PEOPLE, POULTRY AND POVERTY: Assessing Economic Value of Poultry Health Service and Genetic Resources in Rural Ethiopia

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy by Zelalem G. Terfa

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Abstract

Demand for animal protein is growing with growing human population and urbanization. In developing countries where food security is still a challenge and access to animal protein is limited, village poultry could be a viable livelihood option for smallholder farmers and it could improve peoples' access to animal protein. Research and development in village poultry is minimal and farmers keep poultry under unfavourable production environments. Lack of genetic improvement in poultry that are suitable to the prevailing production system and impact of infectious diseases are among major bottlenecks to village poultry. Farmers' capacity and perception to use village poultry as a potential livelihood could also be influenced by a number of factors that need to be identified for village poultry development and to target interventions to promote poultry based livelihood. This research aims to evaluate the role of poultry in rural livelihoods and to assess farmers' preference and willingness to pay for poultry breed and vaccine technology in Ethiopia. Survey data are used and a number of statistical and econometric tools are employed for data analysis. Findings of the study show that village poultry plays important economic and social roles, though the degree to which households utilize and benefit from poultry production varies between areas and across households' wealth status. Poultry are used as a gift to relatives, which is more common among poorer households, and poultry are consumed during festive periods in areas where the socio-cultural role of poultry is significant. Infectious diseases also had an impact, leading to unutilized potential of benefit from village poultry. Contingent valuation method (CVM) and discrete choice experiment (DCE) surveys were used to elicit farmers' preference and willingness to pay for poultry vaccine service and traits of chicken. The results from CVM study show that farmers recognise the benefits of the vaccine programmes and are largely willing to pay for it. The result from exponential probit reveals that farmers' willingness to pay for village poultry vaccine service is influenced by age, education level and region of respondents. Our results suggest that younger and better-educated farmers and farmers from Horro are more likely to pay for village poultry vaccine services. The result from the CVM study was further substantiated by conducting DCE survey to understand farmers' preferences for attributes of possible Newcastle disease (NCD) vaccine programme. Results from this study show that famers prefer a vaccine programme that has better capacity to reduce the severity of NCD, a vaccine service that would be delivered by an animal health development agent and that could be given with water. Results from DCE study in village poultry show that important traits of chicken to farmers are mothering ability, disease resistance and meat and egg taste. These findings question the appropriateness, at least, in the prevailing production system, of the Ethiopian national government's effort to improve productivity in village poultry by targeting specialized egg layer improved chicken. The findings also suggest that poultry breeding programmes aiming to provide readily acceptable breed technology by farmers need to prioritize traits of adaptive and socio-cultural importance instead of focusing on egg productivity only. This suggests the unique qualities of the indigenous poultry breeds that are important to farmers need to be carefully considered, instead of resorting to those that proved to be successful in different production systems.

Key words: village poultry, livelihood, attribute preference, willingness to pay, vaccine

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Acronyms and Abbreviations

ADLI = Agricultural Development Led Industrialization

AnGR = Animal Genetic Resources

ANOVA= Analysis of Variance

CH4D = Chicken Health for Development

CIDLID = Combating Infectious Diseases of Livestock for International Development

CSA= Central Statistical Agency

CVM = Contingent Valuation Method

DCE = Discrete Choice Experiment

DFID =Department for International Development

EEA= Ethiopian Economic Association

ETB = Ethiopian Birr

FAO = Food and Agricultural organization

GDP = Gross Domestic Product

GTP = Growth and Transformation Plan

HDI = Human Development Index

IBD = Infectious Bursal Disease

IIA = Independence of Irrelevant Alternatives

IID = Independent and Identically distributed

ILRI= International Livestock Research Institute

MoFED = Ministry of Finance and Economics Development

NBE = national Bank of Ethiopia

NCD = Newcastle disease

NOAA = National Oceanographic and Atmospheric Administration

PRA= Participatory Rural Appraisals

RPL = Random parameter logit

RRA = Rapid Rural Appraisals

TLU = Tropical livestock unit

UNDP = United Nations Development programme

WTP = Willingness to Pay

Chapter 1

Introduction

1.1 Background

1.1.1 A brief overview of the Ethiopian economy

The Ethiopian economy is hugely dependent on agriculture. The agricultural sector plays a central role in the life and livelihoods of most people in Ethiopia, where about 12 million smallholder farming households account for an estimated 95% of agricultural production in the country and 85% of all employment (FAO, 2011). Smallholder agriculture is the dominant sector, which provides about 90% of the total foreign exchange earnings (Diao, 2010; FAO, 2011). The agriculture sector dominates GDP by accounting for more than 45% of GDP on average, as indicated by data from the National Bank of Ethiopia between 2004/5 and 2011/12 (NBE, 2012). Crop-livestock mixed farming is the most common farming system practised by farmers mainly in highland areas. Over the past few years, however, the contribution of industry and service sectors to GDP has started to increase; this could be attributed to the privilege given to these sectors through various government policies. While the services and industry sectors together have recently outstripped agriculture in terms of their share of GDP, agriculture remains a critical component of the national economy.

