PARTICIPATORY EPIDEMIOLOGY OF NEWCASTLE DISEASE ACROSS THE RIFT VALLEY IN MANYONI DISTRICT, TANZANIA

GEOFREY KISWAGA

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN TROPICAL ANIMAL PRODUCTION OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

The study was conducted to assess the contribution of local knowledge, practices and attitudes of the rural community in relation to disease occurrence, poultry production systems, and management practices in the face of outbreaks of Newcastle disease in vaccinating and non-vaccinating wards. Participatory epidemiology techniques were employed in twelve selected villages to collect data. The information collected covered the existence of poultry diseases, clinical signs, disease incidences, perceptions regarding disease causes, the use of the vaccine, seasonal patterns, veterinary and local knowledge concerning the control of Newcastle disease. A questionnaire was used to collect data on the production system and management practices. Data were subjected to descriptive statistical analyses. The Chi-square statistic was used for testing relationships between categorical variables. Friedman test and Kendall coefficients of concordance were used to determine the level of agreement between informant groups. Results from the study indicated that village chickens, at 21.1%, constituted the largest proportion of livestock species kept. Newcastle Disease, fowl typhoid, coccidiosis, fowl pox, ectoparasites and endoparasites were reported to be the poultry diseases affecting poultry production. Newcastle disease was described to be the most economically important disease in non-vaccinated areas and ectoparasites were the most important in vaccinating areas. The occurrences of Newcastle disease was described to coincide with onset of dry season with a peak in September. Also, there is a considerable use of local remedies and antibiotics to treat Newcastle disease. The traditional remedies used are neem tree, aloe vera and moringa while conventional treatment included tetracycline, amoxicillin and metronidazole. The results from the study show the difference in attitude and management practices between vaccinating and none vaccinating households had a contribution to the outbreaks of Newcastle disease to the village chickens.

DECLARATION

I, Geofrey Kiswaga, do hereby declare to the Senate of Sokoine University of Agriculture that, this dissertation is my own original work done within the period of registration and that it has neither been submitted nor concurrently being submitted in any other institution.

_____ _____

GEOFREY KISWAGA Date

(MSc. Topical Animal Production candidate)

The above declaration is confirmed by

_____ _____

Prof. S. I. Kimera Date

(Supervisor)

_____ _____

Prof. A. M. Katule Date

(Supervisor)

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DEDICATION

This work is dedicated to the memory of my lovely mother, Elida Kuyava and to my late lovely father Melechizedeck Fungameza Kiswaga and my family for their support, care, and love throughout my study period.

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LIST OF ABBREVIATIONS AND SYMBOLS

%	Percentage
°C	Degrees Celcius
Bd	Beginning of the dry season
E	East
Ed	End of the dry season
h/day	Hours per day
km	Kilometer
Md	Mid-dry season
MdEd	Mid-dry season and end dry season
n	Sample size
N	Total number of observation
ND	Newcastle disease
NDV	Newcastle diseases virus
P	Significance level
PE	Participatory epidemiology
S	South
SSI	Semi-structured interview

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

1.1.1 Poultry production in Tanzania

The significance of poultry industries to the economy of Tanzania is evidenced by it's contribution to the Gross Domestic Product of Tanzania as in many other low- and middle-income countries. The livestock sector contributes about 4.7% to the total Gross Domestic Product with poultry production representing about 16% of this contribution (Kisungwe, 2015).

The poultry production in Tanzania is divided into two major sub-sectors, i.e. the traditional and commercial sub-sectors. The traditional sub-sector predominates in low-income countries. Free-range system is dominant production system in traditional sub-sector. The free-range production system is the main system of keeping the chicken in rural areas (Yongolo *et al.,* 2002; FAO, 2008). Of the 36.2 million chicken kept in Tanzania, around 34.3 million are raised under free-range system (Kisungwe, 2015). Village chickens supply all the chicken meat and eggs in many rural areas, where 70.4% of the population live. They also provide about 20% of the chicken meat and eggs for urban consumers (Yongolo *et al.*, 2002; de Bruyn *et al*., 2017).

Free-ranging village chickens have an important role in meeting economic and nutritional needs for the Tanzanian people, especially in rural areas. Most village poultry is kept as small flocks in a free-ranging system which provides a source of nutrients and capital to cover basic needs to rural households (de Bruyn *et al.,* 2017). Poultry products are a good source of high-quality animal protein and micronutrients for improved health. However,

poultry production in village settings faces a number of constraints including poor health, insufficient nutrition and poor housing (Queenan *et al.,* 2016).

Poor health is the main constraints of poutry production in village chickens due to many diseases which affecting chickens. According to available information, the disease has been reported in all regions of Tanzania, affecting all age groups and causing high mortality rates, sometimes up to 100% (Buza and Mwamuhehe, 1999; Yongolo *et al*., 2002). Newcastle disease is an acute, contagious, rapidly spreading viral disease, causing, neurogical, gastrointestinal and respiratory signs to village chickens of all ages (Okeke and Lamorde, 1988). In Tanzania, control and prevention of Newcastle disease outbreaks rely on vaccination and biosecurity. The vaccines that are commonly used are live vaccines and include those using the I-2 or La Sota strains (Young *et al*., 2002).

Rural communities have a wealth of indigenous knowledge on diseases including diagnostic skills and awareness of the mode of transmission of disease (Yongolo *et al*., 2002; Jibril, 2014). It is imperative to make the best use of this knowledge and develop appropriate disease diagnostic systems in rural areas. Such systems should be action-oriented and should contribute to disease control activities that are designed in partnership with poultry keepers (Catley *et al.,* 2012) In general, the production of village chickens can be enhanced through a combination of husbandry practices, supplementation of feeds, prevention, and control of diseases and good housing (Queenan *et al.,* 2016).

1.2 Problem Statement and Justification

High mortalities of chicken occur in rural areas and there are several studies that established relative causes of chicken mortalities in Tanzania (Yongolo *et al*., 2011; Yongolo *et al.,* 2002). Poultry diseases are one of the major causes of chicken mortalities.

Newcastle disease was mentioned to be among poultry diseases causing high mortality rate in chickens (Alders *et al.*, 2000; Ashraf and Shah, 2014; Abdisa and Tagesu, 2017) With regard to Manyoni District, the pattern of disease epidemics suggests that Newcastle disease might be the major killer of chickens in rural areas (Buza and Mwamuhehe, 1999; Minga *et al*., 2001; de Bruyn *et al*., 2017). It appears that the period in which the disease and deaths occur differs from one area to another. However, the disease can be prevented through the use of vaccine and biosecurity. The extent of farmer's awareness in the use of vaccine between vaccinating and non-vaccinating areas is not reported in Manyoni communities.

Likewise chicken keeper's attitude and practices regarding Newcastle disease have not been reported. The purpose of this study, therefore, was to gauge farmers' understanding of the disease, the pattern (spatial, geographical, seasonal and trend) of the spread of disease with a view to understanding farmer's knowledge in prevention and control of Newcastle disease. The information obtained from the study would help to refine methods for limiting the spread and impact of Newcastle disease.

1.3 Objectives

1.3.1 General objective

To determine factors which contribute to the spread of Newcastle disease to the chickens in rural communities along the Rift valley area of Manyoni District, Tanzania.

1.3.2 Specific objectives

i. To investigate local knowledge, practice and attitude of rural poultry keepers in Manyoni District regarding Newcastle Disease.

ii. To establish and gauge the effects of seasonal and spatial patterns, as well as occurrence and on the spread of Newcastle disease among the chicken populations in Manyoni District.

iii. To assess poultry production systems and management practices that might affect the spread of Newcastle Disease.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Epidemiology of Disease

Epidemiology is the study and analysis of the distribution (who, when and where), patterns and determinants of health and disease conditions in defined populations. The application of the study is to the prevention and control of disease problems. Epidemiology involves data collection on determinants (causes, risk factors) and distribution (frequency, patterns) and events in a specific population in the community (Bonita and Beaglehole, 2006). Information in the community can be collected through the use of participatory epidemiology methods (Jibril *et al*., 2015).

2.2 Participatory epidemiology

Participatory epidemiology is a field that uses participatory techniques to gather qualitative epidemiological information within the communities. These techniques are used to extract information through observations, existing veterinary knowledge and traditional oral history to extract information (Mariner, 1999). Drawing on the knowledge of rural people, who possess creative strategies and analytical capacity to address issues that affect their lives, can greatly assist in the development of improved livestock practices (Chambers, 1991). The knowledge including indigenous veterinary knowledge which is based on oral traditions can be collected through the use of participatory methods. This information helps in sharing the life experiences of individuals. Fundamentally, indigenous veterinary knowledge is based on observations of pathology and epidemiology (Action Aid, 1998). Through the use of these techniques, the researchers can recognize the availability of knowledge in the community. The rural people have a lot of information about the animals they keep and serious constraints like

diseases that are encountered during the periods of raising livestock (Jost *et al.*, 2007; Catley *et al.*, 2012; Jibril, 2014).

2.2.1 Principles of participatory epidemiology

In many cases, participatory epidemiology is an important qualitative process, which involved qualitative data or information. In veterinary diagnostic methods, it involves a clinical examination, including compiling the historical background of the animal and a post-mortem examination (Catley and Mariner, 2002). Participatory epidemiology also includes assessments of professional, cultural preferences and biases in the community. It involves learning from rural farmers by active listening without lecturing (Jost *et al.*, 2007).

2.2.2 Participatory epidemiology methods

Interviewing, scoring, ranking, and visualization are participatory epidemiology methods that are used to gather information in the community. These methods either can be used all together or alone depending on the kinds of information to be collected (Jost *et al.*, 2007).

2.2.2.1 Semi-structured interview

A semi-structured interview is a major tool for participatory epidemiology which involves the use of checklists of topics to be covered rather than the use of a structured questionnaire (Jost *et al.*, 2007). Apart from using structured questionnaires, participatory epidemiology uses semi-structured interviews as a guide in conversation (Slim and Thomson, 1994). The interviewer can structure the questions depending on his/her interest based on the type of information to be collected.

The semi-structured interview can be used in a combination of visualization and ranking scoring methods (Mariner and Roeder, 2003; Bagnol, 2008; Ahlers *et al.*, 2009).

2.2.2.2 Ranking and scoring

Ranking and scoring techniques are used mostly to collect information which needs discussion and decisions to compare findings. The decision should be initiated by the community and further analysis should be carried out. The techniques use simple ranking like pair-wise ranking (matrix scoring) and proportional piling as reported by (Jost *et al.*, 2007). However, simple ranking uses an arrangement of items or matters according to criteria set up, while the pair-wise ranking is used to compare individuals with all matters or items one-by-one.

The resulting scores after ranking are used to inform the discussion and decision before further analyses are carried out. To improve the accuracy of the information, probing questions are employed to understand the relative importance of information. For example. The ILRI (2009) reported on the use of ranking and scoring method to determination livestock population and contribution of income in the community.

2.2.2.3 Proportional pilling

This method uses a pile of counters such as (stones or seeds) to get numerical data. A pile of the counter is placed on the subject matter depending on the decision of respondents and the counter is deemed to be the answer of respondents. The method can be repeated with individuals or groups to collect more accurate information before being summarized and analyzed through the use of conventional statistical tests (Jibril, 2014).

2.2.2.4 Matrix scoring

In the method, a list of items is described within a matrix format. For example, the method can be used to identify a specific disease and the names of diseases are matched against the clinical signs or causative agents. The method use characteristics of livestock diseases and the meaning of local names to describe and to identify the disease. Matrix scoring can work together with proportional piling exercises as reported by Catley *et al.,* (2001). These tools use local characteristics to compare items (Catley, 2006; Admassu *et al.,* 2005).

2.2.2.5 Visualization tools

Visualization tools are used for the type of data that could not be expressed verbally or in writing rather than in drawing diagrams. Constructions of diagrams use local material to describe and to present information (Catley *et al.,* 2011). In some cases, these diagrams did not provide enough information because of the use of local materials which lack enough space to describe and to present all features and signs around the areas. Visualization tools use seasonal calendars, diagrams and maps to describe and to present information in the area (Jost *et al.,* 2007).

2.2.2.6 Seasonal calendar

A seasonal calendar is used to identify the problems and issues that vary across the seasons. Most of disease epidemiology data use the seasonal calendar to identify disease occurrence and the spread of disease. The main interest of the seasonal occurrence of diseases is to understand the relationship to seasonal factors such as climate, management practices and vectors (ILRI, 2009). The seasonal calendar can be used in animal health and human livelihoods to study seasonal differences in disease incidence and variation

(Catley *et al.*, 2002). Likewise, Bagnol (2008) reported on the use of seasonal calendar to assess the consumption of livestock products and livestock trade.

2.2.2.7 Participatory mapping

Participatory mapping is the most useful tool in the early stages of disease research. The reason for starting with this tool is that it facilitates the involvement of a good number of participants by stimulating a lively discussion within the group. The tool uses disease mapping to get an overview of the spatial distribution of community resources, like the livestock population, herding patterns, livestock populations contact structure and spatial distribution of risk factors. In mapping diseases, the outbreaks of disease for both spatial and temporal are identified. Participatory mapping is used within the rural and urban communities where participants can indicate the locations, time of events, clinical sign and another sequence of events that reflect the spread of disease within the community (Jost *et al.,* 2007). Also, the mapping is used to indicate livestock movement, water points, grazing points and spatial incidences to disease agent or vectors (Hadrill and Yusuf, 1994; Catley, 2004).

2.2.3 Applications of participatory epidemiology

For over twenty years to date, the participatory epidemiology approach has been expanded and used in many countries and organizations to collect information in communities. The approach used published and non-published participatory epidemiology training materials to collect specific information in the community. International organizations like the Food and Agriculture Organization of the United Nations and the African Union Inter-African Bureau for Animal Resources have supported participatory epidemiology through the provisional of training material to support the government's veterinary services (Mariner and Paskin, 2000; Catley, 2005). Participatory epidemiology

is used for research with local prioritization of disease surveys and economic study in the community. In a disease survey, participatory epidemiology is used to gather information about disease surveillance, assessments of veterinary services and disease economic impacts to the community (Bekele and Akuma, 2009).

