COST EFFECTIVENESS OF AND WILLINGNESS TO PAY FOR VACCINATION OF VILLAGE FREE-RANGE POULTRY AGAINST NEWCASTLE DISEASE IN IGANGA DISTRICT

BY

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DECLARATION

I **Mbabazi Esther Gloria** declare that this work is original and it is my own work. It has not been submitted in Makerere University or any other university for the award of a degree before.

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To my parents Mr. & Mrs. Mulekezi

&

My husband Emmanuel, son Ethan, siblings: Jackie, Carol, Richard and Timothy

As well as my nephews and nieces.

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LIST OF ACRONYMS

BCR	Benefit-Cost Ratio
CBA	Cost Benefit Analysis
CV	Contingent Valuation
DCE	Discrete Choice Experiment
IRR	Internal Rate of Return
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
KII	Key Informant’s Interview
MAAIF	Ministry of Agriculture Animal Industries and Fisheries
MFPED	Ministry of Finance Planning and Economic Development
MRS	Marginal Rate of Substitution
ND	Newcastle Disease
NGOs	Non-Governmental Organizations
NPV	Net Present Value
SPSS	Statistical Package for Social Scientists
UBOS	Uganda Bureau of Statistics
UNHS	Uganda National Household Survey
VIPOSIM	Village Poultry Simulation Model
WTP	Willingness to Pay

ABSTRACT

Newcastle disease is the major constraint to village poultry production in the world but more so in developing countries. Eradication of this disease is unlikely but it can be effectively controlled through vaccination. This study was conducted in Iganga district in *Bulyansiime* and *Kikunu* villages, purposively selected because of their high level of poultry activity, prevalence of Newcastle disease and limited vaccination intervention. The study sought out to determine the challenges that constrain the effective control of Newcastle among village chickens; to assess the cost-effectiveness of poultry vaccination against this disease and to determine the poultry farmers' willingness to pay (WTP) for its control through vaccination as well as the underlying factors that influence their willingness to pay. The methodology entailed use of descriptive statistics to establish the challenges whereas the benefit-cost ratio was used to determine the cost-effectiveness of vaccination and the *logit* model was used to determine the factors influencing poultry keepers' willingness to pay for vaccination.

The major challenges constraining effective Newcastle disease control were high cost of and lack access to vaccines and limited extension services. The costs and benefits pertinent to vaccination were analysed and a Benefit-Cost Ratio of 15:1 was obtained implying that it is cost effective and profitable to vaccinate poultry against Newcastle. Of the 240 poultry keepers in the study, 75% were willing to pay for vaccination and they were willing to pay a minimum of one hundred shillings per chicken which corresponds to the current market price charged for vaccination per bird in the area. Farmers' income, level of education, membership in a farmer group and total flock size positively and significantly influenced their WTP for vaccination. The female poultry keepers were more likely to pay for vaccination than their male counterparts. Poultry keepers

who mainly acquired their stock from the market, those that rear the birds mainly for income as well as those who had lost a large percentage of their flock in a previous outbreak were more likely to pay for vaccination in addition to those who had obtained positive results from previous vaccination. On the other hand, the poultry farmers that had challenges accessing extension services and those staying further away from the trading centres were less likely to pay for vaccination.

In order to effectively and sustainably control Newcastle and other poultry diseases, suitable extension programmes need to be developed and extensive disease control and vaccination campaigns should be embarked on with active involvement of the community leaders. Famers are advised to join farmer groups from which they can acquire and share knowledge and work jointly especially in combating epidemics. Government involvement in creating a suitable environment to enhance public-private partnerships in rural areas is of the essence; in addition to improvement of infrastructure in remote places. Since farmers' level of education significantly affects the decisions they make, it is suggested that community leaders urge them to send their children to school without segregation and the Government should make an effort to improve the quality of education services offered especially in rural areas.

CHAPTER ONE

INTRODUCTION

1.1 Background

In developing countries, many rural households keep poultry in their farmyard. Poultry provide food and a small cash income and are used as presents to strengthen social relationships (Udo *et al.,* 2006). Poultry farming represents one of the ways in which Africa has engaged to increase its production of animal protein. It offers the best yield in converting vegetable calories into high yield animal protein (Awuni, 2002). Farmers are, in principle, more willing to sell poultry and their products rather than the larger livestock. Poultry therefore represent a regular cash flow and since women and children are often in charge of the farmyard poultry, this provides them an opportunity to uplift themselves and earn an income (Awuni *et al.*, 2006). Local chickens play an important role in social life in villages during ceremonies, rituals, in traditional healing and gifts to respectable guests (Msami *et al.*, 2006). Hence their role cannot be over emphasized.

Village poultry production, specifically local chicken production, is widely practiced in Africa especially among rural communities. The village poultry production systems of Africa are mainly based on the scavenging indigenous chicken found in virtually all villages and households (Otim *et al*., 2007). These systems are characterized by minimal or no input supply in terms of feed and medication with low productivity. Nevertheless, over 70 percent of the poultry products and 20 percent of animal protein intake in most African countries come from village poultry. Therefore, increasing rural poultry production would result in a positive impact on household food security both in increased dietary intake and income generation (Awuni *et al.*, 2006). This would help to improve the welfare of society.

In Uganda the majority of people live in rural areas where they practice subsistence farming which hardly meets their food requirements (Ssewanyana *et al*., 2003). In these rural areas there are few opportunities for employment. Despite the economic shortfalls of those areas, there exist potential for harvesting and utilizing the existing resources for improved productivity for better living standards.

Among the resources available are the indigenous chickens (Ssewanyana *et al*., 2006) which they can rear and earn a living. Uganda has an estimated poultry population of 37.4 million birds (UBOS, 2008), more than 87 percent of which are local chickens managed under the free-range system in rural areas. In 2000, the chicken population was estimated at 30 million, of which 80 percent were indigenous breeds (MAAIF, 2000). These birds commonly referred to as “village chickens” in the literature, contribute to basic socio-economic welfare in rural families and play various cultural roles in communities (FAO, 2009). Village chickens are raised mainly in free-range, backyard or semi-intensive systems (Mukiibi-Muka, 1992; Byarugaba, 2007) but mainly free-range.

In many of the poorest rural households, indigenous chickens are the only livestock that the household owns, and are the main or only source of cash and/or savings for essentials and household emergencies (Bagnol, 2001). Indigenous chickens have, however, low productivity of meat and eggs caused by two major challenges. The first one is their inherently low genetic potential for those traits. The second is the high mortalities due to Newcastle Disease (Ssewanyana *et al*., 2006). This is an indicator of the importance of Newcastle disease in rural poultry production.

1.2 Poultry Production in Uganda

In Uganda, poultry production mainly comprises chicken production as the main type of poultry. However, there are other species including ducks, turkeys, pigeons, guinea fowls, geese and ostriches (Byarugaba, 2007). The poultry production in the country is conveniently categorised into two namely; commercial and free-range. The commercial system essentially refers to production with improved hybrid breeds and more recently with local breeds, under intensive confined management of uniform stocks and age-groups primarily for commercial purposes and they comprise twenty percent of the country’s total poultry (Byarugaba, 2007). On the other hand, free-range poultry comprises local indigenous breeds kept around peasant households and a few sub-urban homesteads (Ssewanyana *et al.,* 2003).

Free-range poultry are an important constituent of Uganda's animal industry with eighty percent of the country's chickens reared in traditional free-range systems in the villages (Otim *et al*., 2007); the highest percentage (37.3%) of which are found in the Eastern region (Byarugaba, 2007). Most flocks are of small size and mixed age, are distributed in many households usually 5-20 birds per household and feed mainly by scavenging (Alexander *et al.*, 2004) a feeding habit that exposes them to contact with wild birds which might be a source of ND virus infection (Otim *et al*., 2007). ND is the major constraint to village poultry production. The output of traditional village chickens in terms of weight gain and number of eggs per hen per year might be low but it is obtained with minimum input in terms of housing, disease control, management and supplementary feeding (Kitalyi, 1998; Alders and Spradbrow, 2001) thus a little extra input would yield more benefits.

1.2.1 Importance of Village Poultry

Although free-range (village) poultry production forms a large proportion of the poultry sector in Uganda, it does not rate highly in the mainstream economic importance. This is mainly because of lack of measurable indicators of its contribution to macroeconomic indices such as gross domestic product. Estimating the value of rural poultry is more difficult than for other livestock because of lack reliable production data (Byarugaba, 2007). Village poultry however play a vital role in sustaining the livelihoods of rural households especially women and children who are actively involved in the management of the local birds (Awuni *et al*., 2006). Village chickens are also one of the few types of livestock that cause little impact on the environment and that require few inputs in order to yield a significant output in terms of meat and eggs (Alders and Spradbrow, 2001; Alexander *et al.*, 2004). Byarugaba (2007) documented some outstanding attributes of the poultry industry in the livestock subsector: it contributes to improved human nutrition and food security by being a leading supplier of high quality protein in form of eggs and meat; it acts as a key supplement to revenue from crops and other livestock enterprises thus avoiding over-dependency on traditional commodities with inconsistent prices; and last but not least, poultry is highly prized in many social-cultural functions such as dowry and festivities.

Besides village poultry being a source of scarce animal protein in form of meat and eggs, Byarugaba (2007) asserted that they are available for sale or barter in societies where cash is not abundant. It was noted in this study that some of the poultry keepers exchange chickens for other livestock whereas others exchange eggs for household stuff. In one of the Focus Group Discussions (FGDs), a participant mentioned that when poverty stricken, she sometimes exchanges eggs for kerosene and another one exchanges them for pieces of soap at a nearby retail shop.

Furthermore, Byarugaba (2007) outlined some special advantages of poultry production over other enterprises. These include the following: poultry requires less land than crop agriculture and other livestock enterprises; it requires relatively smaller capital investment hence it is suitable for disadvantaged groups such as women, youths and the disabled. In addition, poultry production has high feed conversion rates; shorter generation interval therefore quicker returns on investment; poultry products are accepted in many cultures and religions; and poultry droppings can be recycled as organic fertilizers for sustainable crop production. Alexander *et al*. (2004) and Byarugaba (2007) further stated that village chickens also fulfil a range of other functions to which it is difficult to assign a monetary value. For instance they are active in pest control, provide manure, they are essential for traditional ceremonies and traditional treatment of ailments.

1.3 Poultry Diseases

Newcastle disease (ND) was revealed to be the major constraint inhibiting rural chicken development followed closely by poor housing that causes high chick mortality through diseases and predation. Besides ND, the other diseases documented to limit local chicken productivity include fowl pox, coryza infections, fowl typhoid, Infectious Bursal Disease/Gumboro Disease and parasitic diseases (helminthosis, external parasitism, protozoan diseases). Diseases are the number one causes of chicken losses in form of deaths or mortality. The importance of detecting and controlling the diseases cannot be overemphasized (Udo *et. al.,* 2006). ND is the major constraint to production of village chickens in many developing countries (Alexander, 1991; Spradbrow, 1988).

Circulating strains of ND virus are capable of causing 100 % mortality in unprotected flocks. Outbreaks of ND are unpredictable and discourage villagers from paying proper attention to the husbandry and welfare of their chickens (Alders and Spradbrow, 2001). According to the Iganga District State of Environment report (1997), Newcastle and Fowl Typhoid are major poultry diseases and they are very difficult to control in free range managed poultry as is the case in the district.

ND is a viral disease that mainly attacks poultry amongst which chickens are the most susceptible hosts. The virus is highly contagious and spreads in droppings and nasal discharge via direct contact, through the air, or on contaminated items such as bottoms of shoes, vehicles, food, or infected dishes and cages. The virus can also penetrate eggshells that come in contact with infected tissue or food, thereby, infecting the embryo (Spradbrow, 1999). Tomo (2009) asserts that the usual source of virus is an infected chicken, and spread is usually attributed to the movement of chickens through chicken markets and traders. A chicken incubating ND can introduce the virus to an isolated, fully susceptible flock, resulting in up to 100 % mortality.

The virulence of the disease depends on the particular strain of the virus. Of the highly virulent strains, which are particularly common in South-East Asia and Africa, some grow in the gut (viscerotropic strains), while others grow mainly in the central nervous system (neurotropic strains). The most common indication of a serious outbreak of a neurotropic strain of the disease is seen in a nervous symptom exhibited in infected birds where the neck twists right back and the chickens simply fall over and die (Alders and Spradbrow 2001). An endemic form of ND which causes only occasional deaths is recognized in village chickens. The number of deaths is relatively low and does not attract official attention. The affected flocks usually result from breeding birds that have survived an outbreak. Many birds are immune and the virus passes from one susceptible bird to another. This endemic form will often contribute to mortalities among young birds. Eventually there are enough susceptible birds to sustain an explosive spread of virus with numerous deaths (Spradbrow, 1999). Sometimes there is a hundred percent loss.

1.4 Problem Statement

Newcastle disease is a viral disease that mainly attacks poultry and chickens are the most susceptible hosts (Spradbrow, 1999). It is the most serious constraint for village chicken production throughout the world, particularly in developing countries (Branckaert and Guèye 1999). ND is the major disease that affects traditional small-scale free-range poultry production (Woolcock *et al.,* 2004). In a survey conducted in the North-Eastern, South-Western and central regions of Uganda, ND was clearly identified as the main constraint to rural poultry production and accounted for most of the losses (Poultry report, 2006). The extremely high prevalence, morbidity and mortalities reported for ND are the major factors that discourage peasants from investing much of their time and scarce resources in expanding flock size (Kugonza *et al.*, 2008). ND causes severe economic losses due to the increased number of morbidities, mortalities and a drop in egg production in laying chicken (Illango *et al.*, 2008). It has been acknowledged as the major factor hindering the improvement of rural poultry production in Africa and is responsible for losses of over 80 percent of household poultry annually (Wambura *et al*., 2000). Such a percentage is quite high and needs to be addressed.

The control of ND under free-range conditions is difficult to achieve. Vaccination is rarely provided for village chicken except in isolated cases in peri-urban areas (MAAIF, 2000). This is due to the inaccessibility of the birds, lack of cold chain facilities for the vaccine and logistical problems. There is also general lack of awareness by rural farmers of the need to vaccinate chickens (Copland, 2002) and some use traditional methods such as herbs to control poultry diseases (FAO, 2009). In that case, sensitizing them would increase awareness and enhance control.

Eradication of ND is unlikely and there are few poultry species which are resistant to the disease. Continual vaccination programs currently offer the only effective way of controlling ND (Udo *et al.*, 2006). Thus, chicken vaccination is one of the most important technical possibilities to improve village chicken production (Tomo, 2009). However, Spradbrow (1999) emphasized that before extensive vaccination is undertaken there is need for cost-benefit analysis.

Sustainable ND control requires maintenance of high levels of quality control in production, distribution and administration of the vaccine, all in a timely and low cost manner. Village chicken production systems are based on minimum input use with low productivity. Any cost-effective strategy without high capital costs that increases their productivity will assist in poverty alleviation and food security improvement (Alders and Spradbrow, 2001). Thus, investments in production and extension of technologies for ND control may have significant returns and, more importantly, may have a relevant role in the reduction of rural poverty and food insecurity (Tomo, 2009) which are major constraints in rural areas.

So far, poultry disease control strategies have not been sustainable, because they have not been demand-driven. Very few smallholder farmers request training and take it seriously, even where outbreaks of ND occur every year, with many birds dying. This could indicate that farmers do not observe any cost-recovery benefits in vaccinating, and also do not realise its importance (FAO, 2009). This calls for a cost-benefit analysis. Furthermore, Kitalyi (1998) suggested that transformation of Africa into economically viable enterprises would require better understanding of the socio-economic aspects of the production system. In Eastern Uganda, particularly in Iganga there is no vaccination strategy for free-range poultry as noted by the district veterinary officer in a key-informant interview.

This study seeks to assess the socio-economic effect and viability of vaccination of village poultry against Newcastle Disease. In addition, it will also explore other opportunities that may lead to successful ND control. The study was specifically on local chicken production.

1.5 Objectives of the Study

The main objective of this study was to assess the cost-effectiveness of vaccination of village free-range poultry against Newcastle Disease as well as analyse the community local chicken farmers' willingness to contribute towards control of the disease through vaccination. The specific objectives were:

1. To establish the challenges and limitations which constrain effective control of Newcastle disease in smallholder village free-range poultry production
2. To determine the benefits and costs of Newcastle disease control at community level
3. To determine the willingness of local chicken farmers to contribute towards Newcastle disease control.
4. To determine the factors influencing the local chicken farmers' willingness to pay for vaccination.