Challenges in agricultural development are not uncommon, due to the rain-fed farming system and the country's large and rapidly growing population (Diao, 2010). With a total population of more than 94 million as of 2013 (United Nations, 2013), Ethiopia is the second most populous country in Africa after Nigeria. The increasing population has caused extreme land shortages, particularly in the highlands of the country where most of the population lives and where most agricultural production takes place. According to the World Bank (2005), the average land area owned per rural person has fallen from 0.5 hectares in the 1960s to just 0.21 hectares during the late 1990s. This implies extreme land shortage as a result of the pressure that the massive population is currently putting on the country. Under Ethiopia's predominantly rain-fed agricultural system, an average family of six persons requires around 2.5 to 2.8 hectares to meet its annual household food requirements. Therefore, it can be seen from the average size of farm owned that the majority of Ethiopia's smallholder farmers are dependent, at least for certain periods of the year, on purchased food (FAO, 2011). The agricultural sector also suffers from poor cultivation practices and frequent drought and hence is highly vulnerable to external shocks.

Ethiopia is one of the world's poorest countries by any measurement and the country's per capita income is substantially lower than even the regional average. Poverty is widespread across the country in both rural and urban areas although it is more of a rural phenomenon. Government reports (MoFED, 2012a) show that the gap between rural and urban poverty has narrowed significantly since 1995. The proportion of the population below the poverty line in 1995/96 was 47.5% in rural areas and 33.2% in urban areas (MoFED, 2012b) but by 2010/11 had fallen to 30.4% and 25.7% in rural and urban areas respectively. In the United Nations Development Programme's 2013 human development report (UNDP, 2013), Ethiopia was ranked among the poorest nations in the world based on both the Human Development Index (HDI) and the Multi-dimensional Poverty Index. Since the 1990s, the Ethiopian government has adopted various policy measures and development interventions to reduce poverty and improve national living standards. The country adopted Agricultural Development Led Industrialisation (ADLI) as its long-term development framework for economic transformation. Under this policy, emphasis is put on intensification to increase the agricultural productivity of smallholder farmers. Given that agricultural growth transfers directly into poverty reduction, this plan seemed reasonable for the majority of Ethiopia's poor who live in rural areas. More recently, Ethiopia set a more ambitious plan to achieve middle-income country status by 2025 in its growth and transformation plan (GTP) (2010-2015). This plan aims to lessen the contribution of agriculture by shifting jobs away from the agricultural sector towards industry and service sectors.

Government reports have so far indicated that the policies and strategies put in place to reduce poverty and improve the living standards of the Ethiopian people have produced encouraging and promising results. On average, the economy has experienced double-digit growth since 2004/05 after recovering from the drought of 2003 which saw agricultural GDP fall by 10.5%. A report by the Ministry of Finance and Economic Development (MoFED, 2012b), for example, indicated that the proportion of poor people in the country was estimated to be 29.6% in 2010/11. This is 24% lower than the level recorded in 2004/05. Food poverty is also declining in Ethiopia. The Hunger Index, weighted equally on three indicators consisting of malnourishment, the proportion of underweight children, and child mortality, declined from 43.2% in 1990 to 28.7% in 2010/11 (MoFED, 2012a). Despite the double-digit economic growth, a recent report by the University of Oxford (Oxford Poverty and Human Development Initiative, 2014) ranks Ethiopia as the second poorest country in the world, and revealed that more than 87% of the country's population are poor with 71% in severe poverty, based on a Multi-dimensional Poverty Index. Ethiopia's severe poverty is largely a rural phenomenon and 82.1% of the 71% of the population who are severely poor are rural. While improvement in economic growth in the country is undisputable, multidimensional poverty index gives more sensible picture of poverty level in the country as it accounts for several factors

1.1.2 Livestock sub-sector in the Ethiopian economy

Livestock are central to the livelihoods of rural and pre-urban farmers. They form an integral part of mixed farming systems and help raise whole-farm productivity in Ethiopia. The livestock sub-sector play important economic and social role at both household and national level. Livestock serve multiple household-level needs in Ethiopia, as in other developing countries. In the mixed farming system, livestock provide important draught power; about 80% of Ethiopian farmers use animal traction to plough their fields (Behnke and Metaferia, 2011). They also function in coping with shocks, accumulating wealth, and serving as a store of value in the absence of formal financial institutions and other missing markets. In smallholder crop-livestock mixed farming systems, livestock provides nutritious food, additional emergency cash income, transportation, farm outputs and inputs, and fuel for cooking food. In the pastoral areas of Ethiopia, livestock represent a sole means to support and sustain their livelihoods (Negassa et al., 2011).

