5). Twenty three percent of respondents stated that they did not receive any feedback for the report they submitted to the district authorities. For the livestock field officers, 78% of the responded that they did not receive feedback from their superiors while 22.2% reported that they received feedback when the district officers visit their areas. It is apparent from the findings that provision of feedback was generally below 50% although it was slightly better in the human than in the livestock health sector.

Table 4.4: Provision of Feedback on Reports Submitted from Human Health Facilities and Livestock Field Offices to District Authorities

	Human health Facilities			Livestock Field offices		
	Frequency	**Percent**	**95% confidence limits**	**Frequency**	**Percen**	**95% confidence limits**
No	3	23.08	5.04- 53.81	7	77.78	39.99- 97.19
Not always	4	30.77	9.09- 61.43	0	0.0	0.0
Yes	6	46.15	19.22- 74.87	2	22.22	2.81- 60.01

***Source*: Own field data**

4.2 Identification and Training of Community-Based Health Workers

4.2.1 Identification of Community Based Health Reporters

Before starting the process of identifying community health reporters to be used in disease surveillance, this sought to understand the perception of the community

members on the access and use of health services in human health sector and also to know how the community acquires veterinary services for their livestock. Of 18 respondents interviewed in the human health facilities, 50.0% (9) explained that they gave local medicine first to patient before taking them to health facilities. If a sick person is not cured by local medicines, then medical services are sought. Forty four percent (8) respondents stated that they reported directly to the health facility when members of the family fell sick. On the other hand, one interviewee responded that he buys drugs from the shops and give them to the patient. For sick animals, 87.0% (n=19) of the respondents reported that they treated the animal themselves and worked with the livestock field officers when there is mass vaccination campaigns for certain diseases of livestock. Fifteen percent of the respondents reported to consult LFOs in most cases after their treatment attempts failed to assist sick animals. Community animal health workers were also mentioned to be involved in treatment of livestock in the study community (Table 4.5).

4.2.2 Distance from the Community to Human Health Facilities and Livestock Field Offices

The distance covered from home to where health services are provided varied from one to 24 km for both human and animal health facilities. The time taken to walk was used to measure the distance covered, where a one-hour walk was equated to 3.5-4.5 km distance (Aspelin, 2005). Among the 19 respondents interviewed, 39% and 28% stated that the distance from their places of residence to the nearest health and veterinary facility was in the range of one to five km. The long distance covered showed that 5.7% and 11.1% of the respondents covered between 21-25 km and 16-20 km for veterinary and human facilities, respectively.

Table 4.5: Action Taken by Respondents in the Study Area when Members of the Community and Livestock Become Sick

Variable	Category	Response	Percent
Sex of respondents (n=19)	Male	14	73.7
	Female	5	26.3
Division (n=19)	Ngorongoro	8	42.1
	Loliondo	6	31.6
	Sale	5	26.3
Action taken when family members get sick (n=19)	Give local medicine	9	50.0
	Go to health facility	8	44.4
	Buy drugs/medicine	1	5.6
Action taken when livestock get sick (n=19)	Buy drug and treat	15	78.9
	Report to LFOs	3	15.8
	Report to CBAHWs	1	5.3
Action taken when seen sick/dead wild animal	Do nothing	13	72.2
	Feed to dogs	1	5.6
	Kill for food	1	5.6
	Keep livestock away	2	22.2
	Call veterinarians	1	5.6
Distance to health facility (n=19)	0-5 km	7	38.9
	6-10 km	5	27.8
	11-15 km	4	22.2
	16-20 km	2	11.1
	>20 km	0	0.0
Distance to livestock field office (n=19)	0-5 km	5	27.8
	6-10 km	6	33.3
	11-15 km	3	16.7
	16-20 km	4	22.2
	>20 km	1	5.6

***Source*: Own field data**

Respondents were asked to give their opinions on the attitude of health officials during the delivery of services to the community. The interviewed people (n= 18) responded that medical staff attended the patients immediately when cases were reported to them**.** Seventy-two percent (13) of them stated that patients were attended within 1-5 minutes of arrival in the health facility while 22% reported that patients

were attended within 2-4 hours of arrival at the facility. About six percent of the respondents reported that they never went to the health facility and they only met the medical staff during children immunization campaigns in their villages. In the animal health sector, the respondents stated that although it was not common to consult LFOs when consulted they responded quickly and attended sick animals. Twenty-eight percent of the respondents reported that the response was within 1-5 minutes while and 22% mentioned that they respond after 2-4 minutes. About six percent (5.6%) of the respondents stated that they used community animal health workers while 22% and six percent responded that they did not use the services of LFOs because the LFOs responded very slowly.

4.2.3 Symptoms of Human and Animal Diseases Mentioned by the Community Members

Members of the study communities (n=19) were asked to mention disease symptoms that are common in humans in their localities and 67 percent of them mentioned diarrhoea as the most common symptom, 50% mentioned coughing and 44.4% mentioned sores in mouth as the most common symptom in women immediately after delivery. Thirty-three and 39% mentioned vomiting and head ache as the most common symptoms, respectively. Fever, joint pain and chest pains were also mentioned by 28%, 22% and 17% percent of the respondents, respectively (Table 4.6). In livestock, the respondents mentioned the most commonly observed signs were coughing (61%) and swollen lymph nodes (31%), lameness (33.3%) and sores (33.3%) in the mouth. Other common signs mentioned were corneal opacity, blindness, central nervous system signs, and diarrhoea (Table 4.7).

Table 4.6: Common Human Disease Symptoms Identified by the Local Community Members

Syndrome	Frequency	Percent	95% confidence Limit
Chest pain	3	16.7	3.58- 41.42
Coughing	9	50.0	26.02- 73.98
Diarrhoea	12	66.7	40.99- 86.66
Flu	1	5.56	0.14- 27.29
Joints pain	4	22.2	6.41- 47.64
Skin condition	1	5.6	0.14- 27.29
Sores in mouth	8	44.4	6.41- 47.64
Swollen legs	1	5.6	0.14- 27.29
Vomiting	6	33.3	13.34- 59.01
Fever	5	27.8	9.69- 53.48
Head ache	7	38.9	17.30- 64.25

Source: **Own field data**

Regarding the common clinical signs of disease in wild animals, 56 percent (n=18) of respondents reported that they rarely observed clinical signs in wild animal as such they find dead animals. On the other hand, 27% reported that some of the wild animals become blind and 22% mentioned skin condition as signs seen in wildlife especially in gazelles. Seventeen percent mentioned lameness as a major sign observed in wildebeest.

The other signs mentioned included walking in circles, abortion, emaciation, loss of fear to people, anorexia, dullness and froth from the nostrils, which were mentioned by 6% of the respondent each. Respondents also reported that the signs were noted shortly after the long rains, that is, from June to July.