1.6.1 Hypotheses

1. The net benefits of controlling Newcastle Disease are significantly different from the benefits of not controlling it.
2. Farmers' level of education affects the price they are willing to pay towards Newcastle Disease control.

   A higher level of education was expected to increase farmers' ability to get, process, and use information. Thus, education was hypothesized to play a key role in the decision to pay for new agricultural technologies, in this case vaccination.
3. The farmers' previous experience with vaccination will influence their willingness to pay for vaccination against Newcastle disease.

1.7 Significance of the Study

Village chicken production has traditionally been under-rated in importance as a vehicle for rural development, due in many cases to the constraints that ND imposed on the development of this small scale industry (Gueye, 2000). Control of ND opens up further opportunities for improvement which hitherto were not feasible or worth undertaking. There are many improvements offering substantial benefits which can be achieved by farmers from within their own resources without cash expenditure or external assistance, except for appropriate extension advice. Examples would include measures for reducing chick mortality, predation and theft; management of other diseases; and improving flock management (Woolcock *et al*., 2004). The findings of this study will help community free range chicken farmers understand the benefits and costs involved in controlling Newcastle disease through vaccination and in turn they will be in a better position to effectively allocate their resources as well as prevent the disease. Possible solutions to the prevailing challenges which constrain poultry production will be suggested and once they are implemented the farmers' welfare will increase. Policy recommendations will be made pertaining to poultry disease control in rural communities and these will play a vital role in guiding policy makers in the implementation of sustainable projects.

CHAPTER TWO

LITERATURE REVIEW

For an in-depth understanding of the study, literature was reviewed concerning the challenges faced in the production of village poultry, the economics of animal diseases, the willingness to pay concept and the factors that influence local chicken farmers' willingness to pay for agricultural technologies.

2.1 Challenges encountered in Village Poultry Production

Despite its various advantages, the poultry industry faces various constraints ranging from socio-economic, through infrastructural to institutional and technical constraints. There are several challenges encountered in the marketing of village chickens. The success of a chicken production enterprise is judged by the quantity and quality of products sold (number of chickens and eggs) and consequently the amount of profit gained (Mapiye *et al*., 2008). There have been a few studies in Uganda that have examined the gross margin analysis and the determination of the beneficiaries in the marketing chain of chickens (Mukiibi-Muka and Kirunda, 2005). The main marketing channels for village chickens are from farmer to farmer/consumer or from farmer to retailer then consumer (Byarugaba, 2007). Marketing constraints exist because there is no conscious effort made to identify an existing market before production starts to maintain existing customers and attract new ones (Mapiye *et al*., 2008). Now that almost everyone in the village community produces some chickens and eggs for sale, there is need for effort by individual farmers to market their products. Furthermore, in rural areas transaction costs associated with selling village chickens are high (Mapiye *et al*., 2008) and they arise due to the low amounts of chickens and eggs sold at any given time, long distances travelled, poor infrastructure and lack of market information (Muchadeyi *et al.*, 2005).

Byarugaba (2007) outlined some key factors affecting marketing of local chicken in Uganda including seasonal availability of birds, lack of information on prices, lack of streamlined marketing organisation, transportation challenges and disease outbreaks. Seasonal availability of birds and price fluctuations depend on festivity seasons and crop activities as well as disease outbreaks; normally during festive seasons such as Christmas the prices are high due to increased demand. In addition, farmers lack market information and they depend on that given to them by traders who in turn would like to maximise their own profits by offering as low prices as possible. Although poultry keepers get information that chickens may fetch high prices in towns, they lack the capacity and the economies of scale to gather enough stock for such transactions.

Regarding transportation, since there is no specialised packaging of live chickens, the birds are bundled together either on strings or baskets and transported using different means of public transport together with passengers which predisposes them to transmission of zoonotic infections. Disease outbreaks affect both farmers and middlemen. Once there is a signal of disease in an area, farmers panic and sell their birds cheaply and the middlemen who buy such chickens may lose a number of them due to disease.

Infrastructural constraints include lack of research and education on infrastructure serving the village chickens of the smallholder and poor physical infrastructure; roads, energy, water supply and communication technology (Mapiye *et al*., 2008). Byarugaba (2007) documented that poor road network is experienced both in the urban and rural settings in the country which hampers the marketing of poultry and the products thereof. Lack of farm input supply services tailored to the needs of smallholder farmers, lack of access to credit facilities and lack of access to profitable urban markets are some of the institutional constraints. Perhaps institutional support should be provided to cover all factors of village chicken production. This support can be in terms of credit provision, input supply and distribution, marketing, provision of stock, feed and general capital development. Such support will allow for continuity and building up of farmer confidence and sustainability of village chicken production. Mapiye *et al*. (2008) documented some technical constraints including lack of knowledge, lack of farmer training systems, dearth of information about cost effective chicken and egg production at the level of decision makers and advisors at producer level and inappropriate system for supplying the farmer with technical assistance and advice.

Mortality is the major limitation to village chicken production (Kirunda and Mukiibi-Muka, 2003; Otim *et al*., 2007). Mortality is due to a number of interacting factors such as diseases, parasites, predation, accidents and bad weather among others (Muchadeyi *et al.,* 2005). The most common predators are dogs, cats, eagles, hawks and thieves.

Predation can be reduced by close monitoring of village chickens during scavenging periods and keeping them in proper houses during the night (Mapiye *et al*., 2008). Poor health management resulting in high mortality and compromised productive performance characterise most village chicken production systems in Uganda (Otim *et al*., 2007). Countless authors have cited disease mainly Newcastle (Gueye, 2000; Kirunda and Mukiibi-Muka, 2003; Woolcock *et al.,* 2004; Muchadeyi *et al.,* 2005; Byarugaba, 2007) as the major cause of chicken losses; reducing both numbers and productivity. The existence of multi-entities and their contact with the outside environment and wild animals makes it difficult to control disease outbreaks (Otim *et al*., 2007, Mapiye *et al*., 2008). Farmers do not keep records and disease epidemiology is poorly understood. Contact with veterinary and extension personnel is not sound and a lot of problems go unnoticed (Muchadeyi *et al.,* 2005). The same authors further noted that unlike in commercial set-ups, many complementary factors influence the health of village chicken populations. Such complex phenomena make it even more difficult to design improvement strategies to overcome health constraints. Mapiye *et al*. (2008) emphasised that development of chicken health programmes is required to give reliable information on the epidemiology of disease and the possibilities of reducing disease outbreaks.

2.2 Economics of Animal Disease

Animal disease outbreaks like Newcastle, foot and mouth disease and others are a significant threat to the animal product marketing sector because the impact of an outbreak can be quite costly and far-reaching. According to Bennett (2003), disease in livestock has seven main economic impacts, namely: i) reduction in the level of marketable outputs; ii) reduction in (perceived or actual) output quality; iii) waste (or higher level of use) of inputs; iv) resource costs associated with disease prevention and control; v) human health costs associated with disease or disease control; vi) negative animal welfare associated with disease; and vii) international trade restrictions due to disease and its control. In addition, FAO (2001) considers animal diseases an example of invasive species, and categorizes six areas of their impact, namely, production effects, markets and price effects, trade effects, impact on food security and nutrition, human health and the environment, and financial costs.

Economists and policy analysts have attempted to evaluate the benefits of some vaccines for the population as a whole or for certain groups in the population. In doing so, analysts have relied on two related techniques, cost-effectiveness analysis and cost-benefit analysis (Tomo, 2009). Cost-benefit analysis does, however, have an essential role to play in reaching public sector decisions (Vega and Alzipar, 2011). It is far and away the most effective tool for assembling the data relevant to decisions and quantifying the pros and cons to the extent that they can be quantified (Dorfman and Rothkorpf, 1996). Furthermore, Riley (2006) asserts that in a world of finite public and private resources, we need a standard for evaluating trade-offs, setting priorities, and finally making choices about how to allocate scarce resources among competing uses. Cost benefit analysis provides a way of doing this.

A number of studies have been conducted on cost-benefit analysis on various economic aspects but not much has been done on animal diseases particularly Newcastle. Studies by Tambi *et al*. (1999), Otte *et al*. (2004), Bennett (2003) and McClement *et al*. (2009) have significantly contributed to the better understanding of modelling benefits and costs of controlling animal diseases. Using spreadsheet models, Bennett and Ijpelaar (2003) provided a basis for the economic assessment of animal diseases in relation to: (i) the output losses and resource wastage in animal production as a result of disease; (ii) the treatment and preventive measures undertaken to control disease; (iii) the animal welfare impact of diseases; (iv) the benefits and costs of disease control measures and (v) the benefits of reducing disease incidence.

Alders and Spradbrow (2001) state that when working with village chickens, it is essential that benefit-cost analyses of all interventions be done so that any ND control strategies are cost-effective. The main costs associated with the control of the disease are the purchase of the vaccine, transport and handling costs. Cost-benefit analysis generates several commonly used indicators to characterize the value of the control intervention as an investment. In their study, Tambi *et al.* (1999) used three indicators to characterize the value of disease control intervention namely; (i) Net Present Value (NPV), (ii) Benefit Cost Ratio (BCR) and (iii) Internal Rate of Return (IRR). A worthwhile investment should at least cover initial costs, so the benefits should be greater than costs and therefore the ratio should be greater than one (McClement *et al*., 2009). Tomo (2009) used a Village Poultry Simulation Model (VIPOSIM) with parameters adapted to the study area context for determination of annual incremental benefits resulting from chicken vaccination at the farm level.

For the purpose of Cost-Benefit Analysis (CBA), Tambi *et.al* (1999) considered two types of benefits from rinderpest control namely increased revenue from improved productivity and savings in cost control after the initial campaign. Benefits were represented primarily as increased revenue due to avoided production losses. Net medical-care costs and net health benefits can be used to evaluate a vaccination program. For instance, if the net benefits exceed the costs-or if the ratio of benefits to costs is greater than one, then a vaccination program is considered worthwhile on efficiency grounds (Willems and Sanders, 1981). According to Watkins *et.al* (2005), net health benefits from a vaccination program include reductions in morbidity and mortality from prevention of disease, which are offset by any morbidity and mortality associated with vaccine side effects. A discount rate is applied to costs and benefits that will occur in future years so that they are valued less than costs and benefits occurring in the present.

Two types of costs are generally associated with a control intervention, as follows: *a)* new control costs which are incurred in the implementation of the control measures that would not have been incurred under the existing situation *b)* livestock production revenues foregone due to the control measures. According to Mukhebi (1996), for any livestock disease to be targeted for control, it must be of economic importance. Economic importance can be shown by the amount of losses the disease causes in outputs, and the amount incurred by livestock producers to control the disease. The concept of economic cost is used to measure the economic importance of a disease and is defined as the sum of production losses and control expenditures. Production losses refer to the value of output (meat and eggs) losses from mortality and morbidity whereas control expenditures are the value of resources that the livestock producers spend in controlling the disease (Tambi *et al.,* 1999).

Another useful economic concept is that of an 'optimal level of disease control' which can be defined as the situation whereby an extra dollar (cost) of control expenditure yields one dollar (benefit) of savings in production losses (Mukhebi, 1996). The concept of economic cost can be used to show the relationship between the value of output losses from a disease and the expenditure incurred in the control of the disease (McInerney *et al*, 1992). Such a relationship is key in a cost-benefit analysis.

2.3 Factors that Influence Farmers' Willingness to Pay for Technologies

Research results reveal that the magnitudes of households' WTP for agricultural technologies, as well as the type of payment, vary with the nature of the technology. Holloway and Ehui (2001), for example, looked at the impacts of extension on participation of dairy producers in Ethiopia's milk market and the amount that households would be willing to pay for the extension service. Based on the WTP estimates and the per-unit cost estimates of the extension visit, the authors found that privatization of extension services is a possibility in the context of milk market development. Asrat *et al*. (2004) examined the determinants of farmers' WTP for soil conservation practices in Ethiopia's south-eastern highlands and reported that the majority of the farmers in the study area were less willing to pay cash. However, the farmers were willing to spend substantial amounts of labour and time on soil conservation.

Following Aryal *et al*. (2009), farmers' willingness to pay for a given agricultural service is a function of knowledge, attitude, and intention. Available information influences both knowledge and attitude toward the proposed service. Socioeconomic characteristics such as age, gender, and income also shape a consumer's willingness to pay, because those characteristics affect attitudes toward agricultural technologies (Ulimwengu and Sanyal, 2011). In addition, market characteristics such as accessibility and prices affect purchase behaviour and ultimately farmers' willingness to pay.

A study that looked at irrigation adoption found that small farmers with more profit per unit of land than average were more likely to contribute to irrigation (Koundouri *et al*., 2006). This could be because the use of irrigation equipment is labour intensive and time consuming, so it is more appropriate for small farmers' intensive operations.
Another factor expected to have an influence on farmers' WTP for agricultural technologies is education. A higher level of education is expected to increase farmers' ability to get, process, and use information. Thus, education is hypothesized to have a positive role in the decision to pay for new agricultural technologies.

Farm and nonfarm income are also expected to have an impact on farmers' decision to invest in agricultural technologies. Nonfarm income is expected to have a positive influence, given the assumption that diversification out of agriculture would enable households to earn income; thereby easing the liquidity constraint needed for new technology investments (Pender and Kerr 1998; Holden and Shiferaw 2002). On the other hand, poverty reduces a household's willingness and ability to invest in agricultural technologies (Holden and Shiferaw 2002). Empirical studies have reported positive relationships between income and adoption of agricultural technologies (Holden and Shiferaw 2002; Faye and Deininger 2005).

The impact of a farmer's age can be considered a combination of the effect of farming experience and planning horizon. Although longer experience has a positive effect, young farmers may have longer planning horizons and, hence, may be more likely to invest in agricultural technologies (Asrat *et al*., 2004; Faye and Deininger 2005; Holden and Shiferaw 2002).

The awareness level of agricultural technology is hypothesized to have a positive effect on willingness to participate in technology investments (Pender and Kerr 1998). Asrat *et al*. (2004) found that farmers who were aware of the available options for agricultural technology were more receptive to paying for these technologies.

2.3.1 Empirical Review of Models used to Estimate Willingness to Pay

One of the most effective and widely used techniques to evaluate patients' preferences in the health care domain is the Discrete Choice Experiment (DCE), a stated preference technique that has evolved from conjoint analysis, and is consistent with economic theory (Guimarães *et al*, 2010). Conjoint analysis is designed to resemble real life, everyday choices between goods or services with well-defined but varying attributes and costs. By asking respondents to make choices between these hypothetical scenarios, they are forced to make trade-offs, thereby revealing their preferences. To evaluate patients' preferences for various attributes of insulin treatment, including route of insulin delivery, Guimarães *et al* (2010) used a DCE to quantify patients' preferences. Data were analyzed using conditional *logit* regression and segmented models were also developed to evaluate differences in preferences between subgroups.

In the assessment of the factors that affect consumer choice and willingness to pay for milk attributes, Bernard and Mathios (2005) used the multinomial *logit* model and hedonic price analysis. In order to determine the factors that affected consumer purchases, the multinomial *logit* framework was used to derive the log partial odds ratio, which was then estimated as the log of the ratio of units sold. In this model, the ratio of units sold was modelled as a function of product attributes and average store demographic variables. To infer WTP from the data, the hedonic price model was employed. In this approach, price was modelled as a function of product attributes and the coefficients were interpreted as a measure of the implicit market value of those attributes to consumers.

To estimate the dairy producers' WTP for individual advisory services visits in Ethiopia, Holloway and Ehiu (2001) used a traditional consumer model focusing on the cash income constraint to derive the amount of income that the household is willing to forego in order to have one additional unit of service rendered.

Stated preference methodologies, like the contingent choice exercise used in this study, are based on the theory of utility maximization. Thus, it is assumed that respondents, when presented with a choice of alternatives, will choose the alternative that possesses the combination of attributes that would provide them the highest level of utility. As stated by Ward *et al.* (2011), the utility received from a particular alternative is related to a set of attributes associated with the choice.

The WTP for a unit change in a certain attribute can be computed as the marginal rate of substitution (MRS) between income and the quantity expressed by the attribute, at constant utility levels (Gaudry *et al.*, 1989). The concept is equivalent to computing the compensated variation (Small and Rosen, 1981), as one usually works with a linear approximation of the indirect utility function. Thus as indicated by Sillano and Ortuzar (2005), point estimates of the MRS represent the slope of the utility function for the range where this approximation holds.