2.3 Newcastle Disease

2.3.1 History and definition of new castle disease

Newcastle disease is a viral disease that affects birds. The disease appeared to be the greatest constraint to the development of rural village chicken production in most developing countries (Yongolo *et al.,* 2002; Abraham-Oyiguh *et al.,* 2014). The disease is caused by a specific virus of the avian paramyxovirus type I (APMV-I) serotype of the genus Avulavirus belonging to the subfamily Paramyxoviridae, family Paramyxoviridae (OIE, 2009). Possible origins for the virus are suggested to be a mutation in virulence of a related chicken virus, resulting in an illness, infection with a virulent virus or changes in genetics and husbandry of the host (Spradbrow, 1988). The first outbreak of Newcastle disease was recognized in Java, Indonesia 1926. The first outbreak recognized as Newcastle disease occurred in Java, Indonesia 1926. In that year and the following year, it was recognized in other parts of Asia (Korea, India, and the Philippines) (Spradrow, 1988). It has been suggested that a large outbreak in Scotland in 1896 was due to Newcastle disease virus (NDV). In 1927, ND was also reported in Ranikhet in India, which give the disease its name across Asia. Newcastle disease spread widely after its first recognition in Indonesia and this was the first of the number of recorded panzootics (Spradbrow, 1988).

The origin of the virus is suggested to be from a mutation in virulence of a related chicken virus until then has caused in apparent illness, infection with a virulent virus or changes in

genetics and husbandry of the host (Spradbrow, 1988). In Tanzania, outbreaks of Newcastle disease have been reported but the history of the first outbreak of Newcastle disease is not recorded (Yongolo *et al.*, 2002). The disease appears to have several names depending on the location and meaning of languages used by the community. For example in Tanzania, different names have been used to describe Newcastle disease such as “Mdonde”, “mdondo” or “sotoka ya kuku” in Swahili (Yongolo *et al.,* 2002), “rufwa la ng’uhu” in Bena language and “Kifwa” or “Ikula” for Nyamwezi and Sukuma people. All names convey the meaning of plague or fatality.

2.3.2 Seasonal variability

Awan *et al.* (1994) reported on occurrences of Newcastle disease to the rural poultry, said that disease occurs throughout the year in the rural poultry populations in most countries. However, the seasonal incidence and severity of the disease have been reported by many authors. Jibril (2014) reported that in Nigeria cases of Newcastle disease occur throughout the year but that incidence being highest between January and March, which is the harmattan period when there are extreme cold and wind. The population dynamics of village flocks may also contribute to the seasonal occurrence of Newcastle disease epidemics. Seasonal peaks in egg-laying and hatching increase the numbers of susceptible birds, which are needed to fuel an outbreak, at particular times of the year (Spradbrow, 1988). However, seasonal conditions may be only indirectly involved. Increased movement of chickens may be the direct influence (Awan *et al.,* 1994). In Uganda, it has been suggested that outbreaks of Newcastle disease during the dry season coincide with the travels of unemployed agricultural workers who carry chickens as gifts when they visit relatives (Spradbrow, 1988). Outbreaks occur in other countries as flock numbers increase in anticipation of various festive markets (Spradbrow, 1988; De Bruyn *et al.*, 2017).

2.3.3 Epidemiology of new castle disease

2.3.3.1 Molecular bases for pathogenicity of new castle disease virus

Cleavage of the F protein during viral replication in the host plays a major role in the virulence of the virus (Alexander *et al.,* 2004; Saif *et al.,* 2008). Velogenic and mesogenic strains of Newcastle Disease virus can replicate systemically due to the active state of the F protein. Due to the lack of multiple basic amino acids in low-virulence strains, the F protein must be cleaved by secretory trypsin-like proteases which are limited to the mucosal membranes in the respiratory and gastrointestinal tracts. Low-virulence strains are not able to replicate systemically due to the limited availability of these trypsin-like proteases. Upon infection with Newcastle disease virus, macrophages of the immune system of chicken produce type-I and type-II interferon (IFN) (Seal *et al.,* 2000). Ten genes encode chicken type-I IFN (ChIFN1) while only one gene is responsible for chicken type-II IFN (ChIFN2). Newcastle disease virus can replicate in macrophages despite the immune system response. Peripheral blood lymphocytes and heterophils induce apoptosis when infected with the virus (Seal *et al.,* 2000).

2.3.3.2 Spread of new castle disease virus

The spread of Newcastle disease virus within the village and between villages depends on the village poultry population, climate conditions, production systems and management systems (Awan *et al.,* 1994). The major routes of transmission are through the respiratory tract, the ocular mucous membranes, and the digestive tract. The virus is shed from the respiratory tract and in the faeces and can spread from one chicken to another very easily via breathing contaminated air; drinking contaminated water; eating contaminated feed; contact with sick birds; contact with contaminated products (such as contaminated meat, intestines, egg, feathers); contact with people (the virus can travel on shoes, clothes etc.); contact with parts of infected birds (such as eggshells, feathers etc.), contaminated

chicken houses; contaminated cars, cages and baskets (Alders, 1999, Young *et al.,* 2002). However, other poultry species, wild animals, wild and feral birds, communal water reservoirs and domestic animals play a role in the transmission of disease virus (Awan *et al*., 1994).

2.3.3.3 Species susceptibility and reservoir

Newcastle disease is reported to affect a broad range of both local and exotic breeds of chickens (Sharif *et al*., 2014). Newcastle disease virus has a wide host range including at least 241 species, from 27 of the 50 orders of birds (Alexander, 1995). In poultry, chicken is more susceptible to Newcastle diseases than the other species while waterfowl, guinea fowls and turkeys are the natural reservoirs of Newcastle Disease virus and ducks tend to show no clinical signs (Martin, 1992).

2.3.3.4 Age susceptibility

Birds of all ages are susceptible to Newcastle disease (Abdu *et al*., 2005). However, Abdu and Garba (1989) reported that, a chick of less than two weeks of age may be less susceptible to Newcastle disease because of the high level of maternal antibodies and (Halle *et al*., 1999; Sa'idu *et al.,* 2006) have reported that chicks of 3-4 weeks of age are at risk of getting Newcastle disease because of a decline in the maternal antibodies. Birds of 9-10 weeks show more resistance to Newcastle disease because of age and immunity level (Sa'idu *et al.,* 2006).

2.3.3.5 Clinical signs of Newcastle disease

Clinical signs of Newcastle disease in chicken start to appear after the period of incubation which lasts for 2-15 days depending on the pathogenicity of the virus, age, host species, host immune status, stress, secondary infection and environment condition

the (Saif *et al*., 2008). The amount of virus and the route of transmission can play a big role in the length of incubation and to the servility of disease. The clinical signs of ND after incubation are gasping, sneezing, stretching of the neck, coughing, dyspnea, tracheal rales and opistothonus (Okoye *et al.,* 2000; Young *et al.,* 2002). Other clinical signs include a drop in feeding and water consumption, trembling, dropped wings, twisting of head and neck, weakness or paralysis of the legs and backward movement, greenish diarrhea, marked decrease in egg production and drop in eggs quality (Young *et al.*, 2002; Jibril, 2014).

2.3.3.6 Diagnosis of Newcastle disease

Newcastle disease can be diagnosed based on clinical signs, gross lesions and serological examination by particularly haemagglutination (HA) and haemagglutination inhibition (HI) test (Jibril, 2014). The clinical signs of Newcastle disease vary considerably according to the type of the virus involved, the type of bird, the age and health of the bird and environmental conditions. Consequently, no clinical signs can be regarded as specific for Newcastle disease.

For chickens which infected with strong strains of Newcastle disease Virus may die without showing any signs of illness (Young *et al.,* 2002). However, for weak strains of Newcastle disease virus, chickens show these signs, but sometimes not all signs will appear but some of them it may appear (Mathias, 2010). Greenish diarrhea is the most visible clinical sign that is apparent in local breeds while a marked decrease in egg production, shaking, twisted neck and paralysis of wings and legs sometimes are seen in advanced stages of the disease (Young *et al.,* 2002; Jibril, 2014). When observed, the clinical signs of Newcastle disease, post-mortem findings and presumptive field diagnosis of Newcastle disease will assist with determining the prevalence of the disease. However,

it is important to note that Newcastle disease cannot be distinguished from high pathogenic avian influenza based on clinical signs (Alders and Bagnol, 2007).

2.3.3.7 Contribution of the production system and management practices in the spread of Newcastle disease virus

The free-range system is the most common system that is used in rural areas to raise poultry. The system allows birds to scavenge around homesteads during the day while roosting inside the house at night (Alders, 1999; Yongolo *et al*., 2002). The less grid definition can be used to cover two types of free-range production systems in rural village chicken; extensive scavenging and small extensive scavenging depending on the size of flock and area (de Bruyn *et al*., 2017).

Poor management practices in the system may cause the greatest impact on the transamination of Newcastle disease virus (Sharif *et al*., 2014). These management practices including grouping poultry of different species, mixing chicken of different ages in one chicken house, leaving the dead chicken in open spaces and poor hygiene of feeding and water troughs (Sharif *et al*., 2014; Yongolo *et al*., 2002). Pond, well and pool water may contribute to the spread of disease virus to uninfected birds. The use of transport materials without fumigation may contribute to the spread of the disease virus (Alders, 1999). Also, the introduction of new flocks into poultry houses without fumigation and poor housing with poor ventilation may contribute to the spread of the disease virus (Sharif *et al.*, 2014).

2.4 Application of Local Knowledge to the Control and Preventions of Newcastle Disease

Jibril *et al.* (2015) reported on local indigenous knowledge possessed by local farmers towards common poultry diseases to the chickens. Most poultry keepers have a wealth of indigenous knowledge on disease occurrence and treatment of disease through the use of local remedies and antibiotics (Lagu and Kayanja, 2010). However, Nwanta (2003) reported that the use of indigenous knowledge is not enough to ensure good health to the birds due to poor knowledge and understanding of the etiology, pathology and measures on control of Newcastle disease.

2.5 Chicken Keepers Attitudes Toward the spread of Newcastle Disease Virus

Jibril (2014) reported on chicken keeper's attitudes towards the influence on the spread or controlling of the spread of Newcastle disease virus. These attitudes include selling off their stocks when the birds are in the incubation phase of Newcastle disease and sometimes even soon as they show signs of disease which reported by Awan et al., (1994). Jibril (2014) also reported the use of dead chickens as a source of food for their family and leave the dead chicken in open spaces without properly disposing of them; the tendencies of returning poultry from market to their homestead; mixing of different poultry species with different age groups in the same poultry house and de Bruyn *et al*. (2017) reported on poultry keepers to share their room with poultry.

2.6 Control of Newcastle Disease

Newcastle disease to the village chickens can be controlled through the use of vaccine and biosecurity. Through the use of the vaccine, inactivation of the Newcastle disease virus is one of the methods used to control Newcastle disease. The virus of Newcastle disease is resistant at the freezing point for an indefinite period also can survive to a

temperature up to 130 ºF (56ºC) for 3 hours, and pH 2-12 (Sharif *et al*., 2014). In warm and humid conditions and other poultry materials, NDV can survive for several weeks. In feaces and dust, Newcastle disease virus can survive for up to 12 weeks (Alders, 1999). The killing of Newcastle disease virus requires proper methods of disinfection. These methods are chemical and physical. The chemical method can use lime water and formaldehyde to kill while the physical method uses ultraviolet light and extended drying (Sharif *et al.*, 2014).

Generally, chicken cannot be cured once they get sick from this disease. The only way to combat Newcastle disease is to stop the chicken from getting to the disease. Under village conditions, vaccination is the best way of preventing the chicken from getting sick from Newcastle disease (Alders, 1999). The vaccines in use are mostly live and include the I-2 or La Sota strain of Newcastle disease virus (Young *et al.*, 2002).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of the Study Area

The study was carried out in Manyoni District in Singida Region, Tanzania. This longitudinal study comprises twelve rural villages in four adjoining wards of Manyoni District in the semi-arid central zone of Tanzania. Study sites were selected based on recommendations of poultry vaccination programs which conducted in two wards and absent in other two wards. The District was selected because of the high mortality rate and morbidity rate in poultry and that there is no enough information on diseases which cause high mortality of poultry in the District.

3.1.1 Climate conditions

The District has a unimodal rainfall regime, which is concentrated in a period of six months from November to April (de Bruyn *et al.,* 2017). The average long-term mean annual rainfall is 624 mm. The long-term mean number of rainy days is 49 with a standard deviation of 15 days and a coefficient of variation of 30.6%. The temperature varies according to altitude. The annual maximum daily temperature is 24.4°C (November) and the minimum is 19.3°C (July) respectively (Mary and Majule, 2009; MDC, 2016). Temperatures in the Rift Valley areas vary according to altitude but generally range from about 15 °C in July to 30 °C during the month of October. Moreover, temperature differences are observed between day and night and may be very high, with hot afternoons going up to 35 °C and chilly nights going down to 10 °C. The average annual daily sunshine hours are 7.9 h/day. Winds follow a monsoonal pattern, being north-easterly during the months of November to March and south-easterly for the

rest of the year (dry season). From May to October, the winds are usually dry and contribute to the semi-aridity of the area (MDC, 2016).

3.2 Study Design

3.2.1 Selection of wards and villages

A list of all wards and villages conducting vaccination campaigns against Newcastle disease and those which do not conduct vaccination campaigns was prepared by the District Livestock Extension Officer. Multi-stage sampling technique was adopted to select respondents for the study. In the first stage, the wards were selected purposively based on geographical location (Rift Valley) and then two wards were selected from the wards which are conducting Newcastle disease vaccination campaigns and another two which do not implement vaccination campaigns. Three villages from each ward were selected randomly as epidemiological units, to give a total of twelve villages.

Table 1: Selection of wards and villages of Manyoni District involved in the study

Wards	Category	Names of Villages
Ward 1 (Majiri)	Vaccinating	Mpandagani, Majiri and Kinangali
Ward 2 (Sanza)	Vaccinating	Sanza, Ntope and Ikasi
Ward 3 (Sasajila)	Non-Vaccinating	Chibumagwa,Sasajila and Makasuku
Ward 4 (Chikuyu)	Non-Vaccinating	Mwiboo, Chilejeho, and Mtiwee

3.3 Data Collection

3.3.1 Household questionnaire

The questionnaire was administered to individuals in households raising chickens in all twelve villages. Qualitative information was gathered from five households in each

village. The selection of respondents was based on the list of households raising chickens in a village prepared by the Village Livestock Extension Officer. A respondent from each household was selected to respond to the questionnaire. The questionnaire comprised of questions on poultry production systems and management practice, local knowledge practice and attitudes on Newcastle disease.

3.3.2 Chicken trader questionnaire

The trader questionnaire respondents were obtained from four wards, where the list of traders had been prepared by the Livestock Extension Officer and selections were conducted to obtain five respondents from each ward. Twenty traders were interviewed to establish the role of poultry markets in the maintenance and spread of Newcastle disease.