Table 4.7: The Common Sign of Diseases Observed by Community Members in Livestock

Syndrome	Frequency	Percent	95% confidence Limit
Anorexia	2	11.1	1.38- 34.71
Blindness	4	22.2	6.41- 47.64
Constipation	1	5.6	0.14- 27.29
CNS signs	2	11.1	1.38- 34.71
Corneal opacity	5	27.8	9.69- 53.48
Coughing	11	61.1	35.75- 82.70
Diarrhoea	4	22.2	6.41- 47.64
Dysentery	1	5.6	0.15- 28.69
Dyspnoea	3	16.7	3.58- 41.42
Intraocular pressure	1	5.6	0.14- 27.29
Lameness	6	33.3	13.34- 59.01
Loss of body condition	1	5.6	0.14- 27.29
Nasal discharge	3	16.7	3.58- 41.42
Skin conditions	1	5.6	0.14- 27.29
Sores in mouth	6	33.3	13.34- 59.01
Starry hair coat	3	16.7	3.58- 41.42
Swollen lymphnodes	6	33.3	13.34- 59.01
Loss of tail switch	1	5.6	0.14- 27.29
Loss of body condition	1	5.6	0.14- 27.29

***Source*: Own field data**

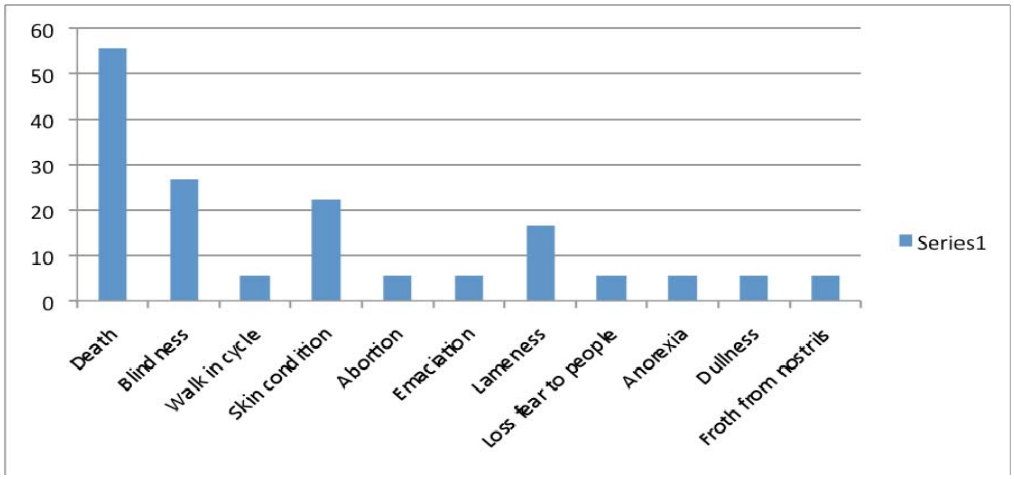

Figure 4.5: Common Signs of Diseases Observed by Members of the Community in Wild Animals

Table 4.5 presents the responses on action taken by members of the community when they saw wild animals with clinical signs of disease or a dead animal. About 72% (n=18) of the respondents said that they did nothing and 22% percent reported that they kept domestic animals away from sick or dead wildlife while other respondents reported the incidences to the veterinarian, fed carcasses of wild animals to dogs or killed the sick ones for human consumption (Table 4.5).

4.3 Utilization of Android Mobile Phones to the Field Personnel

After training the community health workers on how to use the android phones for reporting disease cases and also how to apply community-based participatory approaches in identifying disease cases in the village communities, follow up was made in 13, study villages to establish if there was any improvement in the identification and reporting of disease incidences. It was observed that the LFOs started to report more cases based on the observed symptoms using the android mobile phones.

The reported symptoms included dyspnoea, abortions, nasal discharges, pneumonia, central nervous system signs, skin condition and lesions, diarrhoea, deaths, lameness, coughing.

4.3.1 Symptoms of Diseases Reported by the Community Health Reporters Using Android Mobile Phones

Community health reporters (CHRs) in 10 villages reported symptoms that were specific to certain diseases but did not identify the specific disease conditions. This is due to the fact that CHRs have limited knowledge of diseases but they were good in

picking up the symptoms presented by clinical cases. As presented in Figure 7, during the reporting period, 52% cases of nasal discharges, 43% of lameness and 31% of cases of abortions were reported in domestic animals in different villages. Central nervous system (CNS) signs, dyspnoea, skin condition and pneumonia were reported at 3.5% each and 4% reported diarrhoea and deaths that occurred without showing any signs. The high frequency of reported cases of abortions could have resulted due to brucellosis. Foot and mouth disease outbreaks during the study period could have contributed to high percentage of reported cases of nasal discharges and lameness.

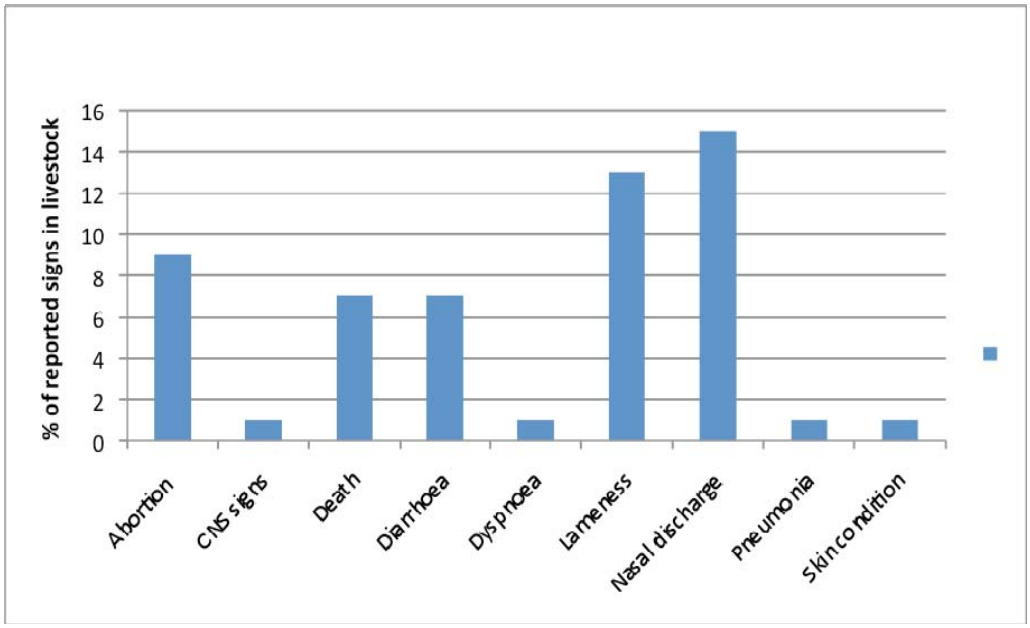

Figure 4.6: Clinical Signs of Diseases Reported by Community Health Reporters

Since CHRs were reporting signs of diseases under the 'one health' concept, Table 4.8 shows the proportion of livestock and human cases reported. Diarrhoea was reported in both animals and humans and this necessitated laboratory identification of the causative agent to establish the relationship. Lameness and nasal discharges were

also reported in both animals and humans. This could be attributed by foot and mouth disease in livestock. Community reporting offers opportunity in the future for rapid alert and hence diagnosis of epidemics and zoonotic diseases.

Table 4.8: Distribution of Disease Signs Reported by CHRs in Humans and Animals

Sign	Human (n=3)	Percent	Animal (n=26)	Percent
Abortion	0	0.0	9	34.6
CNS signs	0	0.0	1	3.8
Death	0	0.0	7	26.9
Diarrhoea	2	66.7	5	19.2
Dyspnoea	0	0.0	1	3.8
Lameness	1	33.3	12	46.2
Nasal discharge	1	33.3	14	53.8
Pneumonia	0	0.0	1	3.8
Skin condition	0	0.0	1	3.8

***Source*: Own field data**

The species affected and number of reported cases was identified and reports showing significant changes compared to the baseline data. The reports were flowing from 10 villages where CHRs were given android phones and the information delivered to the higher levels for analysis and response on the course of action to be taken. In some instances, this information saved lives.