Negrín *et al*., (2008) applied mixed *logi*t models to analyse the willingness to pay for alternative policies for patients with Alzheimer's disease. All coefficients were specified to be normally distributed and both maximum simulated likelihood and hierarchical Bayes methods were used to estimate the models. The authors found that there was significant heterogeneity in the preferences for all the attributes including cost. The authors reported WTP measures calculated at the means of the coefficient distributions.

Özdemir *et al*., (2009) analysed how "cheap talk" affects estimates of the willingness to pay for health care using a mixed logit model estimated in WTP space. The WTP space approach was chosen because it allows the authors to estimate WTP values directly and to compare estimates from two different samples without adjusting for scale differences. The authors conclude that being exposed to "cheap talk" has an impact on the estimated willingness to pay.

To examine the determinants of fish farmers' willingness to pay for extension services in Nigeria, Folola *et al*., (2012) used the logistic regression model. The results indicate that the age of the farmer, level of education, number of fish stocked and the nature of production significantly influenced fish farmers' WTP for extension services. On the other hand, Oladele (2008) utilized the *probit* regression model to examine the factors determining farmers' WTP for extension services in Oyo State, Nigeria. The author found that farmers' age, education level, farm size, farming experience, land tenure, income and proportion of crops sold are significant determinants of farmers' WTP for extension services.

Horna *et al.*, (2005) examined farmers' preferences for new rice varieties seed and their willingness to pay for information as a measure of WTP for rice production advisory services in Nigeria and Benin. Farmers' preferences were modelled as a function of the utility obtained from rice seed varieties, the farmer's social and economic characteristics, and the level of information about the varieties. Conjoint utility analysis was used to estimate the marginal values of rice seed attributes and to derive the WTP for seed-related information.
The results of the study indicate that variety attributes are important determinants of the seed preferences stated by farmers; however, in many cases, the sign of the coefficient contradicted what was sought by rice researchers.

This study is different from those of the aforementioned scholars in that it utilized the compensating variation technique to capture local chicken keepers' WTP for vaccination which was modelled in a random utility framework where the local chicken keeper had two choices; either to choose contributing towards disease control or not. Because of the binary and categorical nature of the dependent variable, that is whether a local chicken keeper was willing to pay for vaccination or not, the *logit* model was used. The dependent variable was regressed against various attributes such as the local chicken keeper's age, education level, income, poultry stock and others as indicated in Table 3.1 in the following chapter.

2.4 Summary from the Literature Review

Village poultry production although not given so much attention has been documented to play a significant role in the welfare of rural communities especially for the disadvantaged groups mainly the women, children and the disabled. Local chicken have been noted to be of great importance in cultural ceremonies, they are quick sources of cash and they are the major source of animal protein in form of meat and eggs. However, village chicken production is hampered by various constraints including poultry diseases, lack of feed supplements, poor infrastructure and lack of market information to mention but a few. Amongst all these, Newcastle disease unanimously stood out as the major challenge. Eradication of this disease is unlikely and vaccination is the way to go as far as its control is concerned.

The relevance of a cost-benefit analysis particularly for any vaccination exercise is evident in the reviewed literature and needs not be over-emphasized. Thus this study aimed at assessing the cost-effectiveness of vaccination of local chicken against ND by comparing the benefits with the cost therein. Furthermore, not much had been done as far as assessing the local chicken keeper's willingness to pay for vaccination as well as the factors that influence their willingness to pay and yet these aspects are crucial hence this research was aimed at bridging that gap.

CHAPTER THREE

METHODOLOGY

3.1 Description of the study area

The study was conducted in Iganga district in Eastern Uganda. This district was selected because of its high level of poultry activity, limited participation in local chicken vaccination activities and high household density. According to the National Household survey (UBOS, 2005) and Byarugaba (2007), the Eastern region has the highest numbers of free range poultry in Uganda. Furthermore, the 2002 National population census estimated the annual population growth of the area at 2.8% one of the highest in the country (UBOS, 2003). An increase in population is likely to increase the demand for poultry.

3.2 Study design and sampling

The approach was a combination of a survey and an ethnographic study. A survey is an examination of opinions, behaviour and knowledge among others by asking questions. Ethnography basically is a study design aimed at understanding and presenting systematic meaning of lives of people/groups of people. The survey was conducted through administering semi-structured questionnaires. The enumerators were well trained prior and the questions were asked in the local dialect that farmers are familiar with to ensure that accurate information is obtained. Regarding ethnography, during the various data collection phases, the researcher was living in the same environment with the local chicken keepers thereby observing their behaviour.

In the district, two areas were purposively selected. Selection was based on areas with minimal vaccination intervention but high poultry activity. Both qualitative and quantitative data was collected. The sample size was determined using the (Kish, 1965) formula for cross-sectional studies. The formula is as follow:

$$n = \frac{Z^2pq}{e^2}$$

Where;

n = sample size

Z = statistical certainty with 1.96 at 95% confidence interval

p = prevalence of appropriate Newcastle disease control 50% (p=0.5)

q = difference between 1 and p; q = 1-0.5 = 0.5

e = desired level of confidence = 5%; e = 0.05

$$n = \frac{1.96^2 (0.5 * 0.5)}{0.05^2}$$

n = 384

The desired sample size 384 households but due to resource constraints, a total of 240 households were randomly selected from the two areas (*Bulyansiime* and *Kikunu*) hence that was the sample size for the research.

3.3 Data Collection

Both primary and secondary data was collected and used. Primary data was collected through consultations with the relevant stakeholders at the district level; focus group discussions and key informants' interviews at the village level which were conducted on a quarterly basis; as well as surveys and discussions at the household level. A questionnaire was designed to obtain information regarding the extent to which survey respondents think ND affects the productivity of local chicken. The questionnaire was administered before any intervention (baseline) and again a year later (follow-up) after four quarterly vaccination cycles. This data was supplemented by observations by the researcher.

Data was collected using face to face interviews. Semi-structured questionnaires were administered to capture information on the nature and perceptions of Newcastle Disease in the study sites, adaptive or other types of response to ND, factors affecting these responses and impact of the responses to people's livelihoods and economic development. The data collected included socio-demographic data, production data, economic data, marketing constraints and stakeholder's willingness to support ND control. Secondary data was obtained from publications on livestock and poultry production including but not limited to newspapers, reports, library sources, documentaries, agricultural journals, NGO's, international and government publications such as FAO, MAAIF, UBOS, MFPED, websites and the district production directorate.

3.4 Data quality control

To ensure high data quality, precautionary measures were taken at the various stages of the study. Prior to the baseline survey, a questionnaire pre-test was conducted to ensure that the questionnaire is clear, precise and exhaustive. After the pre-test, some questions were edited and to some more information was added for clarity. Simple random sampling was used in selecting respondents to avoid bias and a multiple methodological approach was followed. Furthermore, only well trained research assistants were involved in data collection. To ensure accuracy and efficiency, face to face interviews were conducted and the questions were asked in the local language which farmers understand best. Data cleaning was done shortly after it was collected to iron out any errors or inconsistencies. Each questionnaire was labelled (1 through 240) so as to be able to trace responses to participants and to record responses effectively. The data was then carefully entered and analysed. The data obtained through focus group discussions and key informants interviews was captured using tape recorders to ensure that no valuable information is lost and this data was then transcribed, analysed and reported.

3.5 Data analysis

The data collected by the researcher together with well-trained research assistants working under the researchers close supervision was entered and cleaned personally by the researcher. To analyse the four objectives, descriptive statistics, cost benefit analysis and *logit* models were used. For the first objective, descriptive statistics was used including but not limited to percentages and means. SPSS (Statistical Package for Social Scientists) and *Stata* analytical packages were used in data analysis.

3.5.1 Analysing Local Chicken Keepers' Benefits and Costs of Controlling Newcastle Disease

The study sought out the benefits and costs involved in participating in ND control and prevention through vaccination. To determine the cost-effectiveness of vaccination, cost-benefit analysis was used as in Tambi *et al.,* (1999); Hoy *et al*., (2001) and Tomo *et al*. (2012). The benefits were largely assumed to include the control cost savings arising from the avoided losses after ND control and the increased revenue due to improved productivity. The avoided losses mainly of eggs and chickens were estimated as the difference between the losses incurred without ND control and those with control. The costs on the other hand largely comprised the amount charged by village vaccinators for vaccination per chicken which price encompasses the cost of the vaccine, labour and transport.

Following Tambi *et al.,* (1999); Hoy *et al*., (2001) and Tomo *et al*. (2012), the benefit-cost ratio (BCR) was used to compare the value of incremental benefits with the value of incremental costs. Basically, the approach involves aggregating all the incremental costs associated with the control intervention and comparing these costs to the total value of benefits generated attributable to the intervention which in this case is vaccination. Basing on the fact that costs and benefits occur over several years, these values were appropriately discounted to account for the time value of money as shown:

$$BCR = \left\{ \frac{\sum B_t}{(1+r)^t} \Big/ \frac{\sum C_t}{(1+r)^t} \right\} \text{.. (i)}$$

Where BCR is the Benefit-Cost Ratio, B is the benefit resulting from a disease control programme, C is the cost of disease control, r is the discount rate which was given by the prevailing bank interest rate and t is the time (years).

For simplicity, the Benefit-Cost Ratio will be expressed as shown below:

$$BCR = \frac{DB}{DC} \text{ .... (ii)}$$

Where DB are the Discounted Benefits and DC are the Discounted Costs respectively.

The cost for vaccination is the major cost involved in the control of Newcastle. According to Tambi *et al*. (1999), the economic cost (C) of a disease is computed as the sum of the direct and indirect production losses (F) from mortality and morbidity plus the expenditures incurred (E) for its control represented as C = F + E. For this study, the cost of vaccination was obtained directly from the average price charged by local vaccinators for vaccination per chicken. Since the chickens are predominantly free-range, the costs of feed were assumed to be zero. The vaccinators on open market were charging Uganda shillings 100 per chicken vaccinated. This caters for the cost of the vaccine, transport and labour. Vaccination is carried out once every three months and the average cost per household per vaccination was captured from the quarterly records obtained from the field. These costs were discounted at a rate of 18% based on the inflation rate of 18.7% obtained from UBOS (2012). The costs were then discounted using the following formula obtained from Tomo *et al*. (2012).

$$DC = \sum_{i=1}^{4} \frac{C_i}{\left(1+\frac{r}{4}\right)^i} = \sum_{i=1}^{4} \frac{(F_i + E_i)}{\left(1+\frac{r}{4}\right)^i} \text{ .... (iii)}$$

Where: DC are the total discounted costs; C_i are the additional costs related to technology use (cost of vaccination) incurred in season i, in Uganda shillings; F_i are the losses from mortality and morbidity in Uganda shillings; E_i are the costs incurred for disease control through vaccination and; r is the discount rate.

As a result of vaccination there are both direct benefits (increase in the number of birds and eggs) and indirect benefits (manure and the value of immediate availability of birds for cash and social needs). This study mainly focused on the direct benefits resulting from the avoidance of bird and/or egg loss but some indirect benefits were highlighted as well. The direct benefits of vaccine use could be in terms of an improved quality of chickens, increased flock size and/or increased off-takes (Tomo *et al*., 2012).

Due to the low level of quality differentiation in the market for village chickens in Uganda, and due to the difficulty in getting data on quality improvement resulting from vaccination, only direct benefits related to increased off-take of chickens and eggs are considered. The additional indirect benefits such as the value of manure, social roles of the chickens, among others, that may increase due to vaccination were not estimated in the study, in part because it is difficult to assign a monetary value to these benefits. The benefits were assumed to be the physical production losses avoided by reducing the incidence of Newcastle disease through vaccination. These include eggs and live birds valued at prevailing market prices. The avoided physical losses in the control of ND were estimated as the difference between the value of output produced without the disease and that produced with the presence of the disease computed quarterly over a period of one year.

To determine the net benefits of chicken vaccination against ND at household level, a formula specified by Tomo *et al*. (2012) adapted from the Village Poultry Simulation Model (VIPOSIM) was used and it is stated as follows:

$$NB_i = B_i^{wi} - B^{no} - C_i \quad \text{(iv)}$$

Where:

NB_i are the net benefits of ND control at community level for season i in Uganda shillings

B_i^{wi} are the benefits (total value of meat and eggs) in Uganda shillings for the “with control” situation in season i

B^{no} are the benefits in Uganda shillings for the "without control" situation and C_i are the additional costs related to technology use (cost of vaccination) that would be incurred in season i, in Uganda shillings.

From the net benefits determined for each season, and taking into account that the interest is compounded quarterly (based on the length of the chicken production season and vaccination cycles of about 3 months), the total present value or discounted benefits for the period of one year were estimated using the following equation adapted from Hoy *et al.* (2001):

$$DB = \sum_{i=1}^{4} \frac{NB_i}{\left(1+\frac{r}{4}\right)^i} \text{ .... (v)}$$

Where: DB are the total discounted benefits for the period of one year; and r is the discount rate. A discount rate of 18% was used based on the rate of inflation of 18.7% stated in UBOS (2012).

The benefit-cost ratio (BCR) is computed by dividing the total discounted benefits over the total discounted costs. A value greater than one is ideal since it implies that the benefits outweigh the costs (McClement *et al.*, 2009).

$$BCR = \frac{DB}{DC} \text{ .... (vi)}$$

3.5.2 Assessing Local Chicken Keepers' Willingness to Pay for Newcastle Disease Control

Willingness to pay (WTP) can be defined as the maximum amount of money an individual would be willing to pay rather than to do without an increase in a good or service such as improved animal health (Ajani, 2008). The WTP measures are considered useful for several reasons. Firstly, they can directly inform policy makers by providing information about how much people value some goods or services and can thus inform the pricing of these goods or services (Hanley *et al.*, 2003). Secondly, WTP measures are a convenient tool for making relative comparisons and rankings of the desirability of goods and services (Negrin *et al.*, 2008).

Thirdly, such measures are important inputs in economic evaluations such as cost benefit analyses (Negrin *et al.*, 2008). WTP values provide crucial information for assessing economic viability of projects, setting affordable tariffs, evaluating policy alternatives, assessing financial sustainability, as well as designing socially equitable subsidies (Whittington, 2002; Carson, 2003; Gunatilake *et al*., 2006; van den Berg *et al*., 2006). To estimate WTP, either Revealed Preference or Stated Preference Techniques can be used (Gunatilake *et al*., 2007). At present, one of the most used approaches by economists is the revealed preference approach (Powdtharvee and Van den Berg, 2011).

Revealed preference (RP) models are built upon the hypothesis that it is possible to infer people's preferences for goods such as environmental goods and estimate demand curves by observing their actual behaviour. This behaviour may involve the purchase of market goods or other types of economic decisions (Kahn, 1995). Revealed preference techniques can be divided into non-demand curve approaches and demand curve approaches. The demand curve approaches include the hedonic price method (HPM) and the travel cost method (TCM). The greatest advantage of these direct revealed preference techniques is that they are relatively simple to use (Navrud, 2000) and they offer a clear objective indicator of individual’s health preferences (Smith, 2003). Despite their appeals, there are a number of empirical limitations to the use of RP techniques. For instance, the RP methods do not easily allow for generalisation across different cases of health conditions, and a representative data can sometimes be very difficult to collect (Smith, 2003). Furthermore, the methods ignore the behavioural responses of individuals to changes in environmental amenities (Navrud, 2000).

As a solution, Stated Preference Techniques, mainly the contingent valuation (CV) method, which is a survey-based hypothetical and direct method to elicit monetary valuations of effects of health technologies and conditions has been adopted by many economists as an alternative approach to the RP method (Tsuchiya and Williams, 2001). By asking individuals to directly state their willingness to pay for treatments of a certain illness, or for inclusion of treatments in a health insurance package, or on reimbursement list in case of national health system, the CV approach allows for easy generalisation across different health conditions of interest, while it is also cheap to collect on a large scale (Liu *et al*., 2000; Amin and Khondoker, 2004). This could be the underlying reason why it is a widely used method.

When a good or service is not traded in a market setting for instance because of public good characteristics, natural monopoly or due to other market failures, survey-based stated preference approaches are commonly used to provide input for policy and planning purposes (Freeman, 2003). The primary stated preference methods in use by economists are the contingent valuation method and the choice modelling method or choice experiment (Tessendorf, 2007). Choice-experiment (CE) refers to a group of methods, where individuals are asked to choose between different alternatives, which involve a good and more often than not the environment, but where there are no direct questions about valuation (Vega and Alzipar, 2011).