3.3.3 Focus group discussions

Focus group discussions were conducted in four wards and involved three villages from each ward. Groups of ten to twelve participants were formed in twelve villages in four wards. The participants were selected randomly from the list of households which raise chicken in each village. A cross-sectional study was carried out using participatory epidemiological approaches for data collection. The information on existing local knowledge, practice and attitude of rural poultry keepers were collected. The effects of seasonal and spatial patterns and vegetation on the occurrence and spread of Newcastle disease among the community flocks were also collected. The Participatory epidemiology methods employed were semi-structured interviews (SSI), ranking, scoring, proportional pilling, seasonal calendars, participatory mapping and transect walking to collect information as described by Jibril (2014) and detailed below:-

3.3.3.1 Semi-structured interview for focus group discussion

The semi-structured interview was used at every stage of the participatory process and in all the villages in combination with other tools, to gather information on ethnoveterinary knowledge about poultry diseases, with an emphasis on Newcastle disease. Participants were asked to list the different livestock species they kept and to categorize them based on population, contribution in household income and other basic need in the household. Also, participants were asked to mention the different poultry diseases that affected their chicken. The participants were asked to describe local treatment methods and other methods used to control and prevent Newcastle disease. The interviews were guided by a checklist of open-ended questions using Ranking Pairwise as adapted by (Mariner, 2003; Bagnol, 2008).

3.3.3.2 Pairwise ranking

The pairwise ranking was used to compare individual poultry diseases identified in the semi-structured interview with other poultry diseases one by one. The names of poultry diseases were written vertically (y-axis) and horizontally (x-axis) on a piece of cardboard. For each pair of diseases (x, y), participants were asked which poultry disease is more important. The pile of 100 beans was used by participants to indicate poultry disease. Probing questions were asked, such as why a participant thought a particular disease and why was more important than another.

Figure 1: Participants of Makasuku Village participating in the identification of which poultry disease is more important than other (Source: G. Kiswaga 2018)

3.3.3.3 Ranking method

3.3.3.3.1 Proportional piling

Proportional piling was used to estimate the relative occurrence of poultry diseases, morbidity, mortality and case fatality of poultry diseases during the preceding 12 month period.

3.3.3.3.2 Relative occurrence of poultry diseases

The method adopted by Catley *et al*. (2001) was used for estimating the relative occurrence of poultry diseases. A pile of 100 beans was used to represent poultry diseases. The beans were divided among individual participants and then participants had to put the beans in different circles to represent poultry disease. Agreement levels between informants were assessed by the use of Kendall's coefficient of concordance.

3.3.3.3.3 Relative morbidity, mortality and case fatality of poultry disease

The estimation of morbidity, mortality and case fatality of major poultry diseases during the previous 12 months of the period in their flocks were used as described by (Bagnol, 2008). A pile of 100 beans was used to indicate poultry disease and then the beans were allocated to the participants. The participants then divided the beans into different circles to estimate the relative proportion of sick and healthy chicken during the 12 months. Then participants were asked to subdivide the beans belonging to sick circle into the relative number of chicken that died from each disease during the previous 12 month period.

Figure 2: Participants participating in scoring the relative occurrence of poultry diseases in Mtiwee village of Chikuyu Ward. (Source: G. Kiswaga 2018)

3.3.3.4 Matrix Scoring

Matrix scoring was used to recognize the local perceptions of the main clinical signs of poultry diseases. This tool was used as described by Conover (1999). A matrix was

written of poultry diseases horizontally (x-axis) on a piece of flip chart and main clinical signs were listed vertically (y-axis). The participants were asked to use 60 beans to rate each of main sign based on how commonly the disease is known and seen.

Figure 3: Participants discussing their perceptions of disease signs of different poultry diseases in Ikasi Village of Sanza Ward. (Source: G. Kiswaga 2018)

3.3.3.5 Seasonal and monthly scoring of Newcastle disease outbreaks

The method described by Catley *et al*. (2001) was adopted and used to identify the seasonal occurrence of Newcastle disease in the community. The participants were asked to mention or to list all months in the year and to divide it into the common seasons that are recognized by the community. The names of seasons were listed horizontally (x-axis) on a flip chart and participants in a groups were asked to use a total of 60 beans to rate or to indicate the seasonal occurrence of disease. Then, again the participants in a group were asked to use a total of 100 beans to rate the occurrence of Newcastle disease across the months.

Figure 4: Seasonal occurrence of Newcastle disease in Chibumagwa Village of Sasajila Ward according to focus group participants (Source: G. Kiswaga 2018)

3.3.3.6 Participatory mapping

Participatory mapping was used to provide information on poultry distribution and outbreaks of Newcastle disease to identify natural resources and infrastructure as described by Catley (2004). Participants were asked to indicate the location of key features in the village e.g. main roads, public places, areas of recent outbreaks, disposal sites, live bird markets, silos, resting points, farms, rivers, lakes, trade routes, slaughtering points. The map was drawn on a flipchart paper and this was conducted for four groups in each ward. Group sizes varied from ten to twelve people.

3.3.4 Secondary data

Secondary data was gathered from published and unpublished literature on Newcastle disease; along with geographical and socioeconomic information about the villages.

3.4 Data Management and Analysis

The data obtained from these participatory methods were entered and stored in Microsoft Excel 2010. Descriptive statistics were used, and the results were exported to Statistical Analysis System (SAS) and Statistical Package for the Social Sciences (SPSS) for analysis. The Chi-Square statistic was used for testing relationships between categorical variables. Agreements between informant groups on the data obtained from simple and pairwise ranking were assessed using Friedman's rank test (Conover *et al.*, 1999) and (Catley *et al.*, 2002). Agreement between participant groups on the data was obtained from proportional pilling, disease matrix impact scoring and seasonal scoring was assessed using Kendall's coefficient of concordance (W).

CHAPTER FOUR

4.0 RESULTS

4.1 Preliminary Information about the Study Area

4.1.1 Characteristics of the study population

The majority of the residents of the selected villages belong to the Gogo, Nyaturu and Sukuma ethnic groups. Most of them are involved in crop production and livestock keeping. However, there is a variation in settlement areas, crop production, livestock production and socio-economic systems between these three tribal communities. The majority of Gogo and Nyaturu tribal communities are settled near the village main road and their farms are far from their residences. But Sukuma tribal community lives some distance further from the village main road. All groups are involved in the production of crops and livestock. Food crops produced are sorghum, maize and sweet potatoes and these are cash crops they produce, green peas, sesame and sunflower.

4.1.2 Livestock production and contribution to livelihoods

4.1.2.1 Poultry production systems

The rate of respondents to the questionnaires was 100% and was comprised of rural poultry keepers from vaccinating and non-vaccinating wards. The main production system used in the study area was extensive system (free-range) with about 96.4% of participants use the extensive system to raise their chicken (Table 2).

Table 2: Poultry production system in the study area

vaccination status	Production system: Extensive system	Production system: Intensive system	Total percentage	Chi-square value ($\chi 2$)	P value
Vaccinating wards	48.3	1.7	50.0	0.0	1
Non-vaccinating wards	48.3	1.7	50.0		
Total percentage	96.7	3.3	100.0		

4.1.2.2 Types of chicken breeds raised by poultry keepers in the study area

Most of the poultry keepers in the study area raise local breed chicken. The results of the study show that 100% of participants raise local chicken (Table 3).

Table 3: Types of chicken breed raised by poultry keepers in the study area

	Chicken breed		Total percentage
vaccination status	Local chicken	Exotics chicken	
Vaccinated	50.0	0.0	50.0
Non-vaccinated wards	50.0	0.0	50.0
Total percentage	100.0	0.0	100.0

Livestock species numbers in the study area differ depending on the contribution of economic income, basic needs and disease incidences. Results from simple ranking and proportional pilling show that chickens are the most commonly raised species of all livestock species which constituted about 17.1%, followed by cattle with 16.4%. In non-vaccinating wards chickens were in the second position, constituting about 16.1% and the first position was cattle with 16.7% (Table 4).

Table 4: Livestock species composition in the community in vaccinating and non-Vaccinating wards

	Vaccinating wards			Non-vaccinating wards		
Livestock species	**Means ranking**	**Percentage**	**Rank**	**Mean Ranking**	**Percentage**	**Rank**
Cattle	18	16.4	2	18.9	16.7	1
Goat	17.2	15.7	3	16.6	14.7	3
Sheep	12.9	11.7	4	13.7	12.1	5
Donkey	6.5	5.9	8	7.5	6.6	7
Ducks	11.3	10.3	5	14	12.4	4
Chicken	18.8	17.1	1	18.2	16.1	2
Guinea fowl	3.8	3.5	10	5	4.4	9
Pigeon	8.8	8.0	6	8.6	7.6	6
Cats	5.5	5.0	9	4	3.5	10
Dogs	7.1	6.5	7	6.5	5.8	8
Total	**109.9**	**100**		**113**	**100**	

1= most populated 10= least populated. There is a statistically significant difference between ranks of the groups (Friedman test, vaccinating wards P = 0.011 and non-vaccinating wards P= 0.013)

The contribution of livestock species to the economic income of households in the study areas differed depending on the type of livestock species, population size and availability of markets. The results from the study area show that chickens were considered the most important contributor to household needs at 18.2% in both vaccinating and non-vaccinating wards (Table 5).

Table 5: Income contribution of livestock species in the households in vaccinating and non-vaccinating wards

Livestock species	Vaccinating wards			Non-vaccinating wards		
	Means ranking	%	Rank	Means ranking	%	Rank
Cattle	16	14.5	3.0	16.1	14.6	3
Goats	17.7	16.1	2.0	17.7	16.1	1
Sheep	11.2	10.2	5.0	12.8	11.6	4
Donkeys	7.5	6.8	6.0	6.6	6.0	8
Ducks	12.8	11.6	4.0	9.4	8.5	5
Chickens	20	18.2	1.0	20.0	18.2	1
Guinea fowls	6.5	5.9	7.0	9.4	8.5	6
Pigeons	6.5	5.9	8.0	5.2	4.7	10
Cats	6.5	5.9	9.0	7.2	6.5	7
Dogs	5.3	4.8	10.0	5.7	5.2	9
Total	**110**	**100.0**		**110.1**	**100.0**	

[1] To Interpret ranking, 1= highest contribution 10= the least contribution. There were statistically significant differences between ranks of the groups (Friedman test, in vaccinating wards P = 0.01 and non-vaccinating wards P= 0.009)

A result of the study area shows the contribution of livestock species to basic needs in the household. Chickens were considered to contribute much compared to other livestock species at about 22.2% in vaccinating wards and about 21.9% in non-vaccinating wards (Table 6).

Table 6: Basic need contribution of livestock species in the households in four wards

	Vaccinating wards			Non vaccinating wards		
Livestock species	**Means ranking**	**%**	**Rank**	**Means ranking**	**%**	**Rank**
Cattle	14	19.4	2	14.1	19.6	2
Goats	10.9	15.1	3	11.6	16.2	3
Sheep	7.7	10.7	5	5.6	7.8	7
Donkeys	4.5	6.2	8	4.3	6.0	8
Ducks	8.9	12.3	4	8.5	11.8	4
Chickens	16	22.2	1	15.7	21.9	1
Guinea fowls	5	6.9	7	6	8.4	5
Pigeons	5.2	7.2	6	6	8.4	6
Total	**72.2**	**100**		**71.8**	**100**	

[1] To Interpret ranking, 1= highest in contribution 8= lowest in contribution. There is a statistically significant difference between ranks of the groups (Friedman test, vaccinating wards P = 0.031 and non-vaccinating wards P=0.022)

4.1.3 Common Poultry diseases found in the study area

This study revealed that there are six major poultry diseases affecting chickens in selected villages namely *mdonde*-Newcastle disease, "*kupanza mazeru/manjano*"-Typhoid, "*kupanza sakami*"-coccidiosis, *vidonda mwiitwe*"-fowl pox, "*utitiri*"-ectoparasitism and "*Ntakwi*"-endoparasitism (Table 7).

Table 7: Comparison of poultry disease occurrences between vaccinating and non-vaccinating wards

	Vaccinating wards		Non vaccinating wards	
Disease	**Mean ranking**	**Rank**	**Mean ranking**	**Rank**
Endoparasite *(Ntakwi)*	8.3	3	4.2	5
Coccidiosis *(Kupanza sakami)*	4.2	5	3.2	6
Ectoparasite *(Utitiri)*	10	1	8.8	2
Fowl pox *(Vidonda mwiitwe)*	9.5	2	7.3	3
Typhoid *(Kupanza mazeru/manjano)*	7.3	4	6.5	4
Newcastle Disease *(Mdonde)*	2.7	6	12	1

[1] To Interpret ranking, 1= most important disease of economic importance; 6= the least important disease of economic importance. There is a statistically significant difference between ranks of the groups in vaccinating wards (Friedman test, in vaccinating wards was P = 0.06 and non-vaccinating wards 0.1)

4.1.4 Awareness of Newcastle diseases

Results from the study area supported the presence of awareness to poultry keepers concerning with respect to incidence, distribution and even the way to control the diseases (Table 8 and Table 9).