4.3.2 Proportions of Villages Reporting Signs

The villages with higher occurrence of abortions were Misigiyo (75%) and Alailelai (55%) as indicated in Figure 4.7. This could be attributed to the high interaction

between cattle and buffaloes in these areas and therefore, it is possible that brucellosis was transmitted from buffaloes to cattle. Shirima, (2005), reported the prevalence of 8.3 and 13 percent of brucellosis in cattle and small ruminants respectively in Ngorongoro district. The prevalence of *Brucella abortus* in buffaloes and wildebeest in the Serengeti ecosystem (Serengeti and Ngorongoro) was reported to be 24 and 17 percent respectively (Fyumagwa *et al.*, 2009). Alalilelai had a higher frequency of reports of lameness (64%) followed by Arash (50%). Probably this was due to outbreak of FMD in these areas. Likewise, nasal discharges were also recorded in the same villages where 73 and 75 percent were reported in Alailelai and Arash, respectively. Twenty-one percent of diarrhea cases were reported in Alailelai as well as 55% cases of death, which were also reported in Arash.

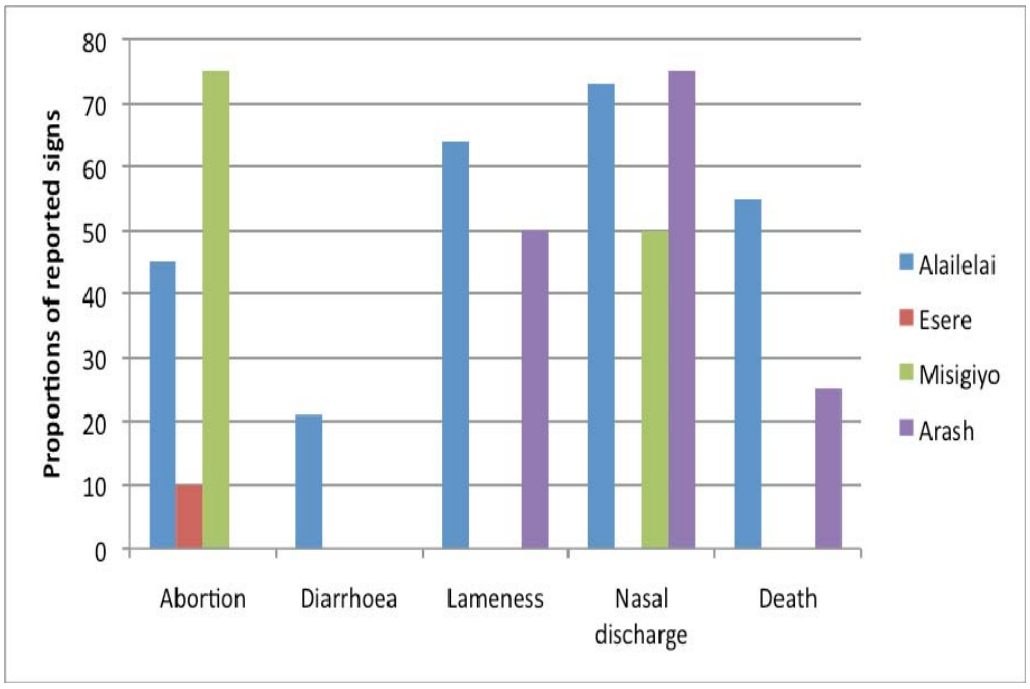

Figure 4.7: Proportions of Disease Signs Reported by CHRs in Different Villages

4.3.3 Frequency of Submission of Livestock Disease Surveillance Forms

The frequency of submission of livestock disease surveillance forms by LFOs in the study area for the period January to July 2012 is shown in Table 4.9.

Table 4.9: Proportion of LFOs that Submitted Disease Surveillance Forms to DVO

Ward	Frequency	Percent	95% Confidence limits
Endulen	16	59.3	38.80- 77.61
Kakesio	2	7.4	0.91- 24.29
Oldonyosambu	2	7.4	0.91- 24.29
Samunge	2	7.4	0.91- 24.29
Malambo	1	3.7	0.09- 18.97
Nainokanoka	1	3.7	0.09- 18.97
Naiyobi	1	3.7	0.09- 18.97
Olbalbal	1	3.7	0.09- 18.97
Oloirien- Magaiduru	1	3.7	0.09- 18.97

***Source*: Own field data**

Twenty six livestock surveillance forms were submitted to DVO by livestock field officers from January to July 2012.The results showed that Endulen was the more active livestock office to submit reports (59%), followed by Kakesio, Oldonyosambu and Samunge with 7.4% each.

The number of livestock cases reported sick was 56 and deaths reported were 43. The number of animals considered to be at risk for the district was estimated to be 555,609. Clinical examination was done for 53 cases and 72 animals were salvaged for human consumption mostly cattle, goats and sheep and one dog was presented for

postmortem examination. Eighty five percent (n=27) of reported sick livestock were under free range grazing system and 11% were under agropastoral farming system. Endulen was the village that reported the highest number of the sick livestock 44.4% (12), then followed by Esere with 14.8%, and Kakesio, Oldonyosambu and Samunge which reported 7.4% each.

Fifty nine percent of the reported sick livestock (16/27) were bovine while other 14.8% were caprine, ovine, (11.0%) avian and wildebeest (3.7). Young livestock reported to be sick were 46% while adults constituted 30% of reported cases. All sex of animals were affected by diseases with 63% of the cases being reported to have affected both sex, 30% of cases were reported predominantly in males and 4% in females.

4.3.4 Identification of the Source of Epidemic

The livestock disease surveillance forms were intended to identify a number of things including clinical signs and pathological lesions of diseases that were affecting the animals as well as identify the modes of disease transmission. Different modes of disease transmission were mentioned with air-borne mode being mentioned by 24%, vector-borne (40%), illegal animal movement (8%), formats (8%) and unknown (20%). The owners' explanation of the case history was the first indication of the possible disease, followed by physical observation/ clinical examination. For dead animals, the environment where the dead animal was found provided some clues followed by postmortem examinations. Clinical samples were taken for laboratory examination for confirmation of diseases.

Routine vaccination records were collected to assess whether disease epidemics occurred due to lack of routine vaccinations or not. Twenty six percent (n= 26) of cattle vaccinated against CBPP, 22% of sheep and goats against PPR and 7.4% and 3.7% mentioned to be vaccinated against ECF and FMD respectively.