The Contingent Valuation Method (CVM) is a survey-based elicitation technique to estimate WTP values of goods that are not traded in the conventional market. These include public resources such as pollution abatement for cleaner air, preserving historical sites, scenic values of natural environment; or nonmarket goods such as water supply, sanitation facilities, reduction of traffic jams, or new vaccines for protecting public health (Gunitilake *et al*., 2007) as is the case in this study.

The Contingent valuation method infers the value of a product not on the basis of the effective observed behaviour of subjects on the market, but with reference to an artificially structured market (Sirchia, 1997; Whitehead, 2006). An important advantage of the CVM is that it is applicable, technically, to all circumstances. It is able to uncover existence values (for example, preservation of rare species, biodiversity for its own sake), which generally do not pass through markets and do not have substitutes or complements that pass through markets (Smith, 2006).

When the open-ended choice method is adopted, respondents are asked to state their maximum WTP with no value being suggested to them (Hanley *et al*., 1997; Whitehead and Blomquist, 2006). Advantages of this method include the fact that it is straightforward, that the maximum WTP can be identified for each respondent and that the results may be assessed using simple statistical techniques (Arrow *et al*., 1993). However, the open-ended choice method can induce large non-response rates, protest answers, zero answers and outliers and unreliable responses (Arrow *et al*., 1993, Tessendorf, 2007). Furthermore, respondents may find it difficult to formulate their true maximum WTP, as they have never had to value the good before (Arrow *et al*., 1993; Tessendorf, 2007).

In this study, compensating variation technique was used to capture local chicken keepers' WTP for vaccination. This was modelled in a random utility framework where the local chicken keeper had two choices; either to choose contributing towards disease control or not. According to Greene (2003), denoting the utility derived from choice i (i.e., contributing towards disease control) as U_{in}, and that of choice j (i.e., not contributing) as U_{jn}, then the *n*th farmer would choose to participate in disease control if and only if; $U_{in} > U_{jn}$ ....(1)

Utility is treated as a random variable since we do not know the individual's utility with certainty. Overall utility can be expressed as the sum of deterministic components expressed as a function of attributes presented and a random component. This can be expressed as;

$$U_{in} = V_{in} + \varepsilon_{in} \ldots\ldots\ldots\ldots\ldots\ldots\ldots(2) \quad \text{and} \quad U_{jn} = V_{jn} + \varepsilon_{jn} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Where U_{in} is the individual $n's$ utility in choosing option i, V_{in} is the deterministic component of utility and ε_{in} is a random component which represents unobserved factors affecting the choice, measurement errors and the use of instrument variables rather than actual variables.

V_{in} is the individual $n's$ indirect utility function resulting from his budget constrained utility maximising choice of option i and we assume it is linear in parameters

$$V_{in}(q_{in}, Y - C, X_n) = \beta_0 q_{in} + \beta_1 X_n + \beta_2 (Y - C_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Where q_{in} are the environmental attributes of the option i, Y is disposable income and C_i is the cost of option or WTP and X_n is individual $n's$ vector of demographic attributes. As noted in Ward *et al.* (2011), if ε_{ij} is independently and identically distributed (iid) with type 1 extreme value distribution, then the probability of individual n choosing option i than option j therefore is the probability that option i provides greater utility U_{in} than option j, with utility U_{jn} and can be expressed as:

$$P_{in} = \Pr(U_{in} > U_{jn}; \forall i \neq j) = \frac{\exp(V_{in})}{\exp(V_{in}) + \exp(V_{jn})} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

The willingness to pay for a disease control option i is unobservable and since responses are discrete in nature with respondents offered an option, a *logit* model was used (Ajani, 2008). The *logit* model was used because of the binary nature of the dependent variable whether farmers are willing to pay for disease control or not. The *logit* model established the relationship between the observable index i and various independent variables. The independent variables were as indicated in Table 3.1. The dependent variable was the probability that the respondent was willing to contribute towards ND control option presented and gave a yes or no response. This was captured by giving farmers a payment option A which they would either accept or reject. Following Gujarati (2004) the *logit* equation is given as:

$$ln\left(\frac{P_i}{1 - P_i}\right) = \beta_o + \beta_i X_i + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where P_i denoted the probability that the respondent was willing to contribute towards disease control, β_i were the estimated coefficients, and χ_i denoted the vector of explanatory variables (X_1 to X_{13}) listed in Table 3.1. The specified equation is as given below:

$$\ln\left[\frac{P_i}{(1 - P_i)}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_{13} X_{13} + \varepsilon_i \ldots\ldots\ldots\ldots (7)$$

The dependent variable (WTP) being categorical and binary in nature was captured as a dummy variable with a value of one if the maximum amount the local chicken farmer was willing to pay for the control of Newcastle disease through vaccination was equivalent to or above the cost price for the service on open market (which is 100 shillings) and it took on a value of zero if the farmer was not willing to pay any amount or if the maximum amount he/she was willing to pay was less than 100 shillings. That is:

WTP = 1 (if the local chicken keeper was willing to pay 100/= or more for ND vaccination per chicken);

WTP = 0 (if the local chicken keeper was willing to pay less than 100/= for ND vaccination per chicken).

Table 3.1: Variables in the estimation of farmers' willingness to pay for ND control

Symbol	Description	Expected sign
X_1	Gender of farmer (1 = male and 0 = female)	+/-
X_2	Age of farmer (years)	+
X_3	Years of schooling of farmer	+
X_4	Farmer belongs to a farmer group (1 = yes, 0 = otherwise)	+
X_5	Source of local chicken (1= market, 0 = otherwise)	+
X_6	Total number of local chicken owned	+
X_7	Major purpose for rearing local chicken (1 = income, 0 = otherwise)	+
X_8	Perception of neighbours' WTP (1= Neighbour is WTP, 0 = otherwise)	+/-
X_9	Previous vaccination experience (1= Bad, 0 = good)	-
X_{10}	Percentage of stock lost due to previous ND outbreak	+
X_{11}	Limited extension is farmer's major challenge (1= yes, 0 = otherwise)	-
X_{12}	Fear of vaccine causing harm is the major challenge(1= yes,0 = otherwise)	-
X_{13}	Farmer's income (Uganda shillings)	+
X_{14}	Distance from the trading centre (kilometres)	-
β_0	Constant	

3.6 *A priori* Expectations

In rural settings men are usually responsible for making decisions regarding cash outlays. In that case they may be more willing to pay for vaccination than women. However, generally women and children are the ones actively involved in poultry keeping (Gueye, 2000; Awuni, 2006) therefore; they are personally affected by the losses that arise as a result of Newcastle hence they may be more willing to pay for vaccination than their male counterparts. Either gender may be more willing to pay for vaccination hence the positive and negative sign.

Age was expected to have a positive impact on the local chicken keepers' willingness to pay for vaccination because older farmers have more experience in rearing local chicken and over the years they have suffered the consequences of ND more therefore they may be more willing to pay for its control. Goldsmith *et al*. (2004) stated that older people are likely to have more avenues for information and have more disposable income than the young farmers. The eagerness for information together with the socio-economic characteristics of the older farmers increase their probability to demand and pay for improved animal health services. Older farmers having more information links will most likely learn about the relevance of vaccination of chickens against ND from one or more of their networks making them more inclined to vaccination and with higher incomes their likelihood to pay for it increases. On the other hand, Faye and Deininger (2005) considered the impact of farmers' age on the WTP for new agricultural technologies as a combination of experience and planning horizon. They found that although longer experience had a positive impact, young farmers have longer planning horizons hence were more willing to invest in agricultural technologies.

Another factor that was expected to have an influence on farmers' WTP for agricultural technologies- in this case vaccination- is education. A higher level of education was expected to increase farmers' ability to get, process, and use information. Thus, education was hypothesized to have a positive role in the decision to pay for new agricultural technologies (Ulimwengu and Sanyal, 2011).

Local chicken keepers who are members of a farmer group are expected to be more enlightened about proper farming methods hence more receptive to new agricultural technologies. Thus membership in a farmer group is expected to positively influence local chicken keepers' WTP for vaccination. Heffernan *et al.* (2008) in their study on livestock vaccine adoption among poor farmers in Bolivia demonstrated that membership of a farmer to an organized group in the community and knowledge transfer through social networks increased vaccine uptake.

Local chicken farmers who acquire their stock from the market place invest in the purchase unlike those who obtain their stock in form of gifts or from other sources. Furthermore, they are oblivious of the health history of these birds. Otim *et al*. (2007) found that majority of the smallholder local chicken keepers purchase chickens from the market and neighbourhood to rebuild their stock after a disease outbreak. The same study identified the restocking chickens from the market and the neighbourhood as the most important risk factors for ND outbreaks. Therefore, the local chicken keepers who purchase their birds from the market were presumed to be more willing to vaccinate so as to prevent the transmission of disease from the purchased birds whose health history is unknown to their stock.

In this study, it was presumed that the bigger the flock size, the more cautious the farmer will be about preventing losses hence he/she will be more willing to pay for vaccination. Similarly Tomo *et al*. (2012) postulated that flock size is expected to have a positive effect on the benefits of ND vaccination at farm level. The bigger the flock, the larger is the number of chickens expected to be saved by vaccination and, the bigger are the expected benefits of vaccination hence farmers with a bigger flock size are more willing to pay for ND vaccination.

Byarugaba (2007) noted that improving the village chicken production systems in Uganda would result in increased opportunities and more equitable distribution of food and income within and among households especially in villages. Awuni *et al.* (2006) documented that farmers are, in principle, more willing to sell poultry and their products rather than the larger livestock therefore, poultry represent a regular cash flow for rural farming households. The farmers rearing village chickens mainly for income and tend to view chicken production as a business venture which they are willing to invest in so as to yield returns. Such farmers are likely to be more willing to contribute towards risk mitigation by investing in ND vaccination.

Farmers in rural areas live and work in close association with their neighbours in the community therefore one's perception of the neighbours' WTP is likely to influence one's WTP. Alexander *et al.* (2004) asserted that ND control strategies in some areas have not been sustainable because the implementers concentrate on technical issues neglecting crucial aspects like socio-economic and cultural dynamics including farmer interactions that affect farmer decisions.

The findings of Modise (2007) indicate that a good number of farmers who had lost some chickens after the first round of vaccination were unwilling to continue with the exercise attributing the deaths to the vaccine. In this study, farmers who had previously vaccinated their chickens and experienced positive returns such as increased flock size or higher number of eggs laid are expected to be more willing to pay for ND control than their counterparts who realised a higher mortality rate for instance. It was presumed in this study that the higher the percentage of stock lost due to the previous outbreak, the more willing the farmer will be to prevent history from repeating itself hence he/she will be willing to pay.

Access to veterinary extension will enlighten farmers more about poultry management in general and the extension workers are in position to vaccinate the farmer's local chicken having enlightened them about the effects of ND and the benefits of vaccination. Byarugaba (2007) noted that because of virtually no extension services in the rural areas, there is very little of modern medicine used in disease control hence ND has continued to wipe out many chickens when it strikes despite the availability of vaccines. Therefore, farmers who do not access extension services are more likely to be unwilling to vaccinate hence the negative sign.

Farmers who have inherent fear or wrong perceptions towards modern medicines such as vaccines thinking they may cause harm to the chickens and/or to the humans that consume the chickens are unlikely to vaccinate their birds and such perceptions will negatively influence their WTP. According to FAO (2009) some farmers believed that there was no point in vaccinating since either way the birds would die yet vaccines are expensive, not easily accessible and sometimes harmful so the majority opted to use herbs.

Byarugaba (2007) documented that although Ugandans have kept poultry for a long time, their knowledge and skills in improved management may be limited in some cases. Therefore, if the farmer is not informed about the cause and control of Newcastle disease, he or she is unlikely to contribute towards its control hence the negative sign.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter gives an account of the study findings and their detailed discussion. The first section gives the demographic characteristics of the respondents. In section two, information on village chicken is presented followed by the major challenges faced by local chicken keepers in section three. The fourth section presents the costs and benefits of Newcastle disease control whereas section five is a summary of what the local chicken keepers are willing to pay for vaccinating each chicken against Newcastle disease. Finally, logit model results of the factors influencing the local chicken farmers' willingness to pay for Newcastle disease vaccination are presented section six.

4.1 Household Demographic Characteristics

The study sought out to assess the cost-effectiveness of vaccination of village free-range chickens against Newcastle disease as well as analyse the community local chicken farmers' willingness to pay for control of the disease through vaccination. In order to contextualise these broad objectives, there was need to understand the demographic characteristics of these farmers. This information will provide the underlying characteristics/qualities of local chicken farmers that influence their willingness (or unwillingness) to pay for vaccination of their chickens against ND.

According to the survey, majority of the local chicken keepers (67.9%) were women and only 32.1% were males. FAO (2009) also found that poultry was mainly cared for by women mainly because poultry management costs are generally low. This is in line with the findings of Gueye (2000) and Awuni *et al.*, (2006) who asserted that poultry provide a means for mainly women and children to earn a living and improve their standards of living. In addition, FAO (2009) highlights three main reasons why poultry remain mainly within women's domain. First, compared to larger livestock, local chicken do not require much investment since they are normally left to scavenge for their feed and only require a little extra input in terms of supplementary feeding, veterinary treatment and vaccination. Secondly, poultry are kept at the homestead hence poultry keeping is an activity that women can undertake without having to leave the household where they are usually occupied with domestic duties such as cooking, cleaning and taking care of the children. As such, they do not have to allocate a lot of extra time to managing the local chicken. In addition to this, in places where religious beliefs or societal norms require that women do not leave their household compound or village, at least not without being accompanied by a male relative, poultry keeping is a suitable income-generating activity.

Socioeconomic characteristics are important for explaining the behaviour of respondents in most studies. In this study they helped in understanding such behaviour as well as in understanding the production environment within which the respondents operated. The socioeconomic characteristics observed in addition to the local chicken keepers' gender include marital status, age, level of education, main occupation and major source of income. The findings as highlighted in Table 4.1 indicate that the majority of respondents were married, which is in agreement with the findings of the UNHS 2005/06 in which it is reported that the majority of Ugandans (73.2 %) were married.

Table 4.1: Marital Status of the Local Chicken Keepers Pre and Post-vaccination (n=240)

	% Pre-vaccination	% Post-vaccination	Chi-square value
Married	84.17	87.92	
Not married (widowed, separated or single)	15.83	12.08	1.405

Source: Field data, 2012

The age of the local chicken keepers ranged between 15 and 84 years with an average of 39.05 years and these findings are similar to those of Jugessur *et al.*, (2004) who conducted a study on family poultry production in the republic of Mauritius. Age is a vital attribute in any form of agricultural production because it affects the productivity of labour. The mean experience in rearing local chicken was 15.2 years. The number of members in the household ranged from one to sixteen with a mean of seven people which is higher than the 5.3 reported in the UNHS 2005/06 indicating a fairly high population density in the region as reported in UBOS (2005). The results also indicate that close to half (47.5%) of the sampled local chicken farmers were Muslims followed by Anglicans who constituted 35.8%

The average number of years schooling was 4.98 indicating rather low levels of education. Of the local chicken keepers interviewed, 31.3% had never been to school, 27.5% had completed primary level, and only 0.4% had acquired tertiary education. These results are consistent with FAO (2009), whose findings indicate low literacy levels among smallholder poultry farmers whereby majority (56.8%) of the respondents were educated only to primary level. UBOS (2005) attributes these low education levels to poor access to learning facilities; a characteristic of rural areas in Uganda.

The results indicate that the respondents were predominantly farmers (95%). Similarly, Ssewanyana *et al*. (2003) noted that in Uganda the majority of people live in rural areas where they practice subsistence farming. These findings are fairly consistent with the UNHS 2005/06 which reported that the majority of Ugandans (73%) were employed in the agricultural sector, specifically in subsistence agriculture. Besides farming, both the males and females in the study were also engaged in private business and civil service. A few females were also involved in tailoring.

Although all the respondents were local chicken keepers, their major sources of income varied as indicated in Table 4.2 and not a very high percentage derived considerable income from poultry. Byarugaba (2007) asserted that because of low productivity, free-range poultry production in Uganda like elsewhere in Africa has been neglected and is frequently considered by farmers as an insignificant occupation compared with other agricultural activities. The majority of the local chicken keepers in this study were cultivators as well and depended mainly on crop cultivation which happens to be their major income source. Similarly, while analysing the characteristics of the poultry farms in Pemba Islands, Ogali (2011) found that 90% of the poultry famers were poor and they relied heavily on small scale mixed farming including livestock and crops for their livelihoods. According to Birol *et al.* (2010), households engaged in poultry keeping are more likely to be engaged in other agricultural livelihood strategies such as livestock and/or crop production. Moreover various previous studies (Gueye, 2000; Awuni, 2002) have found that poultry production is often complementary with crop production, since farm manure and crop land area are inputs to poultry production as providing feed and area for scavenging/roaming. More so, these studies postulated that households who own other livestock are also more likely to be engaged in poultry production since they found that poultry is the first step in the livestock ownership ladder.