Table 8: Comparative awareness of participants in vaccinating and non-vaccinating wards on causative agents and the spread of Newcastle disease

Comparative awareness of participants in causative agents and spread of Newcastle disease in vaccinating and non-vaccinating wards	Percentage of participants in the Vaccinating wards	Percentage of participants in the Non-vaccinating wards	Chi-square value ($\chi 2$)	P – value
Awareness of causative agent (Virus)	8.3	43.3	29.4	0.0001
Entrance of the causative agent in the flock (Virus)	46.6	33.3	6.7	0.0098
The spread of the causative agent in the flock	46.7	48.3	0.4	0.5536
Does ND affect all group age in birds	46.7	31.7	8.0	0.0048
Mortality rate of birds may reach 100% sometime	46.7	50.0	2.1	0.1503
Transmission of disease from one village to other	50.0	48.3	1.0	0.3132
Contacts with infected birds or objects carried ND virus	41.7	21.7	10.3	0.0013
Dogs and cats can transmit NDV through birds carcass with ND	36.7	21.7	5.6	0.0184

Table 9: Comparative awareness of participants in vaccinating and non-vaccinating wards on control of Newcastle disease

Comparative awareness of participants in controlling and prevention of Newcastle disease in vaccinating and non-vaccinating wards	Percentage of participants to the Vaccinating wards	Percentage of participants to the Non-vaccinating wards	Chi-square value ($\chi 2$)	P value
Newcastle disease can be prevented through the use of the vaccine	45.0	31.7	24.8	0.0001
Possibility of controlling Newcastle disease within the flock	41.7	26.7	6.2	0.0125
Possibility of control of Newcastle disease outbreak in an area	46.7	23.3	15.6	0.0001
Treatment of Newcastle disease	41.7	21.7	10.3	0.0013
Return chicken from the market during of Newcastle disease outbreaks	36.7	18.3	8.1	0.0043
Avoidance of introduction of the new bird during Newcastle disease outbreak	1.7	28.3	20.3	0.0001
Avoidance of chickens contact with other birds	40.0	15.0	15.2	0.0001
Effect of good housing it on the disease	38.3	23.3	5.7	0.0169
Provision of supplementary feed can combat Newcastle disease	46.7	26.7	12.3	0.0005
Isolation of all sick chicken helps to control	38.3	13.3	15.0	0.0001
Slaughter the chicken that affected with Newcastle disease can help to control the spread of Newcastle disease	38.3	10.0	19.3	0.0001
To stop transferring of the affected or dead carcass with Newcastle disease can help to control Newcastle disease	36.7	23.3	4.4	0.035
Burying or burning all dead chicken with Newcastle disease can help to control Newcastle disease	40.0	13.3	17.1	0.0001
Waiting at least one months before re-stocking can help to control Newcastle disease	41.7	20.0	11.9	0.0006

Given the disease occurrences, the annual morbidity and case fatality in vaccinating wards were estimated and the results shows, annual Newcastle disease morbidity was 1.98%, fatality was 6.67%, overall flock morbidity was75.48% and overall case fatality was24.0%,(Table 10). There is a good agreement between the six informant groups (Kendall's Coefficient, W= 1).

Table 10: Participants response to morbidity rate and case fatality of poultry diseases in vaccinated wards

Vaccinating Wards	Means and standards devision of participants response				W
	ND Morbidity Mean±SD	ND case fatality Mean±SD	Overall case fatality Mean±SD	Overall flock mortality Mean±SD	
Majiri	3.3±1.5	12.67±8.0	20±5.0	71.67±5.6	1
Sanza	0.67±1.1	0.67±1.1	28±6.5	79.3±17.9	1
Over all mean %	1.98	6.67	24	75.48	

ND= Newcastle disease
SD= standard deviation
Kendall's Coefficient, W = 1

In contrast, the annual morbidity in non-vaccinating wards showed that Newcastle disease morbidity was36.65%, fatality cases (41.0%), overall flock morbidity 82.15% and overall cases fatality 66.84%, (Table 11). There is a good agreement between the six informant groups (Kendall's Coefficient, W= 1).

Table 11: Participants response to morbidity rate and case fatality of poultry diseases in non-vaccinated wards

Non vaccinating wards	Means and standards devision of participants response				W
	ND Morbidity	ND case fatality	Overall case fatality	Overall flock mortality	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Sasajila	36.3±12.5	40±10.0	63.67±18	80.3±11.59	1
Chikuyu	37±6.0	42±9.2	70±6.08	84±6.24	1
Over all mean %	36.65	41	66.84	82.15	

ND= Newcastle disease, SD= standard deviation

4.2 Existence of local knowledge and veterinary knowledge on Newcastle disease

This study revealed that rural poultry farmers believe they can differentiate Newcastle disease from another disease through the clinical signs of Newcastle disease (Table 8). The disease is called "*Mdonde*" in local vernacular, while the words "*kupanza ndedede*" refes to greenish diarrhea. Greenish diarrhea is the major clinical sign used to recognize Newcastle disease. The word "*Kupanza*" in native language refers to diarrhea while "*ndedede*" refers to the greenish color (Table 12).

Table 12: Comparative awareness of poultry keepers in vaccinating and non vaccinating wards on the signs of Newcastle disease

	Vaccinating wards		Non vaccinating wards	
Signs of Newcastle disease	**Number of participants response**	**Percen tage**	**Number of participants response**	**Percent age**
Swollen head (*Kufimba itwee*)	42	7.0	27	4.5
Respiratory difficulty *(Kuhema kwatabu)*	54	9.0	10	1.7
Greenish diarrhea*(Kupanza ndedede)*	139	23.2	200	33.3
Paralysis of legs or wings *(Kukosa ngufu mabava na magulu)*	63	10.5	33	5.5
Twisting of neck *(Kwigoda singo)*	34	5.7	32	5.3
Drop in egg production *(Kuchepuka kutagaa)*	60	10.0	21	3.5
Ocular and nasal discharges *(Kwilafya mate kumlomo)*	91	15.2	42	7.0
Ruffled feather *(Mawehea kwimaa)*	10	1.7	23	3.8
Loss of appetile *(Kuleka lyaa)*	42	7.0	38	6.3
High mortality rate *(Mafwa menji)*	65	10.8	174	29.0
Total	600	100	600	100

The natives believe that they can differentiate each disease from another disease through the use of clinical signs of the disease. Results from the study show that participants understood the scoring methods and they were able to distinguish a sign of a specific disease from signs of other poultry diseases (Table 13 and Table 14).

Table 13: Local perceptions of poultry diseases signs in vaccinating wards

Disease signs	**Means and standards division of participants response towards Poultry diseases signs**					
	Newcastle Disease *(mdonde)*	**Endoparasite *(Ntakwi)***	**Coccidiosis *(Kupanza sakami)***	**Typhoid *(Kupanza mazeru/manjano)***	**Fowl Pox *(Fidonda mwiitwe)***	**Ectoparasite *(Utitiri)***
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Red skin *(Ng'ingo ndung'u)*	2.17±4.02	5.5±11.2	1.16±2.8	1.67±2.5	6.17±2.4	43.3±13.2
Redish diarrhea*(Kupanza sakami)*	0	12.17±12.73	35±13.7	11.8±8.37	0	0.33±0.81
Wounds to the head *(Fidonda mwiite)*	11.5±8.36	0	0.67±1.6	1.83±4.4	38±15.7	8±11.79
Stunted growth, worm in feaces *(Ntakwi matondofi)*	0.83±2.04	44.33±8.23	2.33±3.6	4.33±4.8	6.17±7.6	2±3.16
White or yellowish diarrhea *(Kupanza mazeru/manjano)*	7.67±7.03	7.33±10.27	4.6±6.59	22.8±17.42	15±20.1	2.33±5.24
High Mortality rate (*Mafwa menji)*	11±11.02	3.5±5.5	5.83±8.2	8.33±8.85	13±10.8	18±12.71

SD= standard deviation

A number of informant groups = 6; There is a good agreement between groups (Kendall's Coefficient, W = 0.95).

Vernacular language words are italicized

Table 14: Local perceptions of poultry diseases clinical signs in non-vaccinating wards

Disease signs	**Means and standards division of participants response towards Poultry diseases signs**					
	Newcastle Disease *(mdonde)*	**Endoparasite *(Ntakwi)***	**Coccidiosis *(Kupanza sakami)***	**Typhoid *(Kupanza mazeru/manjano)***	**Fowl Pox *(Fidonda mwiitwe)***	**Ectoparasite *(Utitiri)***
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Greenish diarrhea *(Kupanza ndedede)*	42.67±8.2	1.5±1.37	1.5±1.37	14.167±7.49	0	0.167±0.41
Red skin (Ng'ingo ndung'u)	0	3.33±4.4	0	0	11±5.5	45.67±2.5
Redish diarrhea*(Kupanza sakami)*	2.5±2.5	9.8±5	42±6.5	4.8±2.04	0.33±0.51	0.167±0.41
Wondes to the head *(Fidonda mwiite)*	2.33±2.25	2.167±2.7	0.33±0.52	0.67±1.03	43±8.5	11.5±5.3
Stant growth, worm in feaces *(Ntakwi matondofi)*	0.67±1.2	38±1.4	1.33±2.2	8.67±3.26	1.33±2.16	10±6.26
White or yellowish diarrhea (Kupanza mazeru/manjano)	12.33±4.72	7.33±6.12	5.67±3.01	34±6.811	0	0.67±1.03
High Mortality rate (*Mafwa menji)*	27.33±4.3	1.33±1.5	0.33±0.5	10.5±6.5	11.33±7.9	9.167±5.34

SD= standard deviation

A number of informant groups = 6; There is a good agreement between groups (Kendall's Coefficient, W = 0.91). Vernacular language words are italicized

4.2.1 The use of local remedies and antibiotics to treat Newcastle disease in the study area

This study found that about 63.3% of rural poultry farmers in vaccinating and non-vaccinating wards use local remedies to treat Newcastle disease (Table 15).

Table 15: Participants response on the use of local remedies in chicken as treatment of Newcastle Disease

Vaccination status	The use of local remedies to treat Newcastle disease				
	Yes	No	Total %	Chi-square value ($\chi 2$)	P value
Vaccinating wards	28.34	21.66	50	2.5837	0.4603
Non-Vaccinating wards	35	15	50		
Total	63.34	36.66	100		

Types of local medicine used include neem leaves, aloe vera leaves, and moringa seed and leaves (Table 16). They use grinding and soaking methods to prepare local remedies. After the mixture is well prepared, they let chicken drink it.

Table 16: Types of local remedies and participants responds to the use of particular remedial in the community to treat Newcastle Disease

Vaccination policy	Percentage of participants response to the types of local remedies to treat ND						
	Aloe	Neem	Neem/aloe	Neem/aloe/ moringa	Total %	Chi-square value ($\chi 2$)	P value
Vaccinating wards	10.6	13.2	10.6	10.5	44.7	3.12	0.95
Non vaccinating wards	5.2	15.8	23.7	10.6	55.2		
Total	15.8	28.9	34.2	21	100		

Interpretation of "aloe"= aloe vera leaves but native language called "*madinkulilu*"
"Neem"= neem leaves, a native language called "*mwarubaini*"
"Moringa" = moringa leaves, a native language called "*mronge*"

4.2.2 The response to the use of local remedies to treat Newcastle disease in the study area

The result of using local treatment revealed that farmers believed there were about 36.9% recoveries, 50% no change and 13.2% increase in mortality rate (Table 17).

Table 17: Participants responded to local remedies to treat Newcastle disease

Vaccination policy	Percentage of participants response to the use of local remedies to treat ND					
	Recovery	No changes	Increased mortality	Total %	Chi-square value ($\chi 2$)	P value
Vaccinating wards	23.7	15.8	5.2	44.7	15.72	0.07
Non-vaccinating wards	13.2	34.2	7.9	55.3		
Total	36.9	50	13.2	100		

Moreover, farmers who use conventional medications such as antibiotics to treat Newcastle disease (Table 18).

Table 18: Participants response on the use of antibiotics as a treatment against Newcastle Disease in non-vaccinating wards

Wards	Use of antibiotics		
	Yes	No	Total percentage
Chikuyu	44.3	5.71	50
Sasajila	44.3	5.71	50
Total percentage	88.6	11.4	100

The types of antibiotics used are tetracycline, amoxicillin, and metronidazole for treatments. They mix antibiotics with water and administer it orally to chickens (Table 19).

Table 19: Types of antibiotics used and the participant's response on the use of particular antibiotics in the treatment of Newcastle disease in non-vaccinating wards

Villages	Tetra	Amox	Tetra/ Amox	Tetra/ Amox/Metra	Total percentage	Chi-square value ($\chi 2$)	P value
Mwiboo	8.5	3.4	1.7	3.4	16.9	15.18	0.4
Mtiwe	10.2	0.0	1.7	5.1	16.9		
Chilejeho	8.5	3.4	3.4	1.7	17.0		
Chibumagwa	8.5	3.4	5.1	0.0	17.0		
Makasuku	6.8	3.4	5.1	0.0	15.3		
Sasajila	5.1	6.8	5.1	0.0	16.9		
Total %	47.5	20.3	22.0	10.2	100.0		

Interpretation of "Tetra"= Tetracycline
"Amox"= Amoxicillin
"Metro" = Metronidazole

There were claims, antibiotics used to lead to recoveries 28.6%, no change and an increase in mortality rate 28.6% (Table 20).

Table 20: Participants assessment on the result of using antibiotics to treat Newcastle disease villages in non-vaccinating wards

Non vaccinating villages	Participants respond to the use of antibiotics to treat ND					
	Recovery	No changes	Increase mortality	Total percentage %	Chi-square value ($\chi 2$)	P value
Mwiboo	4.3	8.6	4.3	17.2	2.81	0.985
Mtiwe	5.7	7.1	2.9	15.7		
Chilejeho	4.3	8.6	4.3	17.2		
Chibumagwa	5.7	7.1	4.3	17.1		
Makasuku	4.3	4.3	5.7	14.3		
Sasajila	4.3	7.1	7.1	18.6		
Total percentage	28.6	42.9	28.6	100.0		

4.2.3 Access to veterinary services centers

The poultry keepers can access veterinary services centers for several purposes. They can access veterinary centers to seek disease information, treatment and even to get advice on livestock production. The outcome from the study area on accessing veterinary centers shows, about 45.0% of poultry keeper had access veterinary service and 55.0% did not (Table 21).

Table 21: Percentage of poultry farmers who access veterinary centers or consulting veterinary officers for veterinary services

	Access to Veterinary services				
Vaccination policy	**Yes**	**No**	**Total percentage**	**χ2**	**P value**
Vaccinating wards	26.7	23.3	50.0	1.7	0.1945
Non-vaccinating wards	18.3	31.7	50.0		
Total percentage	45.0	55.0	100.0		

It was informed that most of the poultry keepers in the study area treat cases of Newcastle disease themselves without consulting the veterinary officer that about (61.7%). Few about (13.3%) consult veterinary officer for treatments. The remaining, 13.3% consult veterinary officers and sometimes they treat Newcastle disease themselves. Only 11.7% of poultry keepers did not attempt any kind of treatment and prevention (Table 22).

Table 22: Persons administering treatments of Newcastle disease in the study area

	Who treat ND						
vaccination campaign	**Poultry keepers**	**Veterinary**	**Both**	**No treatments**	**Total %**	**Chi**	**P value**
Vaccinating wards	28.3	8.3	5.0	8.3	50.0	2.53	0.4701
Non-vaccinating wards	33.3	5.0	8.3	3.3	50.0		
Total percentage	61.7	13.3	13.3	11.7	100.0		

4.3 Occurrences of Newcastle disease

4.3.1 Seasonal distribution of Newcastle disease

Furthermore, participants were able to identify the seasonal occurrence of Newcastle disease. Participants showed a good agreement to identify the seasonal occurrence of disease. The agreements show, the outbreak is relatively high during the dry season for both vaccinating and non-vaccinating wards (Table 23).