Table 4.10: Clinical Signs of Diseases in Livestock as Reported by LFOs

Signs	Frequency	Percent	95% Confidence Limit
Abortion	1	3.7	0.09- 18.97
Bleeding from natural orifices	1	3.7	0.09- 18.97
Blindness	2	7.4	0.91- 24.29
Corneal opacity	1	3.7	0.09- 18.97
Coughing	4	14.8	4.19- 33.73
Dullness	2	7.4	0.91- 24.29
Fever	7	25.9	11.11- 46.28
Fresh penetrating skin lesion	3	11.1	2.35- 29.16
Hoof condition	2	7.4	0.91- 24.29
Laboured breathing	6	22.2	8.62- 42.26
Lack of appetite	9	33.3	16.52- 53.96
Lacrimation	2	7.4	0.91- 24.29
Lameness	5	18.5	6.30- 38.08
Loss of body condition	3	11.1	2.35- 29.16
Nasal discharge	3	11.1	2.35- 29.16
Pale mucous membrane	1	3.8	0.10- 19.64
Profuse salivation	5	18.5	6.30- 38.08
Reluctant to move	1	3.7	0.09- 18.97
Rough hair coat	1	3.7	0.09- 18.97
Shivering	3	11.1	2.35- 29.16
Skin nodular lesion	3	11.1	2.35- 29.16
Staggering gait	1	3.7	0.09- 18.97
Stiffness	4	14.8	4.19- 33.73
Sudden death	2	7.4	0.91- 24.29
Swollen head	1	3.7	0.09- 18.97
Swollen lymph nodes	2	7.4	0.91- 24.29
Uncoordinated movement	3	11.1	2.35- 29.16
Vesicle eruption in the mouth	3	11.1	2.35- 29.16

***Source*: Own field data**

Results presented showed that the highest reported signs in livestock by LFOs was Anorexia (33.3%), Fever (25.9%), Laboured breathing (22.2%), Lameness and profused diarrhea (18.5%) each, Stiffness (14.8%) and coughing (14.8%). The other signs mentioned were reported below 11% as seen in Table 4.10.

4.3.5 IDSR Monthly and Weekly Forms Submitted by Workers in Health Facilities

After introduction of the use of mobile phones in disease surveillance, the findings of proportion of health facilities reporting is as shown in the Figure 4.8. Endulen hospital scored higher in terms of numbers of report submissions than other facilities in terms of IDSR weekly and monthly surveillance forms (34.5% and 46.1%), followed by Olbalbal 27% and 23% for weekly and monthly reports, respectively. And then Nainokanoka dispensary which reported submission 14% and 7% of weekly and monthly reports respectively.

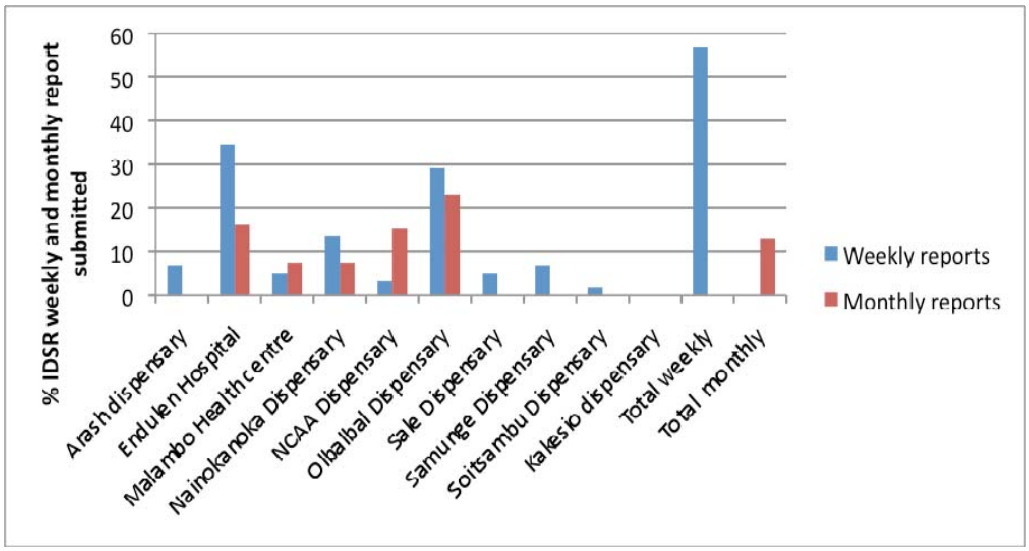

Figure 4.8: Frequency of Health Facilities Reporting IDSR Weekly and Monthly Data

The remaining facilities reported less than 10% and Kakesio reported zero percent for both weekly and monthly IDSR reports. Despite provision of mobile phones in selected health facilities, reporting efficiency has not improved to the level that was expected. This may be attributed by medical staff lack commitments in compiling and sending reports. The IDSR monthly report showed that, in addition to the cases of both livestock and wildlife reported by LFOs, cases of sick human beings were reported in some of the hospitals and dispensaries.

Endulen Hospital reported between January and July 2012 a total of 112 human cases. Between 18 and 25 January 2012, the hospital reported one case of animal bite. Between 25 January and 1st February 2012, the hospital reported a variety of cases which included cholera case that affected 4 male children under five, 5 female children under five, 1 male child under five who died, and 2 female children under five who died. The number of people above 5 years infected with cholera included 5 males and 4 females and death cases reported in this age group were 4 males and 2 females.

The other disease reported by the same hospital was acute flaccid paralysis which affected 5 male and 6 female children under five years. Reported deaths included 3 male and 1 female children less than five years. During the same period measles was reported to have infected both children and people over five years of age. It affected 4 children (3 male and 1 female) under five and the death was reported for 2 males and 1 female. People above five affected include 1 male and 3 females, and death cases reported in this group included 1 male and 1 female.

Neonatal tetanus was another disease reported by the hospital, which infected 2 male and 4 female children under five years of age. Deaths reported resulting from neonatal tetanus were 4 males and 5 females less than 5 years. Cerebral spinal meningitis was another disease that the hospital reported as devastating. The morbidity included 4 males and 5 females children under 5 and the death report in this group included 1 male and 3 females children. The population over 5 years that was affected included 3 males and 4 females, and the deaths reported were 3 males and 3 females.

Olbalbal dispensary had very few cases reported which include 2 cases of measles for 2 male children under five and 2 female over five. No deaths were reported in this health facility. Sale dispensary did not have any notifiable cases in the 6 months, but Malambo Health Centre had reported 5 notifiable cases in 6 months. The cases were measles that affected 2 male and 3 female children under five. No deaths were reported.

Nainokanoka dispensary had the highest number of reported cases all occurring between 13-01-2012 and 19-6-2012. There was a cholera outbreak that affected only females under 5 years of age. Measures were instituted promptly and no deaths were reported. Arash Dispensary reported only 2 cases all of which were animal bites involving a male and female more than 5 years of age. No death was reported. Samunge, Soitsambu dispensaries and NCAA dispensaries did not have any notifiable cases.

Findings of the present study agree with previous findings of poor performance of disease surveillance in animal and human health sectors in Tanzania (Allport *et al.*,

2005; Mboera *et al.,* 2001). The situation is made worse with the delayed reporting of sick individuals at health facilities where disease events are normally captured. A study by Shayo *et al.* (2003) indicated that the majority of rural-based individuals stay at home or consult traditional healers before visiting health facilities to seek medical services. Similar findings have been reported in the animal health sectors where sick animals are usually managed by farmers or community-based animal health workers before intervention of veterinarians (Karimuribo & Swai, 2006).

The present study also revealed a significant variation in completeness of surveillance reports in both animal and human health sectors. Although some wards and health facilities seem to do better than others, the overall picture was one of poor surveillance coverage. In-depth interviews of district officials responsible for animal and human health control stated that the lack of human resources to supervise and manage surveillance systems may seriously affect the performance of the system.

This is confirmed, for example, by the fact that there was no DVO between 2006 and 2009 in Ngorongoro district when there was sharp decline in the number of surveillance reports submitted to the district headquarters. This situation improved in 2010 after recruiting a veterinarian to head the veterinary section in the District Council. Other factors were also noted, for example, where poor reporting was associated with times when key IDSR staff responsible for submitting weekly or monthly reports was away from their work stations. Rumisha *et al*. (2007) also reported that poor disease reporting under IDSR was attributed to staff being on annual leave.