Table 4.2: Respondents' Major Source of Income between June 2011 and June 2012

Source	Percentage (n=240)
Crop harvest	73.3
Poultry	13.3
Livestock	2.9
Monthly salary	1.3
Remittances	1.3
Casual labour	6.3
Business	1.7

Source: Field data, 2012

4.2 Information on Village Chickens

The average flock size per household was 11 local chickens as compared to the baseline survey with an average of 6 chickens indicating a 72.1% increase which may be attributable to the increased knowledge on poultry management through training and/or immunity to Newcastle disease acquired through vaccination, holding other factors constant. The chickens were mainly housed at night and let out to scavenge during the day. No proper poultry shelters were in place, however, majority of the local chicken keepers housed the chickens in their kitchens which were semi-permanent hut-shed structures adjacent to the main houses, others were housed in livestock sheds with other animals whereas some farmers admitted to sharing accommodation with the birds in the human dwellings while a few let their birds sleep in the nearby trees. Similar observations were highlighted by Byarugaba (2007) who noted that under the free range system in Uganda, the average flock size is less than fifty birds and the nature of the housing varies from specific houses, owner houses, trees, kitchens to nothing at all.

The chickens mainly obtained feed through scavenging, a feeding habit which highly exposes them to ND virus infection as noted by Otim *et al.*, (2007). Msoffe *et al.* (2010) also asserted that when chickens from multiple households congregate during scavenging, they create infectious disease exposure and transmission dynamics that are unique among poultry production systems where intervention strategies are difficult to apply. The chickens often feed on worms, insects and household refuse which consists mainly of cassava, sweet potatoes, bananas and rice a similar observation made by Byarugaba (2007) and Ogali (2011). However, some FGD participants asserted that with the current scarcity of food, there are hardly any leftovers to offer to the birds. Worse still, there is hardly any supplementary feeding. Those that supplement do so during the harvest season whereby they feed the birds on the maize husks they obtain when they take their produce to the machine for milling. Only 17.1% supplement with maize bran purposely during the harvest season. Such poor feeding without regular supplements is an underlying factor that predisposes village chickens especially chicks to diseases (Ogali, 2011). Majority of the local chicken keepers sighted high cost of processed feed as the major hindrance to supplementation.

4.2.1 Major Source of Local Chicken Stock

The majority of the local chicken keepers (64.6%) purchase chickens from the market place as indicated in Table 4.3. These results are consistent with FAO (2009) that found that 75% of the poultry keepers sourced the birds from markets, 16% acquired them as gifts and 9% obtained them from hatcheries. However, some key informants asserted that NAADS provides poultry to a few prominent farmers. According to Otim *et al.,* (2007) chickens obtained from neighbouring households and those bought from the market increase the risk of ND outbreak in a household more than chickens raised from post-ND outbreak hatchings, past-outbreak survivors and those obtained as gifts. It was revealed by some FGD participants and key informants that there is no monitoring of the birds brought to the markets which make it easy for local chicken keepers to sell sick/infected birds.

Table 4.3: Major Sources of Local Chicken Stock

Source	Percentage (n = 240)
Gift	16.7
Market	64.6
Hatchery	6.2
Neighbours	12.5

Source: Field data, 2012

4.3 Major Challenges Faced by Local Chicken Keepers

Local chicken keepers face various challenges ranging from socio-economic through infrastructural to technical constraints in the production of local free-range chickens. During the focus group discussions, several participants cited mortality, diseases, theft and limited market access as some of the outstanding constraints to production. One youthful lady said, “Since we do not follow any feeding regime or disease control program for the birds we rear, it is by sheer luck that a chick develops into a hen or a cock. In the fateful event that thieves or diseases strike, we lose out completely which makes poultry keeping a risky venture.” An elderly gentleman mentioned marketing challenges as major constraints to rural chicken production citing very low prices if they sell within the community and yet they have limited access to external markets that could possibly fetch a higher price. Mapiye *et al.,* (2008) noted that in rural areas, transaction costs associated with selling village chickens are high and Muchadeyi *et al.,* (2005) asserted that they arise due to the low amounts of chickens and eggs sold at a given time, long distances travelled, poor infrastructure and lack of market information. In the Ugandan context, Byarugaba (2007) found that seasonal availability of birds, lack of information on prices, lack of streamlined marketing organisation, transportation challenges and disease outbreaks were the key factors affecting marketing of local chickens. Of all the challenges cited, the local chicken keepers stated that disease outbreaks resulting in mortality were the major constraints to production. This is in line with the findings by Kirunda and Mukiibi-Muka (2003) and Otim *et al.*, (2007) who asserted that poor health management resulting in high mortality and compromised productive performance characterise most village chicken production systems in Uganda.

4.3.1 Poultry Diseases

Prior to the vaccination exercise, 90% of the local chicken keepers mentioned Newcastle disease as the major obstacle to village chicken production as shown in Table 4.4. However after one year of vaccination on a quarterly basis, fowl pox emerged as the major problem as shown by the percentages in post-vaccination column in the same Table 4.4. These results are consistent with the findings of Msoffe *et al.* (2010) and Woolcock *et al.,* (2004) who found that that in districts where ND vaccinations have been effectively conducted other diseases particularly fowl pox emerge. This is mainly due to the fact that control of ND increases the survival rate of local chicken hence there is an increase in the number of chickens and this results in congestion which enhances the spread of fowl pox.

Table 4.4: Major Poultry Diseases Pre and Post-ND Vaccination as cited by Farmers (n=240)

Disease	Pre-vaccination %	Post-vaccination %
Newcastle	90.0	29.2
Fowl pox	4.3	55.0
External parasites	3.9	6.9
Others	1.8	8.9

Source: Field data, 2012

4.3.2 Coping Strategies Employed by Local Chicken Farmers to Curb Newcastle Disease

The local chicken keepers used various disease-coping strategies for managing Newcastle disease among the chickens. Utilizing local remedies was however the major coping strategy employed during base line (34.2%) as indicated in Table 4.5. In line with this, Mapiye *et al*. (2008) noted that the wide use of traditional remedies is due to its low cost, local availability, easiness of application and it does not require modern technologies such as refrigeration. While studying the performance and constraints of the poultry production system among farmers in Pemba Islands in Tanzania, Ogali (2011) observed that disease control was limited to the use of herbal medicines such as pepper and leaves of the Aloe plant. Furthermore, from the focus group discussions it emerged that various concoctions ranging from ash and water to mixtures of *aloe vera,* red pepper and other local herbs are given as remedies to birds exhibiting signs and symptoms of illness. Sometimes the birds recuperate but more often than not, they die. However, other farmers acknowledged that those who follow proper vaccination procedures rarely lose their birds. These findings are consistent with FAO (2009) whereby some farmers believed that there was no point in vaccinating since either way the birds would die yet vaccines are expensive and not easily accessible so the majority opted to use herbs.

Table 4.5: Coping Strategies used by Local Chicken Keepers Pre and Post-Vaccination (n=240)

Strategy	Respondents % Pre	Respondents% Post
Vaccinate the birds	18.3	84.7
Sell-off the birds	20.8	3.1
Consume the birds	7.3	1.2
Dispose-off the birds	0.1	0.3
Provide local remedies	34.2	3.6
Give commercial drugs	8.6	4.2
Isolate sick birds from healthy ones	10.7	2.9

Source: Field data, 2012

Sell of birds prior to or at the onset of an outbreak was the second most strategy employed by the local chicken keepers for managing Newcastle disease at baseline (Table 4.5). Byarugaba (2007) noted that because of certain diseases such as Newcastle which wipes out 60-100% of the flock when it strikes, farmers normally sell off many of the birds prior to such disease occurrence in order to avoid making losses from the outbreaks. Within the various FGDs, many local chicken keepers confirmed selling off their birds or exchanging them for other livestock to unsuspecting buyers as soon as they heard of an outbreak or during the months when ND is rampant especially in the dry season. Otim *et al*. (2007) also found that sale and salvage of chickens are the two main actions that flock owners take during suspected ND outbreaks, a practice also observed by Ogali (2011) in Tanzania.

The results also indicate that at the time of baseline, majority (81.7%) of the local chicken keepers were not vaccinating their birds for various reasons namely lack of access to vaccines, high cost of vaccines and fear of vaccines causing harm to the birds and to the humans who consume them, as sighted in some of the focus group discussions. However, the few who vaccinated mainly did it once (12.9%), 4.6% vaccinated twice and none vaccinated more than four times in a year (Table 4.6). One of the key informants, a local vaccinator, asserted that the farmers who would have their local chicken vaccinated believed that one dose was all it took to give the birds life-long protection. Efforts to enlighten them fell on deaf ears with the farmers claiming that the vaccinator was after making money. More so, in case a vaccinated chicken died the cause of death would be attributed to the vaccine without second thought. Similarly, Ogali (2011) found that only 19% of the poultry farmers on Pemba Island were vaccinating birds regularly against ND and the major reasons given for not vaccinating included: vaccine shortage, high cost of the vaccine, doubt about the efficacy of the vaccine, inadequate follow-up/advice from extension workers.

Table 4.6: Number of times Farmers' Chickens are vaccinated in a year (n=240)

Vaccination times	% Respondents Pre	% Respondents Post
Do not vaccinate	81.7	0.4
Once	12.9	7.5
Twice	4.6	13.8
Thrice	0.4	19.6
Four times	0.4	58.3
More than four times	0.0	0.4

Source: Field data, 2012

4.3.3 Challenges Faced by Local Chicken Keepers Pertinent to Vaccination

During the baseline survey the respondents were requested to rank the challenges they were experiencing from greatest to least and the same was done during the follow-up survey a year later. Table 4.7 shows the percentages of local chicken keepers who ranked each challenge as their greatest challenge pre-vaccination (baseline) and post-vaccination. The results indicate that the most outstanding challenges are: lack of information about the prevention and control of other diseases besides ND; limited extension services; long distance to vaccine sale point; theft; lack of vaccines and long lapse between vaccination schedules. Similarly, FAO (2009) revealed that various challenges are constraining the achievement of an effective and sustainable poultry disease control strategy especially the limited number of extension service providers, the inadequate availability and high cost of drugs and vaccines, ignorance of poultry keepers and ineffective vaccines. These findings are also similar to Woolcock *et al.* (2004), who stated that there will continue to be significant risks of disease, predation and theft following ND control, and any interventions in remote rural areas where access to large markets and commercial inputs is lacking. This could probably arise due to the inaccessibility of these markets which results in high vaccine costs. Woolcock *et al.* (2004) further postulated that it is obvious in districts where ND vaccination has been introduced that there is a rapid impact, and farmers quickly start to look for the next steps in improving their chicken production. In such cases, the farmers crave for more knowledge and information on poultry management and disease control.

Extension and veterinary services gain increased prestige and more work when ND control activities are successfully implemented (FAO, 2002). In the FGDs it was unanimously stated that poultry extension services in the rural areas are non-existent. Only a few livestock owners access veterinary services through community animal health workers usually under private arrangements to treat their animals mainly cows. In the course of this study some local chicken keepers were trained as community vaccinators. These will help out their colleagues while earning some income thus sustaining the vaccination exercise. However, they do not have all the answers to poultry issues and they need refresher courses from time to time or as need arises. The new challenge therefore is for the extension service to assist farmers in their quest for advice and solutions for some of the other constraints especially those that take on greater significance once ND disappears.

Table 4.7: Challenges Faced by Local Chicken Keepers Pertinent to Vaccination (n=240)

Status	%Respondents Pre	%Respondents Post
Lack of vaccines	15.6	6.7
Limited extension	13.4	18.3
Lack of access to vaccines	18.2	4.2
Fear of vaccines causing harm	2.9	0.8
Lack of knowledge about vaccination	4.5	7.9
High cost of vaccines	23.7	1.7
Vaccines not working	10.2	1.7
Long distance to vaccine sale point	11.3	11.7
Lack of info about control of other diseases	0.0	29.2
Long lapse between vaccination schedules	0.0	5.8
Theft of chickens	0.2	7.5

Source: Field data, 2012

4.4 Costs and Benefits of Newcastle Disease Control

Cost-benefit analysis is vital in assessing the impact of the control of an infectious disease such as ND. Spradbrow (1999) emphasized that before extensive vaccination is undertaken there is need for cost-benefit analysis. The benefits were largely assumed to include the savings arising from the avoided losses of eggs and chickens after vaccination and the increased revenue due to improved productivity. The avoided losses mainly of eggs and chickens were estimated as the difference between the losses incurred without ND control and those with control. The costs on the other hand largely comprised the amount charged by village vaccinators for vaccination per chicken which price encompasses the cost of the vaccine, labour and transport.

4.4.1 Costs Incurred in ND Control

During the course of the study, the birds in the area aged two weeks and above were vaccinated on a quarterly basis free of charge for a period of one year. The total number of birds vaccinated per cycle was recorded. The cost of vaccination was derived by multiplying the number of birds vaccinated by one hundred shillings which was the prevailing market price for the service. The computed total vaccination costs for each cycle are shown in Table 4.8. The cycles one to four correspond to September 2011; December 2011; March 2012 and June 2012 respectively.

Table 4.8: Derived Cost of Vaccination for June 2011-June 2012

Vaccination Cycle	Total No. Of Birds Vaccinated	Total Cost (Shs) of Vaccination per cycle	Estimated Cost (Shs) of vaccination per bird[1]
Cycle one	3,660	366,000	100
Cycle two	3,476	347,600	100
Cycle three	4,189	418,900	100
Cycle four	5,314	531,400	100
Total		**1,663,900**	

Source: Field data, 2012

[1] Note: Cost of vaccination per bird was estimated at Uganda Shillings 100 based on the prevailing market price for the service.

The cost of the disease as a result of mortality or morbidity was estimated based on the number of birds that died, recorded on a quarterly basis. Each dead bird was valued at the average market price that it would have been sold had it been sold alive. The average market prices were 15,000; 13,000; 7,000 and 2,000 Uganda shillings for each cock, hen, grower and chick respectively. The derived value of the birds that died is as indicated in Table 4.9

Table 4.9: Derived Value of Birds that Died between June 2011 and June 2012

Cycle	No. of cocks	No. of hens	No. of growers	No. of chicks	Total Value of dead birds (in million Ug Shs)
Cycle one	32	28	21	65	1.121
Cycle two	13	11	19	108	0.687
Cycle three	15	8	16	71	0.583
Cycle four	12	19	7	54	0.584
Total	**72**	**66**	**63**	**298**	**2.975**

Source: Field data, 2011/12

The total cost of the disease was obtained as the summation of the total cost of vaccination for each cycle and the value of the birds that died and it was discounted at a rate of 18.7% based on the inflation rate stated in UBOS (2012). The results are indicated in Table 4.10. Kairu-Wanyoike *et al*. (2014) used the benefit-cost ratio to assess the cost effectiveness of controlling Contagious Bovine Pleuropneumonia (CBPP) in cattle in southern Kenya. The benefits were aggregated as the total costs saved as avoided outbreak control costs and total new revenue as avoided production costs as well as total additional costs of managing adverse post-vaccination reactions. These benefits were compared to the cost of vaccinating one animal.

Table 4.10: Total Cost of Newcastle Disease

Vaccination Cycle	Cost of vaccination (Million Shs)	Value of dead birds (Million Shs)	Total cost of the disease (Million Shs)	Discounted cost (Million Shs)
Cycle one	0.366	1.121	1.487	1.424
Cycle two	0.348	0.687	1.035	0.947
Cycle three	0.419	0.583	1.002	0.878
Cycle four	0.531	0.584	1.115	0.935
Total	1.664	2.975	4.639	4.184

Source: Field data, 2011/2012

4.4.2 Benefits arising due to Newcastle Disease Control

Both direct and indirect benefits arise as a result of vaccination. It is quite difficult to quantify the latter so this study mainly focussed on the former. However, some indirect benefits are highlighted. The direct benefits were largely assumed to be the physical production losses avoided by reducing the incidence of ND through vaccination which include eggs and live birds. Avoided losses due to ND control were estimated as the difference between the value of output produced without the disease and that produced in the presence of the disease over time. The avoided physical losses were assigned appropriate economic values based on the average farm-gate prices of the respective products as shown in Table 4.11. In cycle two, the percentage change in avoided losses for chicks was negative possibly because the chicks that were hatched after cycle one had not been vaccinated so many were affected and died.