Table 23: Seasonal occurrences of Newcastle diseases as described by poultry keepers in the study area

Seasons	Vaccinating wards		Non vaccinating wards	
	Participants response	Percentage	Participants response	Percentage
Mid wet season January –April *(Chifuku)*	4	1.1	5.0	1.4
Beginning Dry season (end of April-July) *(Mwanzo wa chibahu)*	46	12.8	85.0	23.6
Dry season (August-beginning of November) *(Chibahu)*	293	81.4	261.0	72.5
Beginning of the wet season (end of November-December) *(Mwanzo wa chifuku)*	17	4.7	9.0	2.5
Total	360	100.0	360.0	100.0

4.3.2 Monthly occurrences of Newcastle diseases as indicated by poultry keepers in the study area

Participants in the study area were able to identify the month in which Newcastle disease outbreaks occur. The results indicated by the participants show that there is good agreement between the groups of participants (Table 24). The outbreak or occurrence of Newcastle disease appeared to be higher in September in all wards in the study area.

Table 24: Monthly occurrences of Newcastle disease as indicated by farmers in four wards in Manyoni district

Month	Vaccinating wards		Non vaccinating wards	
	Participants response	Percentage	Participants response	Percentage
January *(Mwenzii wo Kwanza)*	2	0.3	4	0.7
February *(Mwenzii wekejete)*	0	0.0	8	1.3
March *(Mwezii waekadatu)*	2	0.3	8	1.3
April *(Mwezii mwekane)*	0	0.0	3	0.5
May *(Mwezii wehano)*	0	0.0	9	1.5
June *(Mwezii womtandatu)*	12	2.0	40	6.7
July *(Mwezii wompungate)*	5	0.8	23	3.8
August *(Mwezii womnana)*	102	17.0	47	7.8
September *(Mwenzii welichenda)*	373	62.2	252	42.0
October *(Mwenzii welikumi)*	81	13.5	172	28.7
November *(Mwezii welikumi ni monga)*	23	3.8	28	4.7
December *(Mwezii welikumi na miejete)*	0	0.0	6	1.0
Total	600	100	600	100

4.3.3 Spatial distribution of poultry diseases

In terms of spatial distribution, the study shows that there were variations in poultry distribution patterns among the communities. There were stable settlements near the main village roads with more chickens while in areas which are far away from main roads the populations are scanty. The outbreaks of Newcastle diseases started from the eastern parts of all wards with a percentage of 71.7% as results shown in the table below (Table 25).

Table 25: Sources of outbreaks of Newcastle Disease in the four wards of Manyoni District

Vaccination policy Vaccination campaign	Source of outbreak North	East	Total percentage	Chi-square value ($\chi 2$)	P value
Vaccinating wards	18.4	31.6	50	3.5294	0.317
Non vaccinating wards	10	40	50		
Total percentage	28.3	71.7	100		

4.3.4 Direct community observations

There is variation in settlement pattern among communities. Most communities are organized into linear settlements along major roads. Some form cluster settlements while others form relatively mobile population patterns. Outbreaks of Newcastle disease are closely associated with communities that have streams where migratory birds have contact with domestic birds and houses that are closely situated with live bird markets.

4.4 Poultry Production Systems and Management Practices

The rate of respondents to the questionnaires was 100% and was comprised of rural poultry keepers from vaccinating and non-vaccinating wards. The main production system used in the study area was the extensive system (free-range) with about 96.4% of participants using the extensive system to raise their chicken (Table 26).

Table 26: Poultry production system in the study area

Vaccination policy	Percentage of participants response to production system: Extensive system	Intensive system	Total percentage	Chi-square value ($\chi 2$)	P value
Vaccinating wards	48.3	1.7	50.0	0.0	1
Non-vaccinating wards	48.3	1.7	50.0		
Total percentage	96.7	3.3	100.0		

The system was dominated by indigenous chickens. Most of the poultry keepers in the study area raise local breed chicken. The results of the study show that 100% of participants raise local chicken (Table 27).

Table 27: Types of chickens breed raised by poultry keepers in the study area

	Percentage of participants response to chicken breed		Total percentage
vaccination policy	**Local chicken**	**Exotics chicken**	
Vaccinating wards	50.0	0.0	50.0
Non-vaccinating wards	50.0	0.0	50.0
Total percentage	100.0	0.0	100.0

Generally, most of the poultry keepers in vaccinating wards start a chicken flock by buying chickens from other poultry keepers while in non-vaccinating wards most of them start the flock by buying directly from the markets (Table 28).

Table 28: The origins or sources of the poultry flock in households in the study area

	Sources or origins of the poultry flock					
vaccination status	**Buying or exchange from keepers**	**Buying from markets**	**Gifts**	**Total Percentage**	**Chi-square value ($\chi 2$)**	**P value**
Vaccinating wards	36.7	5	8.3	50	21.4213	0.0001
Non-vaccinating wards	15	31.7	3.3	50		
Total Percentage	51.7	36.7	11.6	100		

4.5 Poultry Management System before and during the Outbreak of Newcastle Disease in the Study Area of Manyoni District

Participant's response on management practices were 100% and their responses are indicated in Table 29.

Table 29: Comparison management practices in vaccinating and non-vaccinating areas

Management practice before and during ND outbreak in the community	Percentage of participants to the Vaccinating wards	Percentage of participants to the Non-vaccinating wards	Chi-square value ($\chi 2$)	P - value
Chicken housing and cleanness				
Provisional of chicken houses	23.3	38.3	5.7	0.0169
Location of chickens during the day	50.0	48.3	1.0	0.3132
Location of chicks during the night	46.7	41.7	6.0	0.0496
Cleanness of chicken houses where they stay at night	36.8	51.0	4.5	0.209
Use of disinfectants to clean poultry house	3.9	-	1.9	0.16
Disposal of poultry manure	6.7	-	12.4	0.0062
Chicken feed and water sources				
Provisional of supplementary feeds	48.3	28.3	13.4	0.0002
Provisional of water to chicken	21.3	34.3	28.7	0.0134
Chicken survival during the period of outbreaks of ND				
Number of chicken prior to the outbreak	50.0	-	60.0	0.0001
Number of chicken after an outbreak	50.0	25.0	55.2	0.0001
Chicken survived outbreak	50.0	31.7	13.5	0.0002
Category of chickens survived the outbreak	61.2	38.8	15.4	0.0015
Chicken that survived two years of outbreak	47.7	21.7	10.3	0.0013
Management practice on housing, handling sick and dead carcass during outbreaks				
Use of disinfectants to clean poultry house	3.9	-	1.9	0.16
Uses of protective gear when handing sick chickens	10.0	3.3	2.0	0.128
Hand washing before and after handling sick chickens	25.0	13.4	3.5	0.1759
Handling of sick chickens in the flock	28.3	26.6	1.7	0.43
Disposal of dead carcasses	25.0	28.3	2.2	0.5361

4.6 Role of Poultry markets in the Maintenance and Spread of Newcastle disease in the Study Area

There are several markets in the study area which supports the persistence of poultry diseases. In the periods of Newcastle disease outbreaks, traders in markets were continuing buying chickens, and some stops and shifting to the other farmers (Table 30).

Table 30: The response of chicken's traders in the markets during disease outbreaks in the study area

Vaccination policy	Traders continuing buying chickens	Traders stop buying chickens and shift to onother farmers	Total Percentage	Chi-square value ($\chi 2$)	P value
Vaccinating wards	27.27	22.73	50	0	1
Non-vaccinating wards	27.27	22.73	50		
Total Percentage	54.54	45.46	100		

In the study area, chickens trader's use several means of transporting birds from the markets place to other markets or the final consumer (Table 31).

Table 31: Transport vessels used by traders to transport birds to other markets or the final consumer in the study area

Vaccination policy	Cars only	Cars and motorcycles	Motorcycle only	Bicycle only	Total Percentage	Chi-square value ($\chi 2$)	P value
Vaccinating wards	18.2	9.2	18.2	4.6	50	4.7778	0.443
Non-vaccinating wards	9.1	18.2	22.7	-	50		
Total Percentage	27.3	27.4	40.9	4.6	100		

In the markets area, traders use several ways of handling sick chickens. Some of the chicken's traders deciding to slaughter sick chickens and others left to die while few of them treat sick chickens (Table 32).

Table 32: The ways used by chickens traders to handle a sick chicken in the markets place in the study area

Vaccination policy	Isolation of infected birds from healthy	Left to die (Do nothing)	slaughtering of sick birds	Treatments of sick birds	Total Percentage	Chi-square value ($\chi 2$)	P value
Vaccinating wards	9.09	18.18	13.64	9.09	50	0.743	0.8631
Non-vaccinating wards	9.09	9.09	18.18	13.64	50		
Total Percentage	18.18	27.27	31.82	22.73	100		

In the markets area, there are a number of chickens dying because of poultry diseases. Chickens traders use several ways to deal with the dead chickens; the majorities of trades use dead chickens as a source of food and some dumping and left on open space and few of traders burying (Table 33).

Table 33: The response of chickens Traders toward the dead chickens in the markets area

Vaccination policy	Burying of dead birds	Dumping or left on open space	Dead chickens used as the source of food	Total Percentage	Chi-square value ($\chi 2$)	P value
Vaccinating wards	4.55	9.09	36.36	50	1.692	0.4291
Non-vaccinating wards	9.09	18.18	22.73	50		
Total Percentage	13.64	27.27	59.09	100		

CHAPTER FIVE

5.0 DISCUSSION

5.1 Poultry Population in the Study Area

In the study area, poultry constitutes the largest portion population-wise of all livestock species kept. Local chickens in the study area formed the largest portion of all poultry raised. This also was described and demonstrated in the work of Jibril (2014) by the use of proportional pilling and simple ranking of livestock species in Zamfara State, Nigeria. Mwapu and Ayi (2011) used the same methods and observed that local chickens constituted the largest population in the communities of the study areas of Plateau State in Nigeria. These findings are consistent with the findings that local chickens are the main source of income amongst livestock species found in the study area. Markets for local chickens and their products are high in the study area. Since markets are available, the village local chickens keepers are selling local chicken to get income that helps the families to acquire basic needs. Also, local chickens in the study area are used as a good source of food (nutrients) for their families. Besides, rural local chicken's keepers prefer to raise local chickens instead of exotics because of local chickens to be the parts of the culture and traditions as same results reported by Robyn (2012) also are more resistant to diseases, they hatch a high proportion of chicks and they can survive to harsh environment.

5.2 Poultry Disease in the Study Area

In the current study, the rural local chicken keepers reported that diseases are a major constraint facing rural local chicken production. Six major poultry diseases were reported in the area, namely: Newcastle disease, fowl pox, coccidiosis, typhoid, ectoparasitism, and endoparasitism. Similar findings have been reported by Butcher *et al.* (2009) and

Sadiq and Mohammed (2017) who observed that Newcastle disease, ectoparasitism, fowl pox, typhoid, endoparasitism, and coccidiosis were among the most economically important diseases in the production of rural poultry.

5.3 Awareness of Rural Poultry Keepers on Newcastle Disease in the Study Area

This study revealed a significant difference in awareness on Newcastle disease based on causative agents, means of spread, control, and prevention between vaccinating wards and non-vaccinating wards. In vaccinating wards, most participants were aware of causative agents, means of spread, control and prevention means compared to the participants from non-vaccinating wards. In vaccinating wards, the awareness of Newcastle disease helps local chicken keepers to prevent and control the outbreaks of the disease compared to the non-vaccinating areas. Similar findings have been reported by de-Bruyn *et al.,* 2017. The awareness gap on Newcastle disease between vaccinating and non-vaccinating wards may explain the higher incidences of Newcastle disease in non-vaccinating wards than in vaccinating wards.

5.4 Local Knowledge and Veterinary Knowledge of rural Poultry Keepers in the Study Area

This study revealed that there was a significant overlap of indigenous knowledge on Newcastle disease and modern veterinary knowledge among poultry farmers in the study area. Rural farmers possessed certain knowledge of Newcastle disease concerning clinical signs, occurrence, and contribution of environmental conditions to the spread of Newcastle disease. To the same extent, the knowledge helps the rural chicken keepers to control the spread of Newcastle disease. Similar findings have been reported by Jibril, (2014) who pointed out that rural poultry keeper had good indigenous and veterinary knowledge on clinical signs and the occurrence of Newcastle disease.

5.5 Local Knowledge and Practice of Rural Poultry Keepers on Newcastle disease

5.5.1 Use of local remedies to treat Newcastle disease

In the current study area, local chicken keepers use local remedies and antibiotics to treat Newcastle disease. The local remedies preferred by chicken keepers were neem leaves (mwarubaini), *Aloe vera* (madinkulilu) and moringa seeds and leaves (mronge). The local chicken keepers use the local remedies either singly or in combination to treat Newcastle disease. However, the majority of the chicken keepers use more than one type of ingredient to make a mixture, thus making it possible to control a broad range of diseases. This may be because the clinical signs of many diseases are relatively similar to each other thus making it difficult for the rural chicken keepers to differentiate between the diseases. Ibrahim *et al.,* 1984; Okitoi *et al.,* 2007 reported the use of broad-spectrum remedies to control various diseases at the same time. Chollom (2012) demonstrated the use of *Moringa oleifera* seed in the control of Newcastle disease and contended that the extracts from the seeds build a strong antiviral activity against Newcastle disease in local chickens. Durrani *et al.* (2008) reported on the use of neem (*Azadirachta indica*) and observed an improvement in antibody titer against Newcastle disease virus antigens and resulted in an increase of growth performance and gross return when 50 mL/L of the fresh drink of neem was used.

The commonly used way of administering local remedies was through the oral method. Some of the chicken keepers prepare the local remedies by chopping and grinding the material well, followed by mixing them in water to form suspension before being offered to chickens. Other keepers prepare the local remedies by soaking the material in water to form a solution without chopping or grinding. Furthermore, the results revealed that there were no significant differences between vaccinating and non-vaccinating areas in the use of local remedial to treat Newcastle Disease.

5.5.2 Use of antibiotics to treat Newcastle disease

In the study area, rural chicken keepers used antibiotics to control Newcastle disease. Most medicines used are prescribed for humans to control diseases, namely tetracycline, amoxicillin, and metronidazole. Similar, findings have been reported by Boamah and Agryare (2016) from their study in Ghana. In this study, twenty different antibiotics for ten classes of essential antibiotics that are prescribed for use by humans were employed (through drinking) in the treatment of different diseases namely Newcastle disease, fowl pox, coryza and coccidiosis.