Although quantitative data on timeliness was not collected in the current study, interview with officials responsible for disease surveillance in the animal and human health sectors indicated that there is always delayed reporting, a problem which is more critical in the animal than in the human health sector. For instance, monthly reports in the animal health sector can be delayed for six to nine months before being received by the Epidemiology section of the Ministry of Livestock and Fisheries Development (Kivaria, personal communication, 2010). In the human health sector, the timely submissions of weekly and monthly reports have been reported to be only 8% and 24%, respectively (Rumisha *et al.,* 2007). The problem of delayed reporting is mainly attributed to the paper-based transmission of data coupled with unfavourable infrastructure and communication networks especially in rural areas.

Given the challenges of surveillance in the animal and human health sectors, the SACIDS designed a 'fit-for-purpose' OH surveillance strategy. The strategy is considered appropriate for southern Africa as it has taken into consideration the situations and challenges prevailing on the ground. Key considerations include the relatively higher proportion of patients receiving treatment at home from traditional healers before visiting health facilities, lack of proper diagnostic facilities at community and village levels, limited human diagnostic and mobility resources in remote areas as well as poor infrastructure for efficient communication between rural communities and district or ministry headquarters (Strasser, 2003). The concept of collaborative efforts in managing infectious diseases in Tanzania and other southern African countries is not new. The emergence of innovative and appropriate technologies, approaches and tools for participatory epidemiology and disease surveillance (Hussain *et al.,* 2005; Jost *et al.,* 2007), such as the use of mobile

technologies (Aanensen *et al.*, 2009; Despont-Gros *et al.*, 2005) will significantly contribute to improved surveillance of infectious diseases. This will contribute to better public health, and economic and social stability in Africa. It is also anticipated that the OH surveillance will foster stronger collaborative links between the animal and human health professionals, and consequently improve management and control of infectious diseases in animals and humans health sectors.

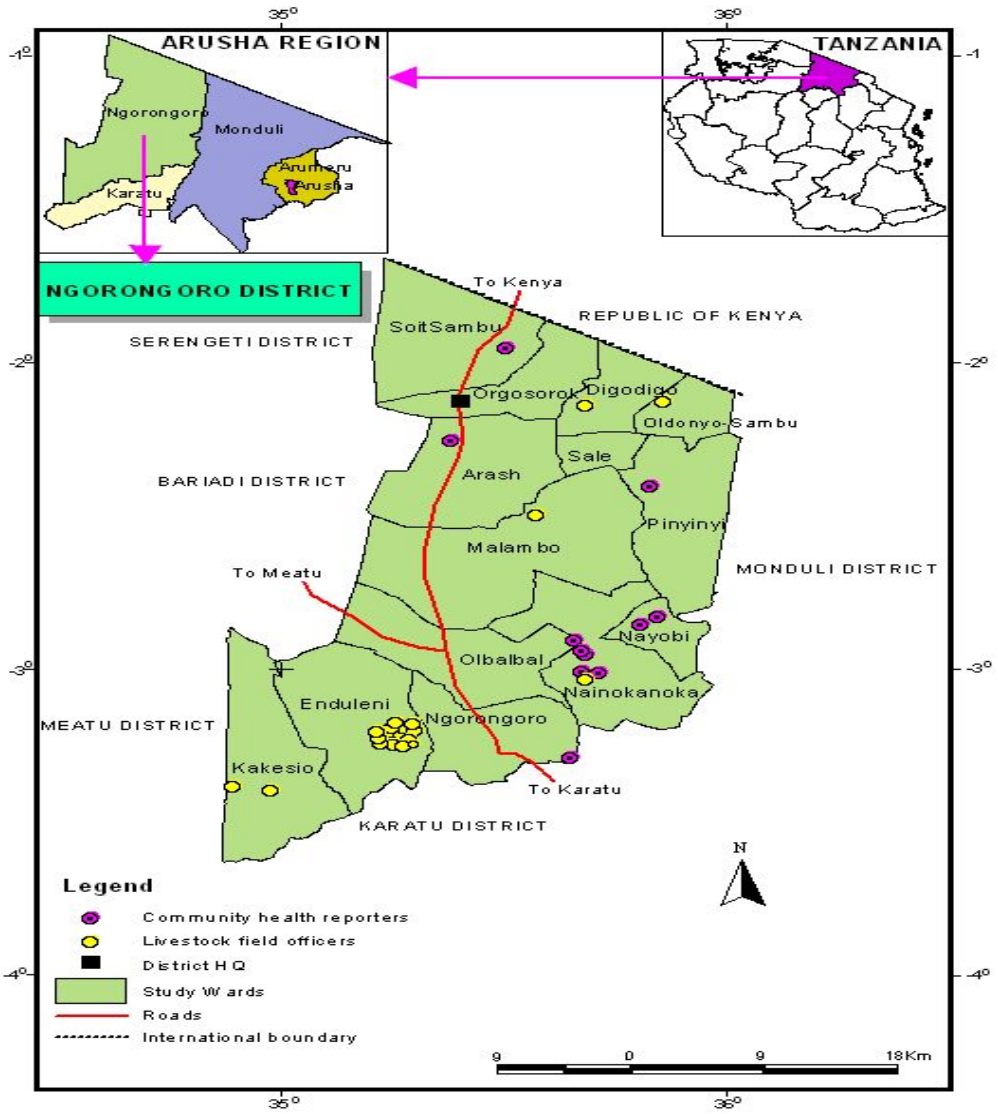

Figure 4.9: Ngorongoro District Map Showing the Geographic Locations of Some of Reported Disease Symptoms by CHRs and LFOs

4.4 Acceptability and Reliability of Mobile Technology in Disease Surveillance

4.4.1 Responses of Livestock Field Officials in the Use of Mobile Phones

The interview on the acceptability of mobile phones involved eight LFOs provided with android phones that were available in their working station during collection of this data. The exclusion of two LFOs was because they were absent and therefore not interviewed. The duration in which the mobile phones were used varied from one to seven months and perceptions from working colleagues was perceived as very good by six (75%) respondents and moderate by two respondents (25%). The responses were correlated to the duration of using the mobile phones, with those who uses the mobile phones longer reporting very good perceptions.

Table 4.11: Responses on the Perception of Working Colleagues on Duration and use of Mobile Phones by LFOs and Human Health Officials

Variable	Category Personnel	Category	Response	Percent
Perception of working colleague	LFOs	Very good	6	75.0
		Moderate	2	25.0
		Not good	0	0.0
	Human health officials	Very good	7	77.8
		Moderate	2	22.2
		Not good	0	0.0
Duration of using the phones	LFOs	1 month	3	37.5
		3 month	1	12.5
		6 month	1	12.5
		7 month	3	37.5
	Human health officials	1 month	2	22.2
		2 month	2	22.2
		6 month	3	33.3
		7 month	2	22.2

***Source*: Own field data**

4.4.2 Response of Human Health Officials on the Use of Mobile Phones

As presented in Table 4.12 below, the duration of using mobile phones by the medical officers ranged from one to seven month. Twenty-two percent of the respondents reported that they used phones for one to two month and 33% pointed out that they used for two to six month. Another 22% of interviewed staff said they used the phones for seven month. At the same time 22% stated that the perception of their working colleague was moderately and 78% said that the perception is very good.