The total annual production savings due to ND control through vaccination amounted to 3,586 hens, 853 cocks, 2,332 chicks and 28,985 eggs as obtained from Table 4.11. The avoided physical losses were assigned appropriate economic values based on the average annual farm gate prices of the respective products. The average annual savings for the 240 farmers or households in the sample were UGX 290,247.29 per household per year.

Table 4.11: Avoided Losses due to ND Vaccination for Four Vaccination Cycles (1 year)

Cycle	Product	Quantity After Vaccination	Quantity Before Vaccination	Avoided Losses (Number)	% Change in avoided Losses	Value[2] million U Shs
Cycle one	Cocks	301	229	72	31.44	1.080
	Hens	1,112	864	248	28.70	3.224
	Chicks	2,247	1,374	873	63.54	1.746
	Eggs	6,166	4,206	1,960	46.60	0. 490
Total						**6.540**
Cycle two	Cocks	386	229	157	118.06	2.355
	Hens	1,369	864	505	103.63	6.565
	Chicks	1,721	1,374	347	-60.25	0.694
	Eggs	8,971	4,206	4,765	143.11	1.191
Total						**10.805**
Cycle three	Cocks	482	229	253	61.15	3.795
	Hens	1,879	864	1,015	100.99	13.195
	Chicks	1,828	1,374	454	23.57	0.908
	Eggs	12,810	4,206	8,604	80.57	2.151
Total						**20.049**
Cycle four	Cocks	600	229	371	46.64	5.565
	Hens	2,682	864	1,818	79.11	23.634
	Chicks	2,032	1,374	658	144.93	1.316
	Eggs	17,862	4,206	13,656	58.72	3.414
Total						**33.929**

Source: Field data, 2011/12

[2] Values are in Uganda shillings. Average price per cock, hen, chick and egg were Uganda Shillings 15,000; 13,000; 2,000 and 250 respectively

The Net benefits, discounted benefits and discounted costs were computed and the results listed in Table 4.12

Table 4.12: Net Benefits, Discounted Benefits and Discounted Costs for the Vaccination Cycles

Vaccination cycle	Net benefit per cycle (Million shs)	Discounted Benefits (Million shs)	Total cost per cycle (Million shs)	Discounted Costs (Million shs)
Cycle one	6.174	5.908	1.487	1.423
Cycle two	10.458	9.576	1.035	0.947
Cycle three	19.630	17.202	1.002	0.878
Cycle four	33.398	28.006	1.115	0.935
Total	69.659	**60.692**	4.639	**4.183**

Source: Field data, 2011/12

Although the main emphasis of this study was on direct benefits, some indirect benefits cannot go unnoticed. During one of the key informants' interviews, one prominent male local chicken keeper mentioned that; "personally, I have benefitted from vaccination in more ways than many; for instance, I have noted increased survival of my chickens, they lay a lot more eggs than before hence I can spare some for my family's consumption and better still, I have been able to progress from a grass thatched house to an iron-roofed one courtesy of the proceeds I obtained from the sale of some of my chickens." Another younger male local chicken keeper and vaccinator had this to say during one of the focus group discussions, "being one of the local vaccinators that were trained during the project, I have acquired invaluable knowledge which is paying off already since the vaccination services I render to fellow village chicken keepers are already earning me a couple of extra shillings."

Furthermore, one of the elderly ladies during a focus group discussion mentioned that she had been struggling to combat ND amongst her flock but her efforts were futile because during outbreaks, the unvaccinated chickens from the neighbourhood would at times infect hers and she would incur tremendous losses. However as a result of the increased awareness and massive vaccination exercise, ND outbreaks have been kept at bay hence fewer losses are incurred, if any.

As a result of controlling ND, the average number of chickens was expected to increase. Alders and Spradbrow (2001) and Alexander *et al.* (2004) emphasised that controlling ND in areas where it is endemic results in substantial increases in village chicken numbers. In line with this, the average household flock size increased from 6 to 20 chickens in just one year. Subsequently, the percentage of households that own livestock increased from 46.8% to 52.5% in the same period. According to some information obtained from focus group discussions and key informants' interviews, some farmers exchange some of their birds for livestock such as goats/kids and calves. As noted by Bagnol (2001), most farmers who practice both agricultural and livestock production seek to increase the number of livestock species that they raise when surplus numbers of chickens permit such purchases. Important to note, 34.6% of the local chicken keepers mentioned that when their chicken flock sizes increase, they exchange some for other livestock such as goats, sheep and/or cows. Similarly, Ogali (2010) found that 10% of the local chicken farmers owned other livestock including cattle and goats.

The benefit-cost ratio (BCR) is a commonly used tool in assessing the viability of enterprises or interventions as is the case here. As the name suggests, the BCR is a ratio of the discounted benefits to the discounted costs (McClement *et al*., 2009). The ratio of the discounted benefits to the discounted costs as computed in the Table 4.12 yielded a BCR of 14.509:1. This ratio implies that for every shilling spent on ND control (vaccination), 15 shillings is obtained as profit. Hence it is cost-effective to vaccinate local chickens against Newcastle, holding other factors constant. This result is consistent with the findings of Asgedom (2007), who analysed the impact of different interventions in a village poultry production system at farm-level and, found that ND control resulted in higher net returns than housing intervention in the Ethiopian context. These results are also in line with the findings from Udo *et al*. (2006) and Woolcock *et al*. (2004), who found that ND control has a positive effect on bird off-take, egg production, egg off-take and flock size. Similarly, Kairu-Wanyoike *et al.* (2014) obtained social benefit to cost ratios ranging from 2.9 to 6.1 for the various vaccination programmes against CBPP in cattle indicating that vaccinating against CBPP was economically worthwhile for all programmes.

In a number of previous studies, the benefit-cost ratio of ND vaccination in small, scavenging flocks of village chickens has been shown to be high. Benefit-cost calculations done for the Tigray region of Ethiopia indicated that ND vaccination was more economically beneficial than the provision of daytime housing, supplementary feeding, cross breeding and control of broodiness (Udo *et al*., 2001). Using the partial-budgeting technique, Nahamya *et al.* (2006) analysed the costs and benefits of ND vaccination of local chicken. They found that vaccinating village chicken against ND saved over 70% of the flock and that although the total cost increased with vaccination, the total benefits and overall net-benefits greatly outweighed the costs.

A sensitivity analysis of the discount rate was conducted to assess the validity of the results of the benefit-cost ratio. When the discount rate was increased by 2%, a BCR of 14.786:1 was obtained. Reducing the discount rate by 2% yielded a BCR of 14.897:1. Both ratios are positive. In summary, it was noted in this study that it is cost-effective to vaccinate. Although vaccination of chickens against Newcastle disease involves some costs constituted in the cost of the vaccine, the benefits outweigh these costs.

4.5 Local Chicken Keepers' Willingness to Pay for Newcastle Disease Vaccination

The study categorised the local chicken keepers who were willing to pay a minimum of 100 Uganda shillings as those that were willing to pay. This fee corresponds to the cost price charged for vaccination per bird per month. Those who were willing to pay between zero and ninety nine Uganda shillings were 25.4% as shown in Table 4.13 and they were categorised as not willing to pay since what they were willing to contribute was less than the cost price. In a study to determine the factors influencing WTP for watershed services in lower Moshi, Pangani Basin in Tanzania, Ndetewio *et al.* (2013) found that 21% of the respondents were not willing to pay any additional payments arguing that it was the responsibility of the government to finance the conservation activities.

Table 4.13: Local Chicken Keepers' Willingness to Pay for Vaccination of Chickens

Range of WTP amount (Uganda Shillings)	%Respondents (n=240)	Cumulative percent
0-49	5.8	5.8
50-99	19.6	25.4
100-149	42.9	68.3
150-199	19.6	87.9
200-249	6.7	94.6
250-299	2.5	97.1
300-349	2.1	99.2
350-399	0.0	0.0
400-449	0.0	0.0
450-499	0.0	0.0
500-549	0.8	100.0

Source: Field data, 2012

Majority (74.6%) of the village chicken keepers are willing to pay for vaccination. These findings are consistent with those of Kusina *et al.*, (2000) where above 80% expressed willingness to have their poultry vaccinated against ND. Alexander *et al.* (2004) noted that such an approach where farmers pay for vaccination and where extension is an integral part of the vaccination programme is thought to ensure sustainability. Furthermore, Msoffe *et al.* (2010) stated that the principles of food bio-security necessitates that all of the households whose poultry co-mingle take collective action to prevent diseases in the village flock. Therefore, coordinated community action is imperative to improve the health of all poultry in the village setting. Thus it is advantageous that about 75% are willing to contribute towards disease control. On the other hand, those who were not willing to pay constituted a smaller percentage (25%) and they cited various reasons as to why they were not willing to pay; 41.3% of these claimed that vaccination was expensive and they were too poor to afford; 23.5% stated that ND was not a threat hence there was no need to contribute towards its control; 17.6% cited that vaccination was the government's responsibility; and 17.6% were unwilling to pay because vaccination is ineffective. Similar results were obtained by Dahlström *et al.,* (2009) who found that 3% of the respondents were not willing to pay for vaccination of their children against the H*uman Papilloma Virus* (HPV). These results also do not differ much from those of Dürr *et al.,* (2008) who in their assessment of the dog owners' WTP for vaccination against rabies in Chad found that only 1% were not willing to pay which was mainly attributed to low income.

4.6 Factors Influencing Farmers' Willingness to Pay for ND Vaccination

The *Logit* model was used to assess the factors influencing local chicken keepers' willingness to pay for Newcastle disease vaccination. The description of variables used in the logit model by willingness to pay category is presented in table 4.14. Overall, local chicken keepers on average were 39 years old, spent about 6 years in school and owned about 10 birds. However, those willing to pay for vaccination were significantly younger, more educated and owned more birds than those not willing to pay for vaccination. The average distance to the main market was 20 kilometers, with those willing to pay being significantly closer to that market (19 km) than those not willing-to pay (21 km). This implies that market availability increases farmers' willingness to pay for agricultural technologies as was noted by Ulimwengu and Sanyal, (2011). Furthermore, a significantly higher percentage of local chicken keepers in the willingness to pay category belonged to a group (53%) compared to those not willing to pay (8.2 %). Similar findings were obtained by Heffernan *et al.* (2008) in their study on livestock vaccine adoption among poor farmers in Bolivia which demonstrated that membership of a farmer to an organized group in the community and knowledge transfer through social networks increased vaccine uptake.

Table 4.14: Summary Statistics of Local Chicken Farmers Willing and not Willing to pay for Vaccination against Newcastle Disease

Variables	Overall (N = 240)	Willing to pay (n = 179)	Not willing to pay (n = 61)	t - value
Gender (1 = Male)	0.321 (0.030)	0.296 (0.034)	0.393 (0.063)	1.407
Age	39.046 (0.930)	38.006 (0.993)	42.098 (2.181)	1.927*
Education level (years)	5.563 (0.540)	5.994 (0.277)	4.295 (0.441)	3.148***
Group membership (1= yes)	0.413 (0.032)	0.525 (0.035)	0.082 (0.035)	6.573***
Total number of birds owned	9.913 (0.559)	11.145 (0.714)	6.295 (3.96)	3.890***
Local chicken source (1= market)	0.413 (0.032)	0.453 (0.037)	0.295 (0.059)	2.169**
Poultry rearing purpose (1= income)	0.821 (0.025)	0.922 (0.025)	0.525 (0.064)	7.795***
Neighbor's perception (1= willing to pay)	0.696 (0.03)	0.732 (0.033)	0.590 (0.063)	2.087**
Stock lost due to previous outbreak (%)	9.967 (1.823)	9.609 (2.087)	11.016 (3.756)	0.336
Previous vaccination experience (1= good)	0.75 (0.028)	0.905 (0.022)	0.295 (0.059)	11.979***
Limited extension a major challenge (1= yes)	0.95 (0.014)	0.944 (0.017)	0.967 (0.023)	0.712
Fear of vaccine causing harm (1= yes)	0.417 (0.032)	0.425 (0.037)	0.393 (0.063)	0.424
Farmer's income	39875 (2653.755)	38100.56 (2653.866)	45081.97 (4938.97)	1.297
Distance to market	20.00 (0.248)	19.553 (0.307)	21.311 (0.321))	3.149**

Figures in brackets are standard errors; *; ** and *** denote 10%, 5% and 1% significance levels respectively

Majority of the local chicken keepers (82%) reared chicken mainly for income and about 41% obtained their stock from the market. Across the two categories, the results indicate that the proportion of local chicken keepers rearing chickens mainly for income was significantly high amongst those willing to pay than those not willing to pay. Similarly, the percentage of farmers that obtained their local chicken stock from the market was significantly higher among the willing to pay category (45%) than those in the not willing to pay category (30%).

Perception of neighbour's willingness to pay and previous vaccination experience also varied between local chicken keepers willing to and not willing to pay for vaccination. About 70% of the local chicken farmers perceived that their neighbours were willing to pay for vaccination. However, the positive perception about neighbours was significantly higher among local chicken farmers willing to pay (73%) than those who were not willing to pay (59%). As expected, good previous vaccination experience was significantly higher among those willing to pay (91%) than not willing to pay (30%). Other variable including gender of local chicken keeper; percentage of stock lost due to previous outbreak; farmers' income; those that had challenges accessing extension services; and those that feared the vaccine causing harm did not vary between local chicken keepers that were willing and those who were not willing to pay for vaccination.

4.6.1 The Logit Model Results

The results of the *Logit* model which was used to assess the factors influencing local chicken keepers' willingness to pay for Newcastle disease vaccination and the results presented in Table 4.15. The model diagnostic test result shows that the model was significant at 1% with R^2 of 68.79%, indicating a good fit. Test for multi-collinearity using Variance Inflation Factor (VIF) also shows that all the variables had VIF of less than 10 with mean VIF of 1.36 indicating that multi-collinearity is not a problem in the model. The Breusch-Pagan test for heteroskedasticity showed that the residuals were not homogenous (Appendix V), thus robust standard errors were used to deal with the problem.

Table 4.15: Logit Model Estimates of Factors Influencing Farmers' WTP for Vaccination

Willingness to pay

Variables	**Coeff**	**Robust SE**	**P-Value**	**Marginal effects**
Gender of farmer (1=male; 0=female)	-1.590	0.588	0.007	-0.100
Local chicken farmer's age	0.007	0.018	0.681	0.000
Farmer's education level	0.164	0.079	0.041	0.007
Farmer group member (1=Yes, 0=No)	2.971	0.922	0.002	0.139
Total number of local chicken owned	0.169	0.051	0.004	0.007
Local chicken source (1=Market, 0=Otherwise)	1.800	0.582	0.003	0.079
Purpose for rearing poultry(1=income,0=otherwise)	3.879	1.083	0.000	0.526
Farmer's perception of neighbour (1=Neighbour is willing to pay, 0=otherwise)	0.539	0.555	0.328	0.027
Previous vaccination experience (1=good,0=bad)	2.272	0.617	0.000	0.190
% of stock lost due to ND in previous outbreak	0.022	0.009	0.026	0.001
Limited extension is the major challenge (1=Yes, 0 = Otherwise)	-2.783	2.282	0.030	-0.051
Fear of the vaccine causing harm is the major Challenge (1=Yes, 0 = Otherwise)	-0.443	0.642	0.481	-0.021
Farmer's Income[a]	1.411	0.592	0.006	0.065
Distance to the market	-0.254	0.077	0.007	-0.011
Constant	-13.983	7.052	0.022	
Number of observations	240			
Log pseudolikelihood	-54.102966			
LR chi^2 (13)	68.79			
Prob > chi2	0.0000			
Pseudo R2	0.6023			

[a]=Logarithm

Source: Field data, 2012

Gender of the farmer significantly influences the farmer's WTP for vaccination albeit negatively. The male farmers are less likely to pay for vaccination than their female counterparts. This could be so because generally women are the ones actively involved in poultry keeping as noted by Gueye (2000) and Awuni, (2006) hence they are directly affected by the losses that arise as a result of Newcastle and as such they may be more willing to pay for vaccination than their male counterparts.