From the farmer's responses, it appears that the administration of antibiotics did not have any effect on the survival rate of the birds. It seems that most of the rural chicken keepers use antibiotics on a trial-and-error basis in the treatment of chicken against Newcastle disease. The farmers used antibiotics that were easy to access either from hospitals or pharmacies. This finding should be a cause for concern given that antibiotics listed are not effective against viral diseases and the practice could contribute to antimicrobial resistance (FAO, 2016). The use of vaccines is the most effective means for the prevention and control of Newcastle disease in rural chicken populations. Alders, (1999) has reported the effectiveness of routine vaccination in the control of Newcastle disease in village chicken in Zimbabwe.

5.6 Effects of Newcastle Disease in the Study Area

Newcastle disease appears to be a great constraint to rural poultry production in non-vaccinating wards in the study area. The high mortality rates of village chicken are caused by Newcastle disease. The disease is considered to be a disease of economic importance in non-vaccinating areas in the study area. The result from the study area shows that Newcastle disease has a high morbidity of 36.65%, case fatality of 41% and overall flock

morbidity of 82.15% and overall case fatality of 66.84%. Jibril (2014) also reported that Newcastle disease is the disease of most economic impact and the greatest constraints to the production of local chickens in unvaccinated areas of Zamrafa State in Nigeria with a morbidity of 27.5 %, case fatality of 49.4 and overall flock morbidity of 61.67% and overall case fatality of 45.6%. Sharif *et al.* (2014) have also reported on the devastating effects of Newcastle disease on rural local chickens in Pakistan. The scenario appears to have been different in vaccinating wards where vaccination against Newcastle disease appeared to significantly reduce the impact of the disease. The disease ranked the least position concerning the mobility rate (1.98%). Similar, findings have been reported by de Bruyn *et al*. (2017).

5.7 Effect of another Poultry Disease in the Study Area

Ectoparasitism ranked first as the most economically important disease in poultry production in vaccinating households. Mites, lice, and ticks are the most obnoxious parasites affecting village chickens in causing morbidity through irritation and sucking blood. Usman *et al.,* 2012 reported that parasites like mice, mites and ticks were the most obnoxious in the poultry production sector in Sokoto, Western Nigeria. The results from the study ere, all free-range chickens were affected by ectoparasites. Furthermore, identifications were carried out to chickens; the parasites found were lice, tick and one of the hemiparasite species. In general, ectoparasitism was a disease of most economically important in areas where vaccination campaigns against Newcastle disease had been carried out.

5.8 Seasonal Occurrence and Spread of Newcastle Disease

The chicken keepers in the study area could associate the occurrence of Newcastle disease with seasonal patterns. They identified both high-risk months as well as the source of the

outbreak. Most participants indicated that Newcastle disease outbreaks were more likely to occur in the dry season (August to the beginning of November). This finding is similar but not identical to that of Yongolo *et al.* (2002) who reported the occurrence of Newcastle disease in free-range village chickens in Tabora-Tanzania during the dry season (between June and October). The participants suggested that outbreaks of Newcastle disease during the dry season are caused by many factors. There are movements of farmers (traveling from towns to villages); traders who come from town to buy chickens, the flock number increases which fuel the traders and wild birds to came. The outbreak of Newcastle disease in the study area was reported to peak in September. Yongolo *et al.* (2002) reported October as the month where Newcastle disease outbreaks were at their peak. The difference in monthly occurrences of Newcastle disease can be attributed to seasonal conditional variations and geographical location of the study area. Also, Spradbrow, (1988) reported that outbreaks of Newcastle disease in free-range village chicken can involve movements of infected chicken and movement of people. People contribute to the spread of Newcastle disease through the mechanical transport of Newcastle disease virus on fomites.

The chicken keepers reported that Newcastle disease outbreaks, to originate from the eastern part of the study area and to spread towards the west. This may be due to the direction of the wind and market location which are allocated in eastern parts of all wards which allows the movements of infected chickens and movements of people (Traders and other travelers). Also in the study area, there are several game reserves where the wild birds found.

5.9 Vaccination against Newcastle Disease

From the results obtained in this study, vaccination against Newcastle disease is perceived by farmers to be most effective if done at the beginning of the dry season, from May to July. Farmers must be made aware of the importance of revaccinating chickens every four months as this has been found to result in lower mortality and higher flock sizes (de Bruyn *et al.,* 2017). Also, the results from the study show, most of the farmers from non-vaccinating areas in the study were not aware of vaccination against Newcastle disease.

5.10 Attitudes and Practice Promoting Spread and persistence of Newcastle Disease in the Study Area

The attitudes of chicken keepers in the study area can influence the spread of Newcastle disease virus. These attitudes include the belief that it is acceptable to use dead carcasses as a source of food for their family and to leave a dead carcass in the open space without properly disposing of it. Poultry keepers believe that it is acceptable to leave poultry feaces in open spaces to dry. Proper disposing of faeces in the poultry houses did not appear to be practiced in the study area. There was also a tendency of returning poultry from the market and allowing them to mix with family flocks. Also, poultry keepers mix different poultry species with different age groups in the same poultry house. Also, there are some of the poultry keepers are sharing their dwellings with poultry in the study area. These attitudes and practices were promoting persistence and the spread of disease in the study area.

5.11 Poultry Production System

While the free-range system affords the good use of scavenged feed resources in villages, it can facilitate the spread of outbreaks of Newcastle disease in the study area. During the day village chickens are left to scavenge and at night they stay in the household or

chicken houses or outside (on trees or under storage structures or old houses). The system provides several routes of interactions between different poultry species from different households.

5.12 Management Practices

Management practices in the study area may also play a great role in the outbreak of Newcastle disease. Local chicken keepers house birds of different species in the same shelters, mixing chicken of different ages. Local village keepers dispose of the dead carcass in open areas. There is poor hygiene of feeding and water troughs in the study area. This situation contributes to the outbreak of diseases. Improper use of ponds and wells allows the contamination of water and Newcastle disease virus which contributes new infections to birds. Contaminated transport vessels which used to transport feed and chickens to markets are not fumigated. Also, new stocks are introduced in houses without fumigating the premises first. A lack of proper poultry production management practices in the study area may cause Newcastle disease to persist in the study area. Yongolo *et al.*, 2002; Jibril, 2014 and Sharif *et al*. (2014) reported the contribution of poor management practices to the outbreaks of Newcastle disease. The awareness gap on control of Newcastle disease between vaccinating and non-vaccinating wards may explain the higher incidences of Newcastle disease in non-vaccinating wards than in vaccinating wards. The study revealed a significant difference in awareness of Newcastle disease control through management practices between vaccinating wards and non-vaccinating wards. In vaccinating wards, the awareness of Newcastle disease which was rise through the project (Strengthening food and nutrition security through family poultry and crop integration in Tanzania and Zambia) helped local chicken keepers to prevention and controls the outbreaks of the disease compared to the non-vaccinating areas. Similar findings have been reported by de Bruyn *et al.* (2017).

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

From the findings of this study the following conclusion can be drawn, the majorities of village rural chicken keepers are full-time farmers with primary education or no formal education. Farmers in the study area possess local knowledge which helps to treat some of the poultry diseases but not Newcastle disease. The tendency of farmers to administer local remedies and antibiotics to treat Newcastle disease is not effective to the control of Newcastle disease and importantly, may contribute to the emergence of antimicrobial resistance.

There is a need of rising farmers awareness on the some of attitudes and practices which supports diseases persistence in the study area, the beliefs like accepting the use of dead carcasses as a source of food for their family and some of them leave a dead carcass in the open space without properly disposing of. Also, there are practices like a tendency of returning poultry from the market and allowing them to mix with family flocks and to mix different poultry species with different age groups in the same poultry house.

The risk of Newcastle disease outbreaks in the study area is between Augusts to the beginning of November each year, during the dry season. Newcastle disease outbreaks start from eastern parts of all wards in the study area. The vaccination against Newcastle disease will be more effective if it will be done at the beginning of the dry season, from May to July before the outbreaks started.

In the study, two ways of controlling and prevention of Newcastle disease were recognized (vaccination and biosecurity), but the most useful way of prevention and control of village chickens against Newcastle disease is the use vaccination.

The type of production system and poor management's practices of farmers in the study had a contribution to the persistence of Newcastle disease to the village chickens. During the day village chickens are left to scavenge and at night some of the chickens left outside on trees or under storage structures or old houses. The system provides several routes of interactions between different poultry species and other birds from the forest. Also, poor management practices in the study area had a contribution to the persistence of Newcastle disease. They are some of the practices were applied in the study area like the use of contaminated water, transport vessels with Newcastle disease virus to transport feed and chickens to markets. In the study area, there is a need for rising farmer's awareness of the factors contributes to the persistence of Newcastle disease in village chickens.

6.2 Recommendations

The following recommendations are suggested: -

i. There is a need for a molecular study on the strains of Newcastle disease virus in the study area.
ii. In non-vaccinating areas, awareness should be raised to poultry farmers regarding ND and its prevention and control measures during an outbreak of disease.
iii. In non-vaccinating areas, vaccination campaigns against Newcastle disease should be introduced given that vaccination has been found to effectively control the disease where free-range production systems are predominant.

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APPENDICES

Appendix 1: Checklist for participatory disease surveillance of Newcastle disease

A. Existing local knowledge and veterinary knowledge

No	Question	Number of answers
1.	The name of the respondent	
2.	Sex of respondent	Male……..…….....…..1 Female……..……..…….2
3.	Educational Qualification.	No formal education…....…..…….…….1 Primary education……..…….....2 Secondary school education…….……..……3 High education …….....…….…….…….4
4.	Age of respondent	Age (years) 16-18 …..…….……...1 18-30....…….....……..…….....…..2 31-40…….…….....…..……..…….....3 41-50 ……..……..……..…4 Above 50 …….....……...5 Don't know …….....98
5.	What are your main income-earning activities? (Circle as many options as apply)	Crop production……..……..……..…1 Livestock production…....….2 Civil servant…….....……....3 Trader…….....…….4 Small business…….....…5 Others…….....…96
6.	How many birds you have? (*it will be written in number*)	Local Chicken Exotic chicken Ducks Geese Guinea fowl Turkeys Other
7.	Did you treat sick bird with local treatment?	Yes……..……..……..…....1 No……..……..……..….2
8.	What did you use to treat these diseases with local treatment?	
	Newcastle	
	Results of using local remedial to treat of Newcastle disease	
	Endoparasitism (flat and roundworms)	
	Coccidiosis	
	Typhoid	
	Fowl Pox	
	Ectoparasitism (Lice, mice, and bags)	
9.	Did you treat sick bird with antibiotics treatment?	Yes……..……..……...…....1 No……..……..……..…….2

10.	What did you use to treat these diseases with antibiotics treatment?	
	Newcastle disease	
	Results of using antibiotics to treat Newcastle disease	
	Endoparasitism (flat and roundworms)	
	Coccidiosis	
	Typhoid	
	Fowl Pox	
	Ectoparasitism (Lice, mice and bags)	

B. checklist of existing local knowledge and veterinary knowledge

1. What are the different livestock species kept?
2. Which of these species is more in terms of population? (Proportional Pilling)
3. Why do we raise/rear chicken?
4. What are the different poultry diseases (local names) affecting this community and how do you recognize these different diseases?
5. How do you recognize ND?
6. Have you seen this disease before (clinical case definition with pictures of signs)
7. Can the disease be transmitted to other birds and how?
8. How do you treat this disease?
9. How do you prevent this disease?
10. Can human contact this disease and how?

B. Ranking and Scoring

i. Simple ranking

1. The ranking exercise of livestock population
2. The ranking exercise of livestock base on family income
3. Ranking exercise base on immediate family needs

ii. Pairwise ranking

1. Comparing the importance of different poultry diseases

iii. Proportional piling

1. Livestock population
2. Exercise on poultry disease importance to livelihood
3. Exercise to demonstrate the impact of poultry disease on flock size
4. Which of the poultry disease occurs most often?

iv. Scoring

1. Disease matrix impact scoring of poultry diseases and clinical signs

C. Visualization tools

i. Seasonal calendars

1. Seasonal calendar exercise
2. What are the different seasons in local names?

3. What are seasonal local factors? (E.g. weather, outbreaks, farming practices, availability of grains, wild birds, poultry population)
4. Which season do you have more outbreaks of ND?
5. Seasonal scoring of poultry disease using counters
6. Which months do you have more outbreaks of ND?

ii. Participatory mapping

1. A mapping exercise of key features related to the site of PE (e.g. resting points, public building, the location of recent outbreaks, poultry market, farms, rivers, lakes, trade route, slaughtering points)

Clinical case definition of Newcastle Disease for this study

Disease of poultry affecting all ages with followings

i. Ocular discharges
ii. Respiratory distress
iii. Greenish-watery diarrhea
iv. The decrease in feed intake
iv. Dragging of legs
iv. Torticollis

With or without

i. High morbidity and mortality
ii. Swollen of head
iii. Paralysis

Appendix 2: Questionnaire of knowledge practice and attitude of Newcastle disease of Manyoni District

A. Demographic data

No	Question	Number of answers
1.	Ward	
2.	Village	
3.	Number of respondents	
4.	Sex of respondent	Male…….....…..1 Female……..……..….2
5.	Educational Qualification.	No formal education…….……..…1 Primary education……..……....2 Secondary school education…..…..……3 High education…….....……..……..….4
6.	Age of respondent	Age (years) 16-18…….....……...1 18-30 ……...……...……..2 31-40……..…….……....3 41-50 ……....……...…4 Above 50 …….....……....5 Don't know ……...…….....98
7.	What are your main income-earning activities? (Circle as many options as apply)	Crop production……..…..……1 Livestock production……..……..……..….2 Civil servant……..……...…....3 Trader……..……..……..….4 Small business……..……...…..…5 Others……..……...….96

B. Newcastle disease (ND) awareness

1.	Have you heard of Newcastle disease *(use local name for ND)*	Yes……..……...….1 No……..……..……..….2	**SKIP**
2.	What are the common poultry diseases (*allow respondents to list diseases without prompting)*	Fowl pox…….……...….1 Lice ……....2 White diarrhoea.……..……...…3 Other, please the name ……..….96	
3.	How do you recognize Newcastle Disease? (*allow respondents to list signs without prompting)*	……1 ……...…….2 …….……...……3 …….……..……4 ……...….5	