4.4.3 Perception of Community Health Reporters on the Use of Mobile Technology

CHRs were expected to collect information on symptoms of disease occurring in remote areas where the communities live. Perception of the communities on the use of mobile phones was collected and the responses are as shown in Table 13. Forty-three percent of the respondents stated that perception of the surrounding community was very good and 57% responded by saying it was moderate. Moderate perception was attributed by lack of response from the district authorities responsible for disease control. Communities expected that the response team would be deployed to the site where an epidemic was reported as soon after the information was relayed to the respective authorities.

The duration with which CHRs used the mobile phone in disease surveillance also ranged from one to seven month. Forty-three of the respondents stated that they used for seven month while 29% of the respondents said they used the phones for one month, and 14% responded by saying they used the phones for two to six month.

Table 4.12: Responses of the CHRs on the Duration and Perception of the Community Members on the use of Mobile Phones

Duration of using the phone	Frequency	Percent	95% Confidence Limit
1 month	2	28.6	3.67- 70.96
2 month	1	14.3	0.36- 57.87
6 month	1	14.3	0.36- 57.87
7 month	3	42.9	9.90- 81.59
Moderate good perception	4	57.1	18.41- 90.10
Very good perception	3	42.9	9.90- 81.59

***Source*: Own field data**

4.4.4 Easiness of Using Mobile Phones in Disease Surveillance

The responses from the 25 respondents (including from LFOs, Medical staff and the CHRs) on the easiness of using mobile phones in disease surveillance varied. All LFOs, 89% CHRs and 71% medical staff said that the mobile phones provided were easy to use. Eighty-six percent, 63% and 56% percent of the medical staff, LFOs, and CHRs respectively, stated that photographs of the disease cases can be included in the messages transmitted through mobile phones.

Furthermore, 86, 78 and 50 percent of the LFOs, medical staff and CHRs reported that it was easy to send disease information using mobile phones. One medical staff further added that the community was happy with the use of mobile phone technology in transmitted disease surveillance data. Others have reported that community involvement in the identification of cases that need to be reported yielded better results than when it was not involved (Karimuribo et. al., 2011).

The speed at which the disease incidences were identified and information transmitted to the DVOs and DMOs was very much faster than had previously been. Transmission of information took seconds to reach the authorities at district, regional and national levels. The use of mobile phones made it possible to create databases on epidemics in the Ngorongoro district. The district officials in both livestock and human health sectors at district level were comfortable with the use of the mobile phones after training done. No advanced information technology knowledge was required in operating the mobile phones but the storage of the information in laptops needed some knowledge in information technology.

Table 4. 13: Response on Easiness of Using Phones by CHRs, Human Health Officials and LFOs

Variable	CHRs (%)	Human health officials (%)	LFOs (%)	Total
Easy to use	8 (88.9)	5 (71.4)	8 (100.0)	21
Rapid transfer of information	7 (77.8)	6 (85.7)	4 (50.0)	17
Picture can be included	5 (55.6)	6 (85.7)	5 (62.5)	16
Community are happy	0 (0.0)	1 (14.3)	0 (0.0)	1

Source: **Own field data**

4.4.5 Problems Associated with the Use of Mobile Phones

The respondents (n=25) expressed that among the problems associated with the use of mobile phones. Seventy-five percent, 71% and 67% of the LFOs, medical staff and CHRs respectively, mentioned network problems while 25% LFOs, 43% medical staff and 11% mentioned the large area covered to gather information before transmission. Twenty-nine percent of the respondents from the CHRs group reported that the short life span of batteries used in the phones was while only one respondent

(12.5%) mentioned delayed feedback from higher DMOs and DVOs as another problem. These responses reflect that the success of the mobile technology to improve disease surveillance depends on the investments of the telecommunications companies in communication satellites, and their operations and maintenance by installing power generators. The other equally business demanding telecommunications is the tourist industry which complements the programme in application of the mobile phone technology in disease surveillance.

Table 4.14: Problems Faced During Using Mobile Phones by the CHRs, Human Health Officials and LFOs

Variable	CHRs (%)	Human health officials (%)	LFOs (%)	Total
Large covering area	3 (42.9)	1 (11.1)	2 (25.0)	6
Fail to synchronize	5 (71.4)	6 (66.7)	6 (75.0)	17
Lack of response from DMO/DVO	0	1 (11.1)	1 (12.5)	2
Difficult language used	3 (42.9)	2 (22.2)	0	5
Short phone battery life	2 (28.6)	0	0	2
Difficult to use	0	1 (11.1)	0	1

Source: **Own field data**

4.4.6 Parameters that Make the Use of Mobile Phone Simple

The type of mobile phones put to test was considered to have certain parameters that made them simple to use. The parameters mentioned included the large diameter of the screen where 71, 89 and 50% mentioned the phones have wide enough screen for CHRs, human health officials and LFOs respectively, clarity of the image and easiness of operating the soft touch screen were CHRs (71.4%), human health officials (89%) and LFOs (87.5%). The technical design of the mobile phone was

that it had a wide screen that enabled the reporters to scribble anything they wanted to submit and also the pictures of the animals having disease signs or dead. The phone has the capacity to transmit pictures that complemented the explanations given on the disease incidents.

Table 4.15: Response of CHRs, Human Health Officials and LFOs on Parameters that Make Usage of Phones Simple

Variable	CHRs (%)	Clinical officers (%)	LFOs (%)	Total
Clear screen	5 (71.4)	9 (100.0)	7 (87.5)	21
Wide enough screen	5 (71.4)	8 (88.9)	4 (50.0)	17
Soft touch screen	5 (71.4)	8 (88.9)	7 (87.5)	20

Source: **Own field data**

4.4.7 Suggestions for Improvements on the Use of the Mobile Phone Technology

The respondents provided suggestions for improvement on the use of mobile phone technology so that it can be effectively applied in reporting disease surveillance in this remote livestock area of Tanzania. Others suggested improved response to submitted reports cases, improved transport to reach the remote areas where many people and livestock are found, increased number of mobile phones for field staff and more regular meetings between livestock field officers, supervisors and the community so that disease cases identified can be reported early. The respondents further suggested that more training is needed to sensitize the people on the importance of early reporting disease incidences to CHRs, LFOs and other relevant authorities. Close follow up by SACIDS was also mentioned as an area requiring improvement.

Table 4.16: Suggestions for Improving Disease Surveillance as Reported by Livestock Field Officers and Human Health Officials

Variable	Clinical officers (%)s	LFOs (%)	Total
Close follow up by SACIDS	0 (0.0)	1 (12.5)	1
Community advised to report cases	0 (0.0)	2 (25.0)	2
Increase number of phones	0 (0.0)	1 (12.5)	1
Rapid response to reported cases	5 (55.6)	2 (25.0)	7
Regular meetings	0 (0.0)	2 (25.0)	2
Solve network problem	0 (0.0)	1 (12.5)	1
Provide Transport to reach remote areas	1 (11.1)	1 (12.5)	1
Train all staffs	3 (33.3)	1 (12.5)	2
Frequent visit by ICT team	5 (55.6)	0 (0.0)	5
Laptop handled to district IDSR focal person	2 (22.2)	0 (0.0)	2
Provide laptops to all facilities	2 (22.2)	0 (0.0)	2
Cover transport cost	1 (11.1)	0 (0.0)	1

Source: Own field data

4.5 Summary of the Findings

From the data provided above, the One Health disease surveillance approach for livestock, human beings and wildlife has been employed to collect data for disease identification and reporting systems in remote areas like Ngorongoro district. The application of android mobile phones has facilitated greater and faster reporting of symptoms of possible disease incidences in the pastoralist communities. Community involvement in terms of training and sensitization on the importance of early

identification of suspicious symptoms and reporting to the close LFOs or Medical Officers has contributed to the increased reporting and prompt identification of epidemic diseases in both animals and human beings. The results show an increasing trend in the application of the android mobile phones in the reporting of disease sign/symptoms to the higher authorities. The area covered was large, and because the pastoralists do not have a good command in English it necessitated that some of the disease signs/symptoms being translated into Swahili for easy of communication.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The following conclusions can be drawn from the present study. The system that existed between 2005 and 2010 for collecting information and reporting disease incidents in Ngorongoro district was inadequate, inefficient and not effective enough to capture and report notifiable diseases to higher authorities (district, regional and national) for prompt feedback on treatment and control measures. The data gathered by this study show low number of cases identified and reported between 2005 and 2008.