The level of education of the local chicken farmers as expected had a positive and significant influence on willingness to pay for ND vaccination. An increase in the farmer's level of education by one year increases the log odds of paying for ND vaccination by 0.7%. Education increases farmers' ability to get, process, and use information (Ulimwengu and Sanyal, 2011). This finding is consistent with findings in studies on farmers' WTP for sustained land productivity technologies in Ethiopia (Holden and Shiferaw 2002; Asrat, *et. al.,* 2004); extension visitation or other extension services in Uganda, Ethiopia, and Nigeria (Faye and Deininger, 2005; Holloway and Ehui 2001; Oladele 2008)

Local chicken keepers who were members of a farmer group as expected were more likely to pay for vaccination of their birds against ND than their colleagues who did not belong to any group. This could be so because in the groups farmers share information that enables them to understand proper animal husbandry aspects including disease control. Similarly, Ulimwengu and Sanyal, (2011) noted that the strength of smallholder farmers lies in group mobilization to meet diverse agricultural needs, such as accessing inputs, pooling resources and sharing information.

The source of local chicken stock was also found to be positive and significant. Those that purchase stock from the markets were more willing to pay for vaccination possibly because they incur a cost to acquire their chickens hence they would rather invest in disease control and prevention than lose their flock in an outbreak. Otim *et al*. (2007) found that majority of the smallholder poultry keepers purchase chickens from the market and neighbourhood to rebuild their stock after a disease outbreak. The same study identified the restocking chickens from the market and the neighbourhood as the most important risk factors for ND outbreaks. Live infected birds obtained from the markets are the most likely means of introduction of the ND virus into village populations. Sometimes these birds are sold before they show any signs or symptoms yet they may be carrying the virus causing the disease thereby spreading it to the entire flock in which they are introduced.

Furthermore, the flock size was found to positively influence farmer's WTP as expected and it was statistically significant at 1%. The higher the number of local chicken owned, the more willing the farmers are to contribute towards disease control. This is probably because in case of a disease outbreak those with a bigger number of chickens are liable to incurring greater losses than those with fewer birds. In line with this, Tomo *et al.* (2012) postulated that flock size is expected to have a positive effect on the size of the benefits of ND vaccination at farm level. The bigger the flock, the larger is the number of chickens expected to be saved by vaccination and, the bigger are the expected benefits of vaccination hence farmers with a bigger flock size are more willing to pay for ND vaccination. On the contrary, Dahlström *et al.,* (2009) in the assessment of parents' WTP for their children's vaccination against the *Human Papilloma Virus* (HPV) found that parents who had a bigger number of children of vaccination age in their household were less willing to pay for vaccination. The authors noted that the cost burden was higher in households with several children in the recommended age bracket and thus they were less willing to pay.

Farmers who rear poultry mainly for income generation were found to be more willing to pay for vaccination than their counterparts who keep birds purposely for home consumption, cultural purposes and prestige. Those that rear local chicken purposely for sale tend to view chicken production as a business in which they are willing to invest in a bid to mitigate risk and increase the chances of acquiring profits. In their assessment of the impact of Newcastle disease control in village chickens on the welfare of rural households in Mozambique, Woolcock *et al*. (2004) found that vaccinating poultry resulted in a decrease in mortality and a subsequent increase in the poultry stock. However, they further noted that with the increase in the number of chickens, poultry farmers increased sales more than they increased consumption. Walker *et al*. (2004) found that possession and trading of some chickens results in marked superiority in rural income. Furthermore, Walker *et al*. (2006) show that chickens are among the first 10 agricultural commodities with the highest contributions to total value of production, and that a 20 percent increase in chicken production could result in a four percent reduction in the severity of poverty.

Farmer's previous vaccination experience also positively and significantly influences their WTP for vaccination. Farmers that had a good experience after vaccination were more likely to be willing to pay for ND control. Those who experienced an increase in the survival rate of their chickens after vaccination attributed their survival to the vaccine hence they were more willing to pay for it. On the contrary, Modise (2007) found that a good number of the farmers who had lost some chickens after the first round of vaccination were unwilling to continue with the exercise because they attributed the deaths of their birds to the vaccine.

The percentage of birds that died due to ND in a previous outbreak increased the farmers' willingness to pay for vaccination. The local chicken keepers who had lost more birds due to the disease were more likely to be more willing to pay for vaccination. As noted in this study and other studies (Woolcock *et al*., 2004; Tomo *et al.*, 2012), vaccinating local chicken against ND results in a decrease in mortality and a subsequent increase in the chicken stock. Thus those who had lost more birds in a previous outbreak and have benefited from vaccination could be more willing to mitigate the current flock against that risk of loss due to Newcastle disease than those that lost fewer birds in previous outbreaks.

The slope coefficient on the dummy variable of those who hardly accessed extension services was negative and significant. This implies that the farmers are oblivious of vaccination and its underlying benefits due to lack of information hence they are less likely to be willing to pay for their birds to be vaccinated. Alexander *et al*. (2004) noted that in many countries rural poor families who keep chickens have little or no contact with veterinary services and with the formal economy thus these resource-poor people are the least likely to take risks and as a result, adopt new technologies only when they are sure of an adequate return on their investment of both time and money.

As predicted, local chicken farmers with more income are more willing to pay for vaccination. An increase farmer's income by a shilling increases his/her willingness to pay for vaccination by 6.5%. Empirical studies have reported positive relationships between income and adoption of agricultural technologies (Holden and Shiferaw 2002; Faye and Deininger 2005). On the other hand, poverty reduces a household's willingness and ability to invest in agricultural technologies (Holden and Shiferaw 2002).

Market availability increases farmers' willingness to pay for agricultural services. This is confirmed by the negative impact of travel distance on the willingness to pay for vaccination. Increasing the distance from the market by one kilometre reduces the farmers' WTP for vaccination by 1%. Similar results were obtained by Ulimwengu and Sanyal, (2011) in their assessment of the factors influencing farmers' WTP for agricultural services.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary and Conclusions

Free-range poultry production forms a large proportion of the poultry sector in the country. Village chickens contribute to human nutrition being the key suppliers of quality protein in form of eggs and meat; they are highly prized in many social-cultural functions and festivities and they are a quick source of cash required to meet immediate household needs. Newcastle disease however is the major hindrance to village poultry production and it can clear up to a hundred percent of the flock. Vaccination is the only viable control measure applicable. This study sought out to establish the major challenges that constrain effective control of Newcastle disease among smallholder free-range chicken production systems; determine and compare the benefits and costs of controlling the disease; determine the local chicken farmers' willingness to contribute towards disease control and assess the factors influencing their willingness to pay for vaccination.

A total of 240 households selected randomly from two areas in Iganga district were used for the study, in addition to focus group discussions held with selected local chicken farmers. The analytical tools used were descriptive statistics, the benefit-cost ratio, the compensating variation technique and the *logit* model.

High cost of and lack of access to vaccines as well as limited extension service were the major outstanding challenges constraining effective control of the disease. The vaccine is costly because it is packaged in large doses for at least one hundred birds yet farmers on average have eleven birds. The benefits and costs involved in controlling Newcastle were assessed yielding a benefit-cost ratio of 15:1 implying that it is cost-effective and economically viable to vaccinate. On average the local chicken keepers are willing to pay a minimum of one hundred Uganda shillings for vaccination per chicken. This tallies with the current market charges for the service per bird.

The study revealed that female local chicken keepers; farmers with higher level of education and income are more likely to pay for vaccination. Furthermore, farmers who own many chickens, those that belong to farmer groups and obtain their chicken stock from markets as well as those that rear local chicken mainly for income were more willing to pay to eradicate Newcastle disease. In addition, farmers whose previous vaccination experience was good and those that suffered high chicken losses in previous Newcastle disease outbreaks were more willing to contribute towards its eradication through vaccination. On the other hand, those that were staying further away from the trading centres and those that had challenges accessing extension services were less likely to pay for vaccination. These findings point to the conclusion that the local chicken keepers are generally willing to pay to control Newcastle disease in their flock especially those that have more chickens and income as well as those that are more educated and/or are members of a farmer group.

5.2 Recommendations

It is recommended that the free-range chicken farmers should join farmer groups from which they can obtain information and acquire knowledge from fellow farmers and extension agents on good production techniques and disease control in addition to other agricultural knowledge. The possibility of offering information about Newcastle disease and its control through the groups can be explored. The leaders of these groups can approach the district production office or sub-county offices and request for these services based on the needs at hand. Such demand-driven approaches are likely to yield quicker responses on the side of the extension workers and consequently better results. Furthermore, in these groups farmers can purchase inputs like vaccines that are normally packaged in large quantities and share them amongst themselves thereby paying less per unit.

A boost in extension services targeted at farmers at the grassroots is highly recommended. Farmers should be availed with relevant information pertinent to animal husbandry practices, market information as well as sources of and proper use of agro-vet inputs and drugs. Most importantly, extension services should have a lot of emphasis on poultry information. More so, extension workers should be given incentives to move deep in the villages to disseminate such information. To facilitate the development of appropriate extension packages, clear national policies for the development of the poultry sector are required for both village chicken and intensive poultry production. It is suggested that interventions in village chickens should be designed so as not to alter the natural competitive advantages that village chicken production has in rural areas.

This study found that it is highly beneficial to control ND in village chickens. These birds play a significant role in the well-being of the rural people hence the government should not neglect but rather emphasize the role of poultry in rural development. While developing programmes through the National Agricultural Advisory Services (NAADS) for crops and other livestock mainly goats and cattle, poultry should not be left out. Proper dissemination of information about the severity of ND and the role of local chicken keepers in mitigating it should be emphasized.

Among the outstanding challenges local chicken farmers face as identified in this study was the lack of access to vaccines. The local vaccinators that were trained in the course of the study could purchase the vaccine and administer it to the birds in the community at the fee that the local chicken keepers are willing to pay per bird which coincides with the prevailing price for publicly administered vaccine. That way, the vaccines would be accessed easily at a fair price and the efficacy would be more guaranteed since it is handled by trained people whom fellow farmers trust. In turn, the vaccinators would also earn some income.

The local chicken keepers' level of education was found to positively and significantly influence their willingness to contribute towards disease control. The current government has made an effort to subsidise education services especially in rural areas but this targets mainly the children. Non-formal education and adult literacy programmes should be encouraged and supported by district authorities and farmer-based organisations to run literacy classes among rural farmers to promote their understanding of scientific technologies in order to enable them utilise those technologies for sustainable improvement in animal husbandry and agricultural productivity as a whole.

Distance to market, an indicator of market access has been found to negatively affect local chicken keepers' willingness to pay for Newcastle disease control. Longer distances to markets causes village chicken farmers to incur high transaction costs in accessing vaccines as well as market for birds. It is recommended that policy makers promote decentralization of services within the villages so that services such as vaccination are brought closer to them.

Since local chicken keepers income is positively related to their willingness to pay for Newcastle disease control, policies that can lead to accumulation of wealth in the form of productive assets as well as farm and off-farm income among the village chicken keepers should be encouraged. The farmers could get involved in income generating activities such as weaving baskets and mats. The government also needs to design programmes that are targeted at increasing the farmers' household incomes for example providing them with heifers which they can rear and give back a calf which in turn can be given to another farmer to raise.

Last but not least, prevention is better than cure. Vaccinating chickens against Newcastle disease has been found to be economically worthwhile and beneficial to the survival of village poultry that play various roles in the welfare of rural livelihoods including better diets and income. The government should therefore support and encourage vaccination through massive awareness and vaccination campaigns as well as encouraging the farmers to contribute towards disease control.

It has been noted in this study and in previous studies that in areas where ND vaccinations have been effectively conducted other diseases particularly fowl pox emerge. This could be mainly due to the fact that control of ND increases the survival rate of local chicken hence there is an increase in the number of chickens and this results in congestion which enhances the spread of fowl pox. Further research is thus recommended in the linkage between Newcastle disease control and the emergence of fowl pox in such environments. Further studies can be conducted in the underlying causes of fowl pox and predisposing factors in the areas where ND has been controlled and recommendations should be made on how to prevent its occurrence in these areas.

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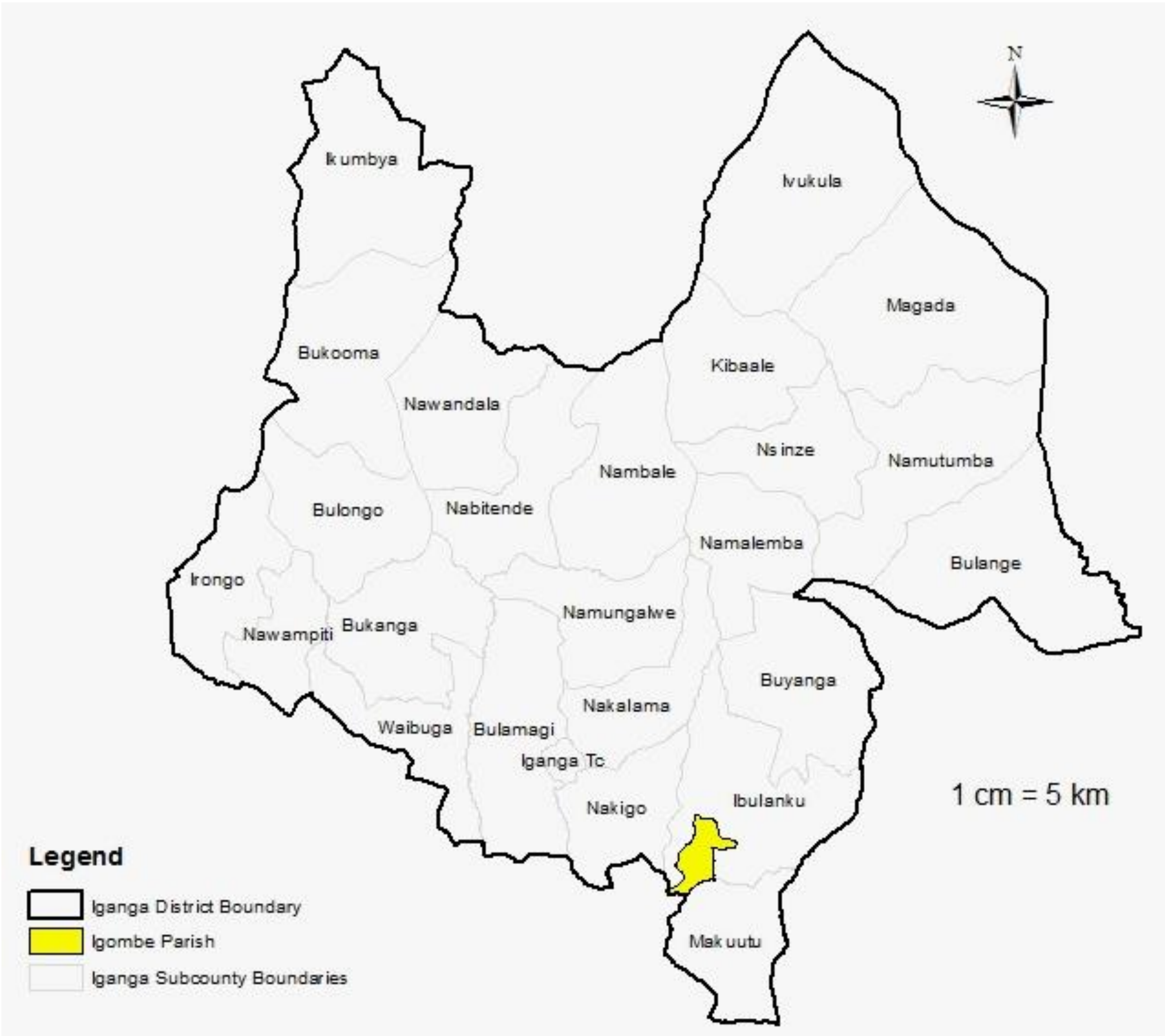
APPENDICES

APPENDIX I: Map of study area



APPENDIX II: Questionnaire

Poultry Health Questionnaire

Participatory control of Newcastle disease in village poultry using thermostable ND vaccines in Uganda

This study is about Participatory control of Newcastle disease in village poultry using thermostable ND vaccines in Uganda. The main objective is to identify opportunities for successful and sustainable ND vaccination community strategies for the free-range poultry production system in Uganda by, first, investigating the current knowledge, attitudes and practices of the stakeholders and communities. In addition, establish the current challenges and limitations that constrain effective disease control, establish the level of protection and impact of live thermostable vaccines and identify lessons, best practices, and opportunities that can be used for instituting a successful and sustainable ND vaccination program for smallholder village free-range poultry production in village communities. You have been identified as a key stakeholder in this exercise who could provide very useful information to achieve this objective. We therefore kindly request you to give as much information as possible using this questionnaire. The information provided is strictly confidential and is only for the purposes of this study. If you require further questions regarding this study, please feel free to contact Dr. Denis K. Byarugaba at Makerere University on Tel. 0414531169. Thank you very much for your time.