4.	At what age do birds die more frequently?	Less than-4 weeks.....1 4weeks-8 weeks……..……..2 8weeks-16weeks .....3 Above 16week……..……4	
5.	Have you heard any outbreak of Newcastle disease?	Yes.....1 No…….……..…..….2	
6.	Do you record mortality during an outbreak?	Yes.....1 No……...…2	
7.	On average how many mortality per day/100 birds?	Less than 5 birds.....1 6-20 birds…….....2 more than 20……..…..…..…..3	
8.	What symptoms do you notice?	Swollen head.....1 Respiratory signs .....2 Greenish diarrhea .....3 Paralysis of legs or wings .....4 Twisting of neck .....5 Drop in egg production….…..……..6 Ocular and nasal discharges .....7 Ruffled feather…….……..……8 Others, specify……..……96	
9.	How many chickens usually survive during an outbreak of disease?	None …….……..…..….1 Very few.....2 Less than half……..……..3 More than half.…….…….4 They survive all……..……..…..…5	
10.	How do you treat the disease?	Antibiotics.....1 Vaccines.....2 Antiviral.....3 Local remedy……...…...…….…4 No treatment…….……..…....5 Others specify……..……..……6	
11.	Do you vaccinate against ND?	Yes…….……...……1 No…….……..……..….2	
12.	How often you vaccinate poultry against disease	Once per year……..…..1 Twice per year…….……2 Three times per year…….……...….3 Never……...…….4	
13.	At what age do you vaccinate?	All chicken…….……..…....1 Less than-4 weeks.....2 4weeks-8 weeks…….……..3 8weeks-16weeks .....4 Above 16weeks.……5	
14.	What is your source of the vaccine?	Market.....1	

		Government……..……..……..…..2 Others specify……..…….……3	
15.	What happened after vaccination?	The death of birds due to disease decrease…….…..…1 Number of a bird dying increased……..…….2 There are no changes …….……3	
16.	Which season(s) of the year do you notice the disease outbreak	Begging of wet season/end of dry season…….....1 Mid-west season…….…2 End of wet season/begging of dry season…….....3 The beginning of dry season/end of the wet season …….…..4 Mid of dry season ……..…….5 End of dry season/begging of wet season…….……6 Don't know …...……...98	
17.	Where is outbreak starting from this village? *(cycle one option)*	North……..…….1 East……...……..……2 South……..….3 West……..…….…….4 Don't know ……...……...98	
18.	Have you heard of avian influenza?	Yes ……..……1 No ……..… 2 Don’t know ……...……...98	

C: Knowledge practice and attitude on Newcastle disease

S/N	ITEM	AGREE	DISAGREE
1	Have you heard about Newcastle disease?		
2	Newcastle disease is a common disease		
3	Newcastle disease is a very dangerous disease		
4	Newcastle disease is a viral disease		
5	Can ancestors and spirit cause this disease?		
6	Can witches send this disease?		
7	Newcastle disease virus enters into flock through on food, people, eggs, and vehicles?		
8	ND virus affected birds can spread the virus within the flock by aerosol?		
9	Does Newcastle disease affect all age group of birds?		
10	Newcastle can cause high mortality rate sometimes up to 100% of the flock		
11	Newcastle disease can be transmitted from one village to other		
12	Newcastle disease can be prevented		
13	Newcastle disease can be prevented through a vaccine		
14	Do you vaccinate chicken that is showing signs of illness		
15	Do you vaccinate a chicken once an ND outbreak has commenced in a village?		
16	Newcastle disease can be controlled		
17	Vaccinating the birds against Newcastle disease will help to prevent a disease		
18	Treatment of Newcastle disease will help to control the disease		
19	Once in the area, it is possible to control Newcastle disease		
20	No matter what you do, to control Newcastle disease is impossible		
21	To avoid the introduction of new birds to flocks during the periods of the year when ND occurs more frequently can help to control ND		
22	Not returning chicken from the market after you failed to sell can help to control ND		
23	To avoid contact with people, cars and animals that have been in contact with the virus and other parts of infected chicken (e.g. eggs, feathers, etc.) can control ND		
24	Dogs and cats can also transmit the virus if they have access to chicken killed by ND.		
25	To minimize contact between chicken and other poultry, such as ducks, pigeons, turkeys, and guinea fowl can help		

	to control ND		
26	The good housing can reduce disease transmission. An elevated chicken house that is well- ventilated allows faeces to fall through to the ground and so minimizes contact with various infectious agents. Keep chicken and chicks away from the base of the chicken house where the faeces have accumulated or clean the area regularly.		
27	Providing supplementary feed, such as maize bran, ground grains, green leaves, insects, insect larvae, and worms. Good nutrition will give the chicken a better chance of combating infections.		
28	Isolating all sick chicken helps to control ND		
29	To slaughter chicken that is very ill can help to control the disease		
30	By stopping the transport of chicken that is ill or dead to other areas those are free of the disease can help to control an ND		
31	Burying or burning all dead chicken can help to control ND		
32	Waiting for at least one month after the last mortality before re-stocking can help to control ND		

E. Production system

1.	Type of farm	Rural……..…..….1 Backyard……....….2 Small-scale Commercial……..….3	
2.	Type of birds reared	Local chicken.....1 Exotic chicken……..…...…2 Ducks .....3 Geese .....4 Guinea fowl.....5 Turkeys.....6 Other ……..…...…….....…96	
3.	How many birds do you have? (*it will be written in number*)	Local Chicken Exotic chicken Ducks	

		Geese Guinea fowl Turkeys Other	
4.	Type of management system	Intensive.....1 Semi-Intensive .....2 Extensive……..….....3	
5.	Category of birds	Local chicken……..…..…...….....1 Layers……..….....……2 Broilers 3	
6.	Sources of flock (origin) birds	Markets.....1 Commercial hatchery …….…….....2 Inheritance .....3 Gifts .....4 Other ……..……....96	
7.	Location of chicken during the day	Free-ranging…….…….…...1 Enclosed pen……...…2 Cage…….....…….....3	
8.	Location of chicken at night:	Outside, no housing provided……..……..1 Chicken house…….....2 Human house…….....3 Other, what? ……..……..96	
9.	Is supplementary food provided to your chicken?	Yes …….....1 No…….……2	
10.	What is the type of feed you're feeding?	Cereals.....1 House remnants .....2 Commercial feed…….....3 Others…….…….....96	
11.	What is a source of water to your chicken?	Stream……..……1 Rain.....2 Well .....3 Borehole .....4 Tap water.....5 Other ……...……..96	

F. Management practices during a disease outbreak

1.	How many chickens do you have prior to an outbreak?	Less than 5 birds……...1 6-10 birds…….…….2 More than 10…….…..……..3 More than 20…….4	
2.	How many chickens survive an outbreak?	None ……..……..….1 Less than 5 birds……...……2 6-10 birds……..3 More than 10…….…..……..4 They survive all……5	
3.	There any chicken was sitting on the eggs where survived an outbreak?	Yes……1 No…….2	
4.	Did you have a poultry house at the time of a disease outbreak?	Yes ……...……....1 No…….……2	
5.	How often do you clean your poultry house?	Sometimes……..…..…..……..1 Rarely .....2 most times .....3 Never…….....4	
6.	How or where did you dispose of poultry manure? (More than one option can be circled)	Dispose of in the toilet…….……1 Dispose of in the field/bush……..2 Bury……...3 Left in open space to dry……...……...4 Don't know……..……98 Others (specify) ……..96	
7.	Does any chicken leave to scavenge during an outbreak survive?	Yes……..……..1 No…….…2	
8.	What is the age category most affected by the disease?	Less than-4 weeks.....1 4weeks-8 weeks…….....2 8weeks-16weeks .....3 Above 16weeks……4	

9.	Do chicken that survived also survive the next or future epidemics?	Yes……..……..1 No…….……2	
10.	With what do you usually clean your poultry houses?	Sweeping only.....1 Sweeping with disinfectants(wood ash).....2 Others specify ……..…3	
11.	Do you put on protective clothing while handling sick birds?	Yes.....1 No……..……...2	
12.	How often do you practice hand washing after handling a sick bird?	Never.....1 Rarely .....2 Sometimes…….……3 Mostly .....4 Always……..……5	
13.	How do you handle sick birds in the flock?	Removal from the flock (isolation) …….....1 Do nothing .....2 Slaughter.....3 Other, what? ……...96	
14.	Did you treat a sick bird	Yes ……..……..…1 No…….....2	
15.	Did you consult veterinarians for ND cases?	Yes ……..……..…1 No…….....2	
16.	Who treats a sick bird	Consult Veterinarians for treatment……..……1 Myself by the use of local treatment.....2	
17.	Did you treat sick bird with local treatment?	Yes……...1 No…….2	
18.	What is that local treatment? (*record it in writing*)		
19.	What happened after the treatments?	Death in the flock stopped……..……..……1 Number of a bird dying increasing……..…….2 Number of birds dying is still the same even after	

		treatment ……..……..…….3	
20.	How do you dispose of dead carcasses?	Bury.....1 Burning .....2 Rubbish heap .....3 Consumption…….……...4	

G: The role of poultry markets in the maintenance and spread of Newcastle disease

The name of ward…….…….

Name of village…….

Name of poultry market…….……..

A number of traders……..……

1.	What is the source of the birds	Direct from poultry keepers…….....1 From another trader……..……...2	SKIP
2.	Where did you sell your birds	Market……..…...……1 To the consumer…….……...…….2	
3.	What the main means of transportation to the market	Car…….……...……....1 Bicycle……..…...2 Foot……...3 Other means mention…….……96	
4.	The average number of birds you take to each market site	0-10……1 20-50…….…....2 50-100…….…..…3 More than 100……..……4	
5.	Have you heard about Newcastle disease?	Yes…….……..…1 No ……...…2	
6.	Newcastle disease is a common disease	Yes……...….1 No……...……..…...2	
7.	Newcastle disease is a very dangerous disease	Yes…….……...…..1 No…….…….……2	

8.	In what season do you face more problems with ND? (*More than one option can be circled*)	Begging of wet season/end of the dry season.1 Mid-wet season……....2 End of wet season/begging of dry season…...3 Begging of dry season/end of the wet season...4 Mid of dry season ……..……..5 End of dry season/begging of wet season……6 Don't know ……..…...96	
9.	In which months did you face the problem of Newcastle disease? (*More than one option can be circled*)	January ……..…..…....1 February…….……..2 March……..…….……....…3 April ……..…..……....…..4 May …….……...….5 June …….……...….6 July …….....…7 August……...……..…8 September …….…...….9 October……..…….…10 November ……..…...11 December……..…..12 Don't know ……..……...96	
10.	Did you diagnose the health status of the birds before you bought them?	Yes……..……..…...1 No…….……..……...2	
11.	How can you identify a Newcastle disease? (*More than one option can be circled*)	Symptoms…….…..…...…1 Other, mention……..…...96	
12.	What clinical signs did you see during an outbreak of Newcastle disease (*More than one option can be circled*)	Swollen head.....1 Respiratory signs .....2 Greenish diarrhea .....3 Paralysis of legs or wings .....4 Twisting of neck .....5 Drop in egg production…….…..….....6	

		Ocular and nasal discharges .....7 Ruffled feather……..…….....…8 Others specify…….....…….……9	
13.	After you identify Newcastle disease what did you do in your business?	You stop buying from that farmer and continue to look for healthy chicken……..…..…....1 You continue to buy……..….2 You stopped doing this business …….....….3	
14.	How do you handle sick birds with Newcastle disease?	Removal from flock ……..……1 Do nothing .....2 Consult Veterinarian…….....3 Local treatment.....4 Slaughter.....5 Other, what? …….....…..96	
15.	Did you consult a veterinarian for treatment?	Yes……..…….....1 No……..2	
16.	Did you use any local treatment to treat sick birds during an outbreak?	Yes…….…1 No…….....2	
17.	What types of medicine are you using? (*Record them*)		
18.	How often are you cleaning your market sites including the cages?	Never.....1 Rarely .....2 Sometimes…….…..…...….3 Mostly .....4 Always……..……5	
19.	How did you usually clean your poultry houses or cage?	Sweeping only.....1 Sweeping with disinfectants(wood ash)….....2 Others specify ……..3	
20.	How do you dispose of poultry manure? (*More than one option*	Dispose of in the toilet……..….1 Dispose of in the field/bush……....2 Bury…….....3	

	can be circled)	Left on open space to dry……..….4 Don't know……...…96 Others (specify) ……..…….....99	
21.	Do you put on protective clothing while handling birds?	Yes.....1 No…….……...…….2	
22.	How often do you practice hand washing after handling the bird?	Never.....1 Rarely….....2 Sometimes…….……..….3 Mostly .....4 Always…….…….……..…….…….5	
23.	How do you dispose of dead carcasses that you thought died of Newcastle disease?	Bury….....1 Burning .....2 Refuse dumping .....3 Consumption……..……....…..4	
24. ave	Have you heard of avian influenza?	Yes ……..……...…1 No ……..2 Don’t know …….….98	

Appendix 3: Summary of results in four wards in Manyoni District

The use of local treatment					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	28.33	21.67	50	1.1483	0.2839
Non-Vaccinating wards	35	15	50		
Total percentage	63.33	36.67	100		

The type of local							
Vaccination status	Aloe	Neem	Neem aloe	neem aloe and moringa	Total	$\chi 2$	P value
Vaccinating wards	10.53	13.16	10.53	10.53	44.75	2.2849	0.5154
Non-Vaccinating wards	5.26	15.79	23.68	10.53	55.26		
Total percentage	15.79	28.95	34.21	21.06	100.01		

The result after treatments						
Vaccination status	Death stop	No changes	Increase the number of death	Total %	$\chi 2$	P value
Vaccinating wards	26.32	15.8	2.6	44.7	8.3	0.0158
Non-Vaccinating wards	7.89	39.5	7.9	55.3		
Total percentage	34.2	55.3	10.5	100.0		

The use of antibiotics			
Non vaccinating wards	Yes	No	
Chikuyu	44.3	5.71	50.0
Sasajila	44.3	5.71	50.0
	88.6	11.4	

	Types of antibiotics						
Non vaccinating wards	Tetra cycline	Amoxi cillin	Tetracy cline and amoxicillin	Tetracycline and metroni dazole	Total	$\chi 2$	P value
Chikuyu	27.1	6.78	6.8	10.17	50.9	9.81	0.0202
sasajila	20.3	13.33	15.3	0	48.9		
	47.5	20.1	22.0	10.2	100		

Awareness and attitudes

Hearing of ND				
vaccination status	wards	Yes	No	
Non-vaccinating wards	Chikuyu	50.0	0	50.0
Non-vaccinating wards	sasajila	50.0	0	50.0