For effective use of the android mobile phones, it is necessary to apply a participatory approach in training and sensitizing the communities to accept that the identification and reporting disease symptoms that may lead to epidemic is for their own good. This was done successfully, but with challenges that need solutions such as network problems, language used in the phones, lack of reliable transport and the delayed responses from the higher authorities after the reports have been submitted. There has been a great increase in the number of disease incidences reported by use of android mobile phones between January and July 2012. This reflects greater awareness and community participation in the identification of cases after learning the relevant symptoms and reporting to the officials who had android mobile phones for quick transmission of the information to the relevant authorities. The introduction of android mobile phones paved the way for application of high technology that is more efficient in reporting disease incidents in Ngorongoro district.

5.2 Recommendations

The following recommendations can be made from the present study: The use of android mobile phones needs to be promoted and it should be complemented with more training and sensitization of communities in Ngorongoro to get greater and effective identification and reporting system. The higher authorities are advised to provide quick response to the information channeled through this modern disease surveillance system so that the efforts of the officials at the field level bear the expected fruits.

The Ngorongoro District headquarters must have reliable vehicles that can move to the wards and villages for monitoring the incidence of diseases and the field officers must be provided with motorcycles to enable them to move quickly to the sites of reported disease incidents. Field work revealed that accessibility of most facilities was difficult. Therefore it is recommended that the Ngorongoro district council have to provide with means of transport such as motorcycles to enable them to move quickly to the sites of reported disease incidents. Because of the poor mobile phone network coverage in the area it is considered that telecommunications companies are informed to improve the network coverage in the district. There is need for further study to establish the comprehensive reasons on why facilities are reluctant to submit reports as required by the profession and the government law.

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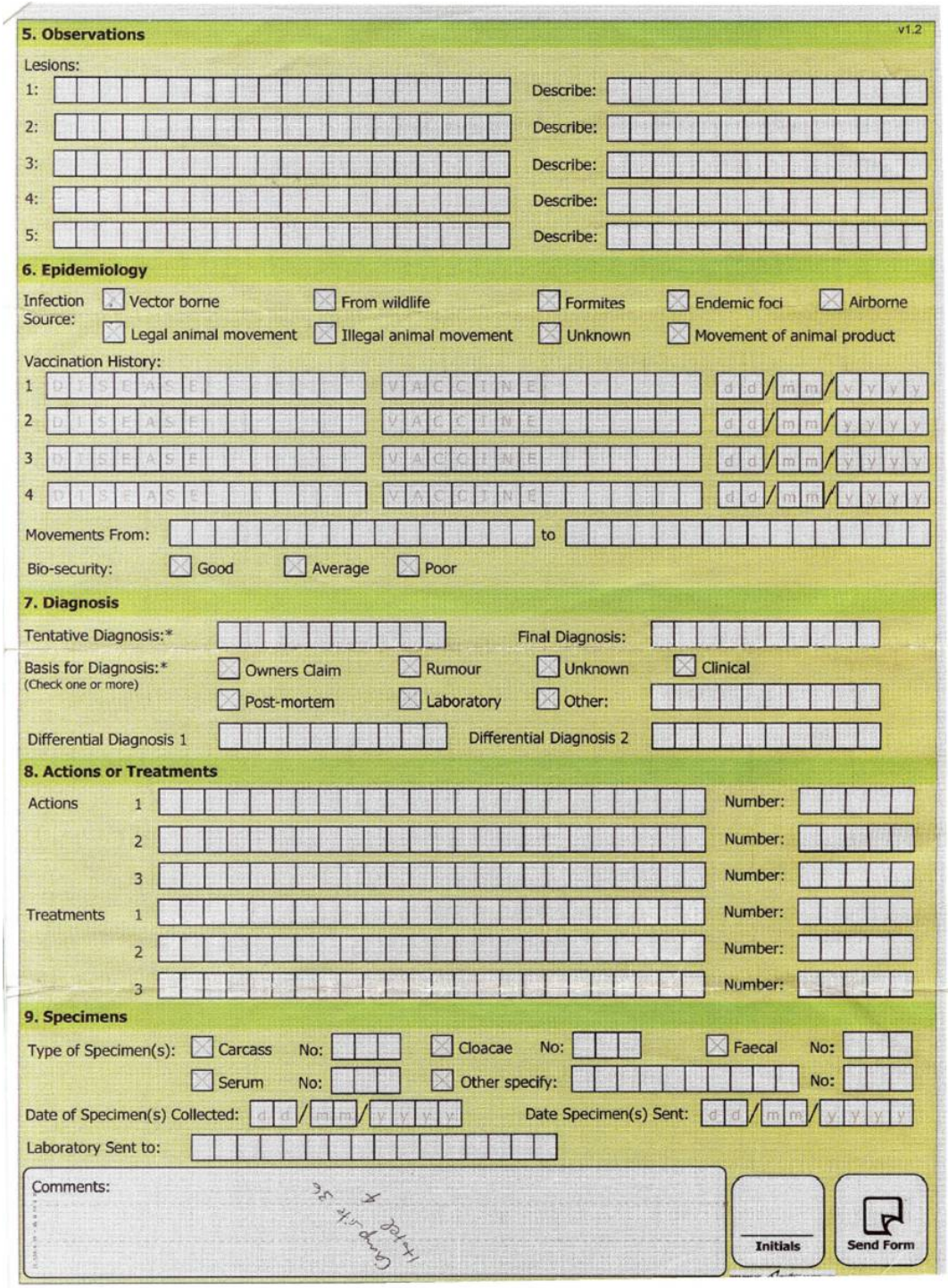
APPENDICES

Appendix I: Livestock surveillance and report form (page 1 and 2)



5. Observations v1.2

Lesions:

1: Describe:

2: Describe:

3: Describe:

4: Describe:

5: Describe:

6. Epidemiology

Infection Source: Vector borne; From wildlife; Formites; Endemic foci; Airborne; Legal animal movement; Illegal animal movement; Unknown; Movement of animal product

Vaccination History:

1 DISEASE VACCINE d d/m m/y y y y

2 DISEASE VACCINE d d/m m/y y y y

3 DISEASE VACCINE d d/m m/y y y y

4 DISEASE VACCINE d d/m m/y y y y

Movements From: to

Bio-security: Good; Average; Poor

7. Diagnosis

Tentative Diagnosis:* Final Diagnosis:

Basis for Diagnosis:* (Check one or more): Owners Claim; Rumour; Unknown; Clinical; Post-mortem; Laboratory; Other:

Differential Diagnosis 1 Differential Diagnosis 2

8. Actions or Treatments

Actions 1 Number:

2 Number:

3 Number:

Treatments 1 Number:

2 Number:

3 Number:

9. Specimens

Type of Specimen(s): Carcass No: Cloacae No: Faecal No:

Serum No: Other specify: No:

Date of Specimen(s) Collected: d d/m m/y y y y Date Specimen(s) Sent: d d/m m/y y y y

Laboratory Sent to:

Comments:

Initials

Send Form

Appendix II: Integrated Disease Surveillance and Response Monthly Data Sheet Used by Health Facilities

FORM 2(A) INTRGRATED DISEASE SURVEILLANCE (MODIFIED)

MONTHLY DATA FOR IN/OUT PATIENTS.