	Questionnaire No.					
	Enumerator’s name:					
	Date completed:					
	Supervisor’s name:					
A	**Demographic characteristics**					
1	Position of respondent in the household					
			1	Husband		
			2	Wife		
			3	Child		
			4	Relative/In-law/Friend		
			5	Worker		
2	Gender of respondent					
			1	Male		

		2	Female
3	Age of the respondent (years)		
4	Marital Status	1	Married
		2	Widowed
		3	Divorced
		4	Single
5	Religion		
	Catholic		
	Protestant		
	Moslem		
	Born again		
	Traditional		
	Others (specify)		
6	Education	1	None
		2	P1-P4
		3	P5-P7
		4	*S1-S4*
		5	S5-S6
		6	University/Tertiary
		7	Other (Specify)
7	LC1/Village		
8	Distance from trading centre....................................... kilometres		
9	What is your main occupation?		
		1	Farmer
		2	Civil servant
		3	Employed by a private company
		4	Private business
		5	Not employed
		6	Other (specify)

10	Your main source of income		11	Other sources of income *(tick all that apply)*	
	Crop husbandry	1		Crop husbandry	1
	Animal husbandry	2		Animal husbandry	2
	Fishing	3		Fishing	3
	Extractive/mining activities	4		Extractive/mining activities	4

	Commerce (buy and sell)	5		Commerce (buy and sell)	5
	Employment	6		Employment	6
	Professional services	7		Professional services	7
	Casual labour	8		Casual labour	8
	Others *(specify)*----------------	9		Others *(specify)*…………	9
12	What are those qualities that indicate socio-economic well being in your area? (*Tick all that apply*)		13	State the kinds of property/ assets owned (*Tick all that apply*)	
	Able to feed oneself or family	1		House	1
	Able to educate children under one's care	2		Agricultural implements (hoes, panga, saw)	2
	Able to provide medical care to oneself or family	3		Livestock	3
	Able to clothe oneself/family	4		Motorbike	4
	Able to house oneself/family	5		Bicycle	5
	Ownership of livestock	6		Beddings	6
	Has own means of transport	7		Television	7
	Having beyond the basic household property	8		Radio	8
	Others (Specify)	9		Others (Specify)	9
14	Which of these best describes your monthly income?		15	What were the major sources of income between May 2011 and May 2012?	
	<50,000 shs	1		Crop harvest	1
	51,000 – 100,000 shs	2		Poultry	2
	101,000 – 150,000 shs	3		Livestock (specify)	3
	151,000 – 200,000 shs	4		Monthly salary	4
	>200,000 shs	5		Remittances	5
				Other (specify)	6
16	Do you have access to agricultural information and extension advice?				
	Yes	1			
	No	2			
17	If yes, what are the sources of your information and extension advice?		18	What type of information?	
	District extension staff			Veterinary information	1
	Other farmers			Production Advice	2

	Farmers' organizations			Sources and provision of inputs	3	
	Traders/marketing agents			Agricultural finance & credit	4	
	Researchers			Farming as a business	5	
	NGO/CBO extension staff			Others (Specify)	6	
	Radio					
	Others (Specify)					
	Level of community organization					
19	Are you a member of any self help group or farmer group?		20	If yes, what type of group do you belong to?		
	Yes			Community self-help group		
	No (*skip to 27*)			Farmer group		
21	Name of the group		22	Is your group registered?		
	……………………..................			Yes		
	………………………………			No		
	………………………………			Don't know		
23	Who helped you form the group?		24	What activities are carried out or promoted by the group?		
	Staff or Agric Department	1		Trainings	1	
	NAADS	2		Marketing	2	
	NGO	3		Counselling	3	
	Community	4		Pooling labour	4	
	Don't know	5		Sensitizing community	5	
	Other (specify)	6		Other (specify)	6	
25	Indicate membership of the group by gender.		26	How often does your group hold meetings?		
	Number of male …………..			Weekly		
	Number of female …………..			Fortnightly		
				Monthly		
				Quarterly		
				Annually		
				Other (specify)		
B	**Poultry Production**					
27	Do you rear poultry?					
			1	Yes		
			2	No		
28	If yes, what type of management system?					

			1	Free-range		
			2	Semi-intensive		
			3	Intensive		
29	Purpose for rearing poultry? (Rank in order of importance)					
			1	Home consumption		
			2	Income		
			3	Cultural reasons		
			4	Leisure		
			5	Other (specify)		
30	Experience in rearing poultry (years)...					
31	Fill in the numbers of poultry species that you currently keep in the table below					

	Poultry species	**Chicks (2wks)**	**Growers (2wks-2months)**	**Cocks (adult)**	**Hens (adult)**
	Chicken				
	Turkeys				
	Ducks				
	Guinea fowls				
	Pigeons				
	Others				

32	List the main source of stock for each of the poultry species indicated in 31 above.				
	Poultry species	**Gift**	**Market**	**Hatchery**	**Other (NAADS, NGOS) etc**
	Chicken				
	Turkeys				
	Ducks				
	Guinea fowls				
	Pigeons				
	Others				

33	Do you find it profitable rearing local village poultry?		34	What benefits have you derived from rearing poultry?
	Yes			Income
	No			Food (consumption)
	Not sure			Exchange them for kids, goats, calves, cows, etc
				Prestige
	Others (*specify*)			Other (specify)

35		Which other livestock do you keep at household level?	
		Type	Number
		Local cattle	

		Exotic/crossbreed cattle		
		Goats		
		Pigs		
		Sheep		
		Others (*Please specify*) ………………..		

36	Indicate quantities of poultry products produced in this household.					
	Poultry Products	**Produced**	**Sold**	**Price per item**	**Consumed**	**Given**
	Eggs					
	Chicken					
	Chicks					
	Ducks					
	Turkeys					
	Guinea Fowls					
	Others					

37	**Production Costs**	**Unit Cost (U shs)**	**Quantity used**	**Total Cost**
	Feeds (Specify)			
	Other vaccines (Treatment)			
	Water			
	Others (Specify)			

38	Do you house your birds?			39	If yes to 38, when are they housed?	
	Yes	1			Night	
	No	2			Day	
					Both	

C		**Knowledge about Poultry diseases and their control**	

40	Do you know of any poultry diseases?			41	If yes in 40, which poultry diseases(s)?	
	Yes	1		1	Newcastle disease	
	No	2		2	Fowl pox	
				3	Fowl typhoid	
				4	Coughing	
				5	External parasites	
				6	Worms	
				7	Others *(specify)*...........................	

42	For all the diseases selected above, give a brief description of the signs and symptoms.

43	Rank the above diseases according to extent of losses (1=biggest losses, 6=least losses)				
			1	Newcastle disease	
			2	Fowl pox	
			3	Fowl typhoid	
			4	Coughing	
			5	External parasites	
			6	Worms	
			7	Coccidiosis	
			8	Other (specify)	
44	Have you had any loss of birds due to Newcastle disease (ND) in the last 1 year?				
	Yes	1			
	No	2			
	Don't remember	3			
45	If yes, how many times in each year do you get deaths due to ND?				
			1		Once a year
			2		Twice a year
			3		Three times a year
			4		Four times a year
46	Please specify the period of high and low incidence of the disease.				
			1	High	…………………………………………
			2	Low	………………………………………..
47	When was the last time you had ND in your flock?				
			1	During the last three months	
			2	About six months ago	
			3	About 12 months ago	
			4	More than 12 months ago	
			5	Do not remember	
48	How many birds died you during the last outbreak? …………………………….				
49	How many birds survived during the last outbreak? …………………………….				
50	Do you ever seek for help from anybody?				
	Yes	1			
	No	2			
51	If you seek help, from whom do you do so?				
			1	Fellow farmers	
			2	Extension agents	
			3	Drug shop attendant	
			3	Community based workers	

			4	Local leaders		
			5	Other *(specify)*................................		
52	Do you know of any control strategies for the ND disease?					
	Yes	1				
	No	2				
53	What control/coping strategies do you use to control ND disease?					
			1	Vaccination		
			2	Treat with commercial drugs		
			3	Treat with local remedies		
			4	Isolate sick from healthy ones		
			5	Sell off the birds		
			6	Other *(specify)*.......................................		
54	Have any of the above control strategies helped you reduce the losses?					
	Yes	1				
	No	2				
55	If yes to 54, rank the control strategies from most helpful (1) to least helpful (5)					
			1	Vaccination		
			2	Treat with commercial drugs		
			3	Treat with local remedies		
			4	Isolate sick from healthy ones		
			5	Sell off the birds		
D	**Practices related to ND vaccination**					
56	Are your poultry vaccinated against ND?					
	Yes	1				
	No	2				
57	If yes to 56, who vaccinates them *(Tick all that apply)*					
			1	Extension agents		
			2	Fellow farmers		
			3	Self		
			3	NGO workers		
			4	Community based animal health workers		
			5	Other (specify)...		
58	What is the source of the vaccine used? *(Tick all that apply)*					
			1	Government Veterinary department		
			2	NAADS		

			3	Private drug shops		
			4	NGOs		
			5	Research groups		
			6	Other		
59	How many times in a year are the poultry vaccinated?					
			1	Once a year		
			2	Twice a year		
			3	Three times		
			4	Four times		
60	How long ago were your birds vaccinated?					
			1	Do not remember		
			2	One month ago		
			3	Three months ago		
			4	Six months ago		
			5	12 months ago		
			6	More than 12 months ago		
			7	Never		
61	Did the vaccination help to control ND?					
	Yes	1				
	No	2				
62	What benefits have you derived from vaccination?					
			1	Reduced mortality		
			2	Increased hatchability		
			3	Increased number of eggs laid		
			4	Increased income		
			5	Other (specify)		
63	Are you willing to pay for vaccination?					
	Yes					
	No					
64	Why or why not?					
65	If no to 63, how much are you willing to pay? ....shillings.					
66	Have you ever vaccinated and birds still died?					
	Yes	1				
	No	2				
67	If yes to 66, what do you think could have been the problem?					
	……………………………………………………………………………………………………					
	……………………………………………………………………………………………………					
68	Do your neighbours vaccinate their chickens?					

	Yes	1				
	No	2				
	Don't know	3				
69	Would you still vaccinate your birds if your neighbour s were not vaccinating theirs?					
	Yes	1				
	No	2				
E	**Challenges and limitations for successful and sustainable ND vaccination**					
70	What are the challenges that limit successful and sustainable ND control? (*tick all that apply*)					
			1	Lack of vaccines		
			2	Lack of access to vaccines		
			3	Limited extension services		
			4	Vaccines not working		
			5	High cost of vaccines		
			6	Long distance to vaccines sale point		
			7	Lack of knowledge about vaccination		
			8	Fear of vaccines killing/causing harm		
			9	Other (specify)		
71	Rank in order of importance (1= biggest challenge; 9=least challenge)					
			1	Lack of vaccines		
			2	Lack of access to vaccines		
			3	Lack of extension agents		
			4	Vaccines not working		
			5	High cost of vaccines		
			6	Long distance to vaccines sale point		
			7	Lack of knowledge on vaccination		
			8	Fear of vaccines killing/causing harm		
			9	Other (specify)		
72	How do you address the challenges above?					
	....					
	....					
73	Do you get support from government or any other organization in ND vaccination					
	Yes	1				
	No	2				
74	What kind of support do you get? (tick all that apply)					
			1	Provision of vaccines		
			2	Mobilization to form groups		
			3	Training farmers as vaccinators		
			4	Advisory services		
			5	Provide vaccinators		

			6	Other (specify)...			
75	How often do you get this support?						
			1	Weekly			
			2	Fortnightly			
			3	Monthly			
			4	Quarterly			
			5	Bi-annually			
			6	Annually			
			7	Other (specify)			
76	Do you consider the support adequate?						
	Yes		1				
	No		2				

THANK YOU SO MUCH FOR YOUR TIME

APPENDIX III: Logistic Regression Model Output

```
logit wtp_new gender  age educ  grpmb total_birds mkt_source_only
rearingPoultry_Income perception_neighbour prev birds_died extchalllenge fearchal
ln_income distance_market, robust

Iteration 0:   log pseudolikelihood = -136.04798
Iteration 1:   log pseudolikelihood = -69.144933
Iteration 2:   log pseudolikelihood = -57.152275
Iteration 3:   log pseudolikelihood = -54.199747
Iteration 4:   log pseudolikelihood = -54.103127
Iteration 5:   log pseudolikelihood = -54.102966
Iteration 6:   log pseudolikelihood = -54.102966

Logistic regression                               Number of obs   =        240
                                                  Wald chi2(14)   =      68.79
                                                  Prob > chi2     =     0.0000
Log pseudolikelihood = -54.102966                 Pseudo R2       =     0.6023
```

wtp_new	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
gender	-1.590771	.5884626	-2.70	0.007	-2.744136	-.4374054
age	.0075051	.0182	0.41	0.680	-.0281662	.0431764
educ	.1648181	.0799264	2.06	0.039	.0081652	.3214711
grpmb	2.971216	.9229843	3.22	0.001	1.1622	4.780232
total_birds	.1692721	.0514834	3.29	0.001	.0683664	.2701778
mkt_source~y	1.800509	.5823171	3.09	0.002	.6591885	2.941829
rearingPou~e	3.879103	1.083836	3.58	0.000	1.754823	6.003383
perception~r	.5397002	.5558432	0.97	0.332	-.5497324	1.629133
prev	2.272014	.6178058	3.68	0.000	1.061137	3.482891
birds_died	.02275	.0095219	2.39	0.017	.0040874	.0414126
extchallle~e	-2.783925	2.282937	-1.22	0.223	-7.2584	1.690549
fearchal	-.4434388	.6423751	-0.69	0.490	-1.702471	.8155934
ln_income	1.411588	.5929998	2.38	0.017	.2493299	2.573847

```
distance_m~t |  -.2547667   .0771652    -3.30   0.001    -.4060076   -.1035258
       _cons |  -13.98322   7.052998    -1.98   0.047    -27.80684   -.1595976
------------------------------------------------------------------------------


. mfx

Marginal effects after logit
      y  = Pr(wtp_new) (predict)
         =  .95153876
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
  gender*|  -.1007932      .06157   -1.64   0.102  -.221458  .019872   .320833
     age |   .0003461       .0008    0.43   0.665  -.001222  .001914   39.0458
    educ |   .0076002      .00421    1.81   0.071  -.000651  .015851    5.5625
   grpmb*|   .1390233      .04973    2.80   0.005   .041561  .236485     .4125
total_~s |   .0078056      .00294    2.66   0.008   .002052  .013559    9.9125
mkt_so~y*|   .0793092      .03885    2.04   0.041   .003172  .155446     .4125
rearin~e*|   .5267244        .173    3.04   0.002   .187643  .865805   .820833
percep~r*|   .0275958      .03135    0.88   0.379  -.033841  .089033   .695833
    prev*|    .190642      .10677    1.79   0.074  -.018632  .399916       .75
bird~ied |   .0010491      .00058    1.80   0.072  -.000094  .002192   9.96667
extcha~e*|  -.0516945      .02088   -2.48   0.013  -.092627 -.010762       .95
fearchal*|  -.0212643       .0295   -0.72   0.471  -.079085  .036556   .416667
ln_inc~e |   .0650922      .03496    1.86   0.063  -.003423  .133607   10.6612
distan~t |   -.011748      .00543   -2.16   0.030  -.022384 -.001112        20
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```

APPENDIX IV: Model Diagnostic Tests

i) Test for multicollinearity

Variable	VIF	1/VIF
fearchal	1.85	0.541489
grpmb	1.83	0.546231
prev	1.74	0.573393
rearingPou~e	1.61	0.621998
educ	1.41	0.710576
age	1.28	0.780708
gender	1.25	0.799819
distance_m~t	1.22	0.820338
total_birds	1.22	0.821016
extchallle~e	1.16	0.860094
mkt_source~y	1.14	0.873486
birds_died	1.12	0.888894
ln_income	1.07	0.932982
perception~r	1.07	0.937027
Mean VIF	1.36	

ii) Test for heteroscedasticity

```
. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of wtp_new

         chi2(1)      =    18.93
         Prob > chi2  =   0.0000
```