ND is a common disease				
vaccination status	wards	Yes	No	
Non-vaccinated wards	Chikuyu	50.0	0	50.0
Non-vaccinated wards	sasajila	50.0	0	50.0

ND is dangers disease						
vaccination status	wards	Yes	No		$\chi 2$	P value
Non-vaccinating wards	Chikuyu	50.0	0	50.0	7.9	0.0049
Non-vaccinating wards	sasajila	50.0	0	50.0		

The causative agents DNV					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	8.3	41.7	50.0	29.4327	0.0001
Non-Vaccinating wards	43.3	6.7	50.0		
Total percentage	51.6	48.4	100.0		

NDV can inter into flock through food, people, eggs and vehicles					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	46.7	3.3	50.0	6.6667	0.0098
Non-Vaccinating wards	33.3	16.7	50.0		
Total percentage	80.0	20.0	100.0		

ND affect all age of the bird					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	46.7	3.3	50.0	8.0	0.0048
Non-Vaccinating wards	31.7	18.3	50.0		
Total percentage	78.3	21.7	100.0		

Birds with NDV can Spread disease					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	46.7	3.3	50.0	0.4	0.5536
Non-Vaccinating wards	48.3	1.7	50.0		
Total percentage	95.0	5.0	100.0		

ND can reach 100% of mortality rate within the flock					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	46.7	3.3	50.0	2.1	0.1503
Non-Vaccinating wards	50.0	0.0	50.0		
Total percentage	96.7	3.3	100.0		

ND can be transmitted from one village to the next					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	50.0	0.0	50.0	1.0	0.3132
Non-Vaccinating wards	48.3	1.7	50.0		
Total percentage	98.3	1.7	100.0		

Involvement in the Vaccination campaign					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	50.0	0.0	50.0	60.0	0.0001
Non-Vaccinating wards	0.0	50.0	50.0		
Total percentage	50.0	50.0	100.0		

vaccination number				
Vaccination status	Three	Twice	Once	Total
Vaccinating wards	76.7	20.0	3.3	100.0
Non-Vaccinating wards	0.0	0.0	0.0	0.0
Total percentage	76.7	20.0	3.3	100.0

Age of vaccination			
Vaccination status	Yes	No	%
Vaccinating wards	100.0	0.0	100.0
Non-Vaccinating wards	0.0	0.0	0.0
Total percentage	100.0	0.0	100.0

Vaccination result				
Vaccination status	Death stop	No change	Death increasing	Total
Vaccinating wards	90.0	6.7	3.3	100.0
Non-Vaccinating wards	0.0	0.0	0.0	0.0
Total percentage	90.0	6.7	3.3	100.0

ND is can be prevented					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	45.0	5.0	50.0	9.9	0.0016
Non-Vaccinating wards	26.7	23.3	50.0		
Total percentage	71.7	28.3	100		

ND can be prevented through the use of the vaccine					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	45.0	5.0	50.0	24.8	0.0001
Non-Vaccinating wards	31.7	18.3	50.0		
Total percentage	76.7	23.3	100.0		

Sick birds are vaccinated			
Vaccination status	Yes	No	%
Vaccinating wards	26.7	73.3	100.0
Non-Vaccinating wards	0.0	0.0	0.0
Total percentage	26.7	73.3	100.0

Vaccination during an outbreak			
Vaccination status	Yes	No	Total %
Vaccinating wards	26.7	73.3	100.0
Non-Vaccinating wards	0.0	0.0	0.0
Total percentage	26.7	73.3	100.0

ND can be Controlled					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	41.7	8.3	50.0	6.2	0.0125
Non-Vaccinating wards	26.7	23.3	50.0		
Total percentage	68.3	31.7	100.0		

Treatment of ND					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	41.7	8.3	50.0	10.3	0.0013
Non-Vaccinating wards	21.7	28.3	50.0		
Total percentage	63.3	36.7	100.0		

The control ND outbreak once to an area					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	46.7	3.3	50.0	15.6	0.0001
Non-Vaccinating wards	23.3	26.7	50.0		
Total percentage	70.0	30.0	100.0		

Introduction of a new bird in the flock					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	1.7	48.3	50.0	20.3	0.0001
Non-Vaccinating wards	28.3	21.7	50.0		
Total percentage	30.0	70.0	100.0		

Return of birds from market					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	36.7	13.3	50.0	8.1	0.0043
Non-Vaccinating wards	18.3	31.7	50.0		
Total percentage	55.0	45.0	100.0		

To avoid contact with birds, implements, and things or parts of infected					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	41.7	8.3	50.0	10.3	0.0013
Non-Vaccinating wards	21.7	28.3	50.0		
Total percentage	63.3	36.7	100.0		

Dog and Cat can transmit NDV					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	36.7	13.3	50.0	5.6	0.0184
Non-Vaccinating wards	21.7	28.3	50.0		
Total percentage	58.3	41.7	100.0		

To minimize contacts between chicken and another bird contact can help to control ND					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	40.0	10.0	50.0	15.2	0.0001
Non-Vaccinating wards	15.0	35.0	50.0		
Total percentage	55.0	45.0	100.0		

Good housing reduce transmission of ND					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	38.3	11.7	50.0	5.7	0.0169
Non-Vaccinating wards	23.3	26.7	50.0		
Total percentage	61.7	38.3	100.0		

Provisional of Supplement to chicken a better chance of combating infections					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	46.7	3.3	50.0	12.3	0.0005
Non-Vaccinating wards	26.7	23.3	50.0		
Total percentage	73.4	26.6	100.0		

Isolation of sick birds help to control					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	38.3	11.7	50.0	15.0	0.0001
Non-Vaccinating wards	13.3	36.7	50.0		
Total percentage	51.7	48.3	100.0		
Slaughter can help to control ND					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	38.3	11.7	50.0	19.3	0.0001
Non-Vaccinating wards	10.0	40.0	50.0		
Total percentage	48.3	51.7	100.0		

Stop transporting sick chicken help to control					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	36.7	13.3	50.0	4.4	0.035
Non-Vaccinating wards	23.3	26.7	50.0		
Total percentage	60.0	40.0	100.0		

Burning and bury all dead parts help to control ND					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	40.0	10.0	50.0	17.1	0.0001
Non-Vaccinating wards	13.3	36.7	50.0		
Total percentage	53.3	46.7	100.0		

Restocking of birds at least one month can help to control the disease					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	41.7	8.3	50.0	11.9	0.0006
Non-Vaccinating wards	20.0	30.0	50.0		
Total percentage	61.7	38.3	100.0		

Hearing of ND outbreak			
Vaccination status	Yes	No	%
Vaccinating wards	50.0	0.0	50.0
Non-Vaccinating wards	50.0	0.0	50.0
Total percentage	100.0	0.0	100.0

Average of chicken survived during an outbreak								
Vaccination status	Survived all	More than ten	Less than ten	Less than five	None	Total	$\chi 2$	P value
Vaccinating wards	36.7	6.7	3.3	3.3	0	50.0	55.2	0.0001
Non-Vaccinating wards	0.0	0.0	5.0	20.0	25	50.0		
Total percentage	36.7	6.7	8.3	23.3	25.0	100.0		

Source of outbreak					
Vaccination status	North	East	%	$\chi 2$	P value
Vaccinating wards	18.3	31.7	50.0	2.1	0.152
Non-Vaccinating wards	10.0	40.0	50.0		
Total percentage	28.3	71.7	100.0		

Production system					
Vaccination status	Extensive	Intensive	%	$\chi 2$	P value
Vaccinating wards	48.3	1.7	50.0	0.0	1
Non-Vaccinating wards	48.3	1.7	50.0		
Total percentage	96.7	3.3	100.0		

Chicken breed			
Vaccination status	Local chicken	Exotics chicken	%
Vaccinating wards	50.0	0.0	50.0
Non-Vaccinating wards	50.0	0.0	50.0
Total percentage	100.0	0.0	100.0

Origin or source of birds in the households							
Vaccination status	Buying from other farmers	Markets	Exchange from another farmer	Gifts	Total	$\chi 2$	P value
Vaccinating wards	36.7	5.0	6.7	1.7	50.0	21.4213	0.0001
Non-Vaccinating wards	15.0	31.7	0.0	3.3	50.0		
Total percentage	51.7	36.7	6.7	5.0	100.0		

Chicken during the day					
Vaccination status	Free-range	Enclosed	Total	$\chi 2$	P value
Vaccinating wards	50.0	0.0	50.0	1.0169	0.3132
Non-Vaccinating wards	48.3	1.7	50.0		
Total percentage	98.3	1.7	100.0		

Chicken overnight housing						
Vaccination status	Human house	chicken house	Outside	Total	$\chi 2$	P value
Vaccinating wards	20.0	26.7	3.3	50.0	6.0075	0.0496
Non-Vaccinating wards	30.0	11.7	8.3	50.0		
Total percentage	50.0	38.3	11.7	100.0		

Provisional of supplement					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	48.3	1.7	50.0	13.4	0.0002
Non-Vaccinating wards	28.3	21.7	50.0		
Total percentage	76.7	23.3	100.0		

Types of supplements					
Vaccination status	Cereal	Cereal and house remnants	Total	$\chi 2$	P value
Vaccinating wards	15.2	47.8	63.0	3.1	0.2085
Non-Vaccinating wards	10.9	26.1	37.0		
Total percentage	26.1	73.9	100.0		

Poultry house					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	23.3	26.7	50.0	5.7	0.0169
Non-Vaccinating wards	38.3	11.7	50.0		
Total percentage	61.7	38.3	100.0		

House cleanness							
Vaccination status	Rarely	Most time	Sometime	Never	Total	$\chi 2$	P value
Vaccinating wards	18.4	14.3	4.1	2.0	38.8	4.537	0.209
Non-Vaccinating wards	12.2	20.4	18.4	10.2	61.2		
Total percentage	30.6	34.7	22.5	12.2	100.0		

Disposal of manure							
Vaccination status	Dried in field	Pit	Dried in the field and left in open space	Left to dry in open space	Total	$\chi 2$	P value
Vaccinating wards	16.7	6.7	11.7	15.0	50.0	12.3599	0.0062
Non-Vaccinating wards	6.7	0.0	31.7	11.7	50.0		
Total percentage	23.3	6.7	43.3	26.7	100.0		

Average number of Chicken survived after the outbreak										
Vaccination status	More ten	More twenty	Less ten	Less twenty	Less five	More twenty	Less ten	Total	$\chi 2$	P value
Vaccinating wards	10.0	30.0	10.0	0.0	0.0	0	0	50.0	60	0.0001
Non-Vaccinating wards	0.0	0.0	0.0	11.7	3.3	31.67	3.33	50.0		
Total percentage	10.0	30.0	10.0	11.7	3.3	31.7	3.3	100.0		

Chicken survived during an outbreak when was sitting on eggs					
Vaccination status	yes	No	%	$\chi 2$	P value
Vaccinating wards	40.0	10.0	50.0	1.4	0.2
Non-Vaccinating wards	33.3	16.7	50.0		
Total percentage	16.7	26.7	43.3		

Served when left to scavenge					
Vaccination status	Yes	No	%	$\chi 2$	P value
Vaccinating wards	50.0	0.0	50.0	13.5	0.0002
Non-Vaccinating wards	31.7	18.3	50.0		
Total percentage	81.7	18.3	100.0		

Category of chicken survived							
Vaccination status	All age	Less five	Above sixteen	Less sixteen	Total	$\chi 2$	P value
Vaccinating wards	59.2	2.0	0.0	0.0	61.2	15.4071	0.0015
Non-Vaccinating wards	22.5	0.0	14.3	2.0	38.8		
Total percentage	81.6	2.0	14.3	2.0	100.0		

Chick survived the previous year and this year outbreak					
Vaccination status	Yes	No	Total	$\chi 2$	P value
Vaccinating wards	41.7	8.3	50.0	10.3	0.0013
Non-Vaccinating wards	21.7	28.3	50.0		
Total percentage	63.3	36.7	100.0		

The use disinfectants during house chicken cleanness					
Vaccination status	Sweep only	Sweep with disinfectant	Total	$\chi 2$	P value
Vaccinating wards	48.1	3.9	51.9	1.9	0.16
Non-Vaccinating wards	48.1	0.0	48.1		
Total percentage	96.2	3.9	100.0		

Wearing protective clothes during handling sick chicken					
Vaccination status	Yes	No	Total	$\chi 2$	P value
Vaccinating wards	10.0	40.0	50.0	2.0	0.128
Non-Vaccinating wards	3.3	46.7	50.0		
Total percentage					

Wash hand after handling sick chicken						
Vaccination status	Never	Rarely	always	Total	$\chi 2$	P value
Vaccinating wards	25.0	13.3	11.7	50.0	3.4758	0.1759
Non-Vaccinating wards	36.7	6.7	6.7	50.0		
Total percentage	61.7	20.0	18.3	100.0		

How do you care for sick birds						
Vaccination status	Slaughter	Isolate	Nothing	Total	$\chi 2$	P value
Vaccinating wards	13.3	15.0	21.7	50.0	1.7	0.43
Non-Vaccinating wards	18.3	8.3	23.3	50.0		
Total percentage	31.7	23.3	45.0	100.0		

Disposal of a dead carcass							
Vaccination status	Slaughter	Bury	Burn	Dump	Total	$\chi 2$	P value
Vaccinating wards	25.0	6.7	11.7	6.7	50.0	2.1792	0.5361
Non-Vaccinating wards	21.7	10.0	6.7	11.7	50.0		
Total percentage	46.7	16.7	18.3	18.3	100.0		

Handling of poultry manure							
Vaccination status	Left dry in the field	Pit	Dry in the field and left in open space	left to dry in the field	Total	$\chi 2$	P value
Vaccinating wards	18.3	6.7	10.0	15	50.0	9.6704	0.0216
Non-Vaccinating wards	6.7	6.7	28.3	8.33	50.0		
Total percentage	25.0	13.3	38.3	23.3	100.0		

Veterinary services					
Vaccination status	Yes	No	Total	$\chi 2$	P value
Vaccinating wards	26.7	23.3	50.0	1.7	0.1945
Non-Vaccinating wards	18.3	31.7	50.0		
Total percentage	45.0	55.0	100.0		

Who treats Newcastle disease?							
Vaccination status	Farmer	Veterinary	Both	No treatments	Total	$\chi 2$	P value
Vaccinating wards	28.3	8.3	5.0	8.3	50.0	2.53	0.4701
Non-Vaccinating wards	33.3	5.0	8.3	3.3	50.0		
Total percentage	61.7	13.3	13.3	11.7	100.0		