Name of District: .....

Month: .....

Year: .....

DISEASES	CASES				DEATHS			
	Childrean		Adult		Children		Adult	
	5		5		5		5	
	M	F	M	F	M	F	M	F
Malaria								
Diarrhoea with some dehydration								
Diarrhoea with severe dehyration								
Typhoid fever								
Neonatal tetanus								
Bacillaty dysentery								
Pheumonia								
Severe Oneumonia								
Acute Flacid Baresis								
Cholera								
Measles								
Cerebral Spinal Meningitis								
Plague								
Yellow Fever								
Animal bite/dog bite								
Rabies								

Date of filling the form .....

Name of thealth facility incharge .....

Title: ..... Signature: .....

Appendix III: Integrated Disease Surveillance and Response Weekly Data Sheet

FORM 3 (a) INTERGRATED D SEASE SURVEILANCE.

W ekly data sheet at district level for weekly new c ses/ deaths reported cases during epidemics.

Na me of Region: .....
Na me of District: .....
W ek: .....
Ye ar: .....

Diseases	Cases				Deaths			
	Above 5		Below 5		Above 5		Below 5	
	M	F	M	F	M	F	M	F
Cholera								
Acute Flaccid Paralisis								
Measles								
Cerebro Spinal Miningitis								
Plague								
Yellow fever								
Animal bite/ dog bite								
Rabites								

N me: .....

T pe of reporting office ..... Title ... . Date .....

Appendix IV: Baseline Data Collection Sheet for the Community Data collection Sheet for the Community - Ngorongoro District

1. District…….. Ward…….

Village…… Sub-village……

2. Name of respondent…… Sex……

Age…… GPS coordinates……

Date: ……..

3a. Do you become sick? YES/NO

3b. Do your animals become sick? YES/NO

4a. How often do you become sick.…….

4b. How often your animals become sick.……...
…….

5a. What action do you take in case of sick person?.....

5b. What action do you take in case an animal falls sick?
……...

……..

6a. Which symptoms/signs of disease are common in people that fall sick in your area?.....

……..

6b. Which signs of disease are common in animals that fall sick in your area?

…….....

7a. What is the age group of people commonly show the mentioned symptoms/signs above?

.....

7b. What is the age group of animals commonly show the mentioned signs above? .....

8a. Where do you get medical services?…… …….

8b. Where do you get veterinary services…….....

9. How far from your home? (Time spent to walk)…….....

For medical services:…….

For veterinary services:…….

10a. How long do the medical staffs take to respond to cases?…….....

…….....

10b. How long do the livestock field officers take to respond to sick cases?…….

…….

11. Which wild animals are found in your area?

12. Do the wild animals sometimes become sick? YES/NO

……..

13. If they fall sick, what are the signs presented by the sick wild animals?

……...

14. What action do you take if you see sick wild animals?…….....

……..

Appendix V: Data Collection Sheet For Medical And Veterinary Practitioners

Data Collection Sheet for Medical and Veterinary Practitioners

1. District…….. Ward……

Village…… Facility…….

2. Name of respondent……. … Position……

GPS coordinates……Date……..

3. How many villages/wards get your service: Villages……Wards……

4. What is the population served?:……

5. How often do you send reports to the DMO/DVO……..

6. How do you send the reports……
…….

7. What is the proportion of sick human/animal reported every week/month?

…….

7. What is the time spent for the report to reach the DMO/DVO? Hours……Days ……Weeks……..Months?

8. How many report/surveillance forms did you submit to the district for the past five years……

……...

9. Do you work with community based health attendants YES/NO

10. If yes explain how ……..

…….

11. Do you get feedback from the district/ministry on the reports submitted……..

……...

12. How often do you get the feedback and duration from sending the report to get the feedback……

Appendix VI: Qestionnaires used for Assessing Acceptability of Mobile Technology in CHRs

FOMU YA DODOSO KUPIMA NAMNA JAMII ILIVYOPOKEA UTOAJI WA TAARIFA ZA MAGONJWA KWA KUTUMIA SIMU.

01. JINA……

TAREHE……..

02. KIJIJI…….

03. Ni Muda gani umetumia simu kutoa taarifa za magonjwa (*Taja miezi*)?……

04. Jamii inayokuzunguka ina maoni gani juu ya utoaji huu wa taarifa

……..

a. Kwa binadamu…(*Weka alama ya vema*)

Ni nzuri sana ( ); Ni nzuri wastani ( ); Siyo nzuri ( )……

b. Kwa wanyama (*Weka alama ya vema*)

Ni nzuri sana ( ); Ni nzuri wastani ( ); Siyo nzuri ( )

05. Nini umekifurahia katika utoaji huu wa taarifa za magonjwa kwa kutumia simu?

Ni rahisi kutumia	
Taarifa zinakwenda haraka	
Naweza kupiga na kuweka picha	
Naweza kupata huduma haraka	
Nyingine, taja……	

06. Ni mapungufu/matatizo gani umeyaona katika kutoa taarifa

Ni ngumu kutumia	
Shida ya mtandao (inagoma kwenda)	
Umbali wa maeneo ya kuchukua taarifa	
Lugha ya Kiingereza kwenye simu	
Nyingine, taja……	

07. Ni vigezo gani vinafanya matumizi ya simu ya kutolea taarifa kuwa rahisi?

Kioo kinachoonesha vizuri	
Ukubwa wa kioo cha simu	
Urahisi wa kubofya herufi na namba kwenye simu	
Nyingine, taja……	

08. Unashauri nini kifanyike ili kuboresha utoaji wa taarifa kwa siku zijazo……....

……

……

…….

……

……

…….

……

……

…

Appendix VII: Questionnaires used to Assess Acceptability of the Technology in Livestock and Human Health Officials

QESTIONNAIRE FOR ASSESSMENT OF ACCEPTABILITY OF MOBILE PHONES IN DISEASE SURVEILLANCE

01.NAME……

DATE……

02. VILLAGE/FACILITY…….

03. How long have you used the phone for disease reporting

(*months*)?……

04. What is the perception of your working colleague regarding this technology

……

……

a. Human…(*Please tick*)

Very good ( ); moderately good ( ); Not good ( )……

b. Animals (*Please tick*)

Very good ( ); Moderate good ( ); Not good ( )

05. What do you find interesting in using phones in disease surveillance?

Easy to use	
Rapid sending of disease information	
Pictures can be included in the information sent	
Quick response from higher organs	
Anything else, mention…….	

06. What are the short falls of the technology?

It’s difficult to use	
Network problem (fail to synchronize)	
Large covering area	
Language used in the phones	
Anything else, Mention……	

07. Which parameters found to make the process of sending information simple?

The mobile screen is clear	
Wide enough screen	
Easy use of keypads/soft touch screen	
Anything else, mention……	

08. What are you suggestions toward improving this reporting system in the future…….....

.....……

……