Ethiopia is said to have the largest livestock population in Africa, regardless of the productivity of this sub-sector. The Ethiopian Central Statistical Agency reported that, in 2013, the country possessed about 54 million cattle, 25.5 million sheep, 24 million goats, 50.4 million poultry, and 8.7 million equines (CSA, 2013). Despite the large livestock population, the Ethiopian livestock sub-sector cannot keep pace with growth in consumption. Consequently, Ethiopia imports livestock products, for example, dairy products valued between USD 8 to 10 million annually (FAO, 2011). Though not comparable to the livestock population of the country, the role of livestock in the national economy is significant, mainly in term of export earnings and contribution to GDP. The livestock contribution to export earning comes from both formal and informal markets (the latter includes illegal cross border trade). Therefore, official data that relies on formal markets will understate the contribution of livestock to export earnings. According to the official figures, livestock contributes about 11 % of all formal export earnings. However, when informal cross border trade are considered in the calculation, livestock is suggested to contribute about 24 % to Ethiopia's export earnings (Behnke and Metaferia, 2011). Moreover, livestock accounts for 15 to 17 % of total GDP, and 35 to 49 percent of agricultural GDP based on the official data (GebreMariam et al., 2010).

Despite the significant role of the livestock sub-sector in the Ethiopian economy, there is historic lack of investment, policy and research focus on this sub-sector. The financial flow to the livestock sector does not reflect its contribution to the economy nor the potential wider impact of investment in livestock. The government reportedly allocates only 3 percent of the recurrent expenditure on livestock (FAO, 2004). Consequently, the supply of livestock products (i.e. per capita production of beef, milk, mutton and goat meat, chicken meat, eggs and fish) is very low, even when compared to the east African average. Inadequate feed and nutrition, widespread disease and poor health, poor breeding practices, inadequate livestock development policies with respect to extension, marketing, and credit, and poor infrastructure have been known to be the major constraints to performance of the livestock sector (EEA, 2005). As a consequence of these bottlenecks to development of the sub-sector's, coupled with limited or absent rigorous research information available to policy makers, the opportunity to improve livelihoods of farmers and to enhance national income from trade remains underexploited.

Interventions to improve the productivity of the livestock sector over the last couple of decades have focused on the introduction of exotic breeds of some livestock species. The major areas of interventions have included increasing milk production through provision of improved breeds, crossbreeds, and provision of artificial insemination to smallholder farmers. Similarly, the introduction of exotic chickens has been attempted to improve the productivity at the smallholder farmer level. These introductions of exotic breeds were made indiscriminately and did not consider protection of indigenous animal genetic resources, which include the animals' adaptive behaviours to the low-input/low-output production system. Moreover, provision of improved breeds to enhance productivity has not been supplemented by adequate extension support, such as animal health services and management support. Consequently, the results from these interventions have not been encouraging under the smallholder production systems.

1.1.3 Poultry production in Ethiopia

Poultry[1] production in Ethiopia has the potential to make a considerable contribution to national and household economies. Village poultry occupy a unique position in rural communities through their capacity to provide valuable protein for smallholder farming families. This is particularly true in Ethiopia where there are few alternative animal protein sources available to the population,and no cultural or religious taboos relating to the consumption of eggs and poultry meat (Tadelle et al., 2000). Poultry in Ethiopia are not only a source of high quality protein for the family, but also provide a small cash income and play an important part in the religious and cultural life of the society (Aklilu et al., 2007; Dessie and Ogle, 2001). Moreover, rearing poultry in Ethiopia is one of the most appropriate activities for rural women and for landless and marginalised farmers for whom it provides an important source of income. It also generates employment opportunities for the poor and at the same time increases the overall supply of high quality animal protein to the community (Aklilu et al., 2007; Tadelle et al., 2000).

The poultry sector in Ethiopia can be characterized into three major production systems. These are the village poultry production system, the small-scale poultry production system and the commercial poultry production system (Alemu et al., 2008; Bush, 2006; Wilson, 2010). The village poultry system is characterized by a low input (with scavenging being the major source of feed), low or no veterinary input, minimal level of bio-security, and high off-take rates. This production system is characterised by its high level of mortalities (Bush, 2006). Village poultry production is ubiquitous in Ethiopia, where it accounts for 99 percent of poultry production (Bush, 2006; EEA, 2005). The small-scale poultry production system in the country has modest flock sizes usually ranging from 50 to 500 exotic breeds are kept for operating on a more commercial basis. In the main, this poultry production system has emerged over the last couple of years and is located around the major urban and peri-urban areas of the country. It is characterized by medium provision of feed, water and veterinary service inputs and minimal to low bio-security (Nzietcheung, 2008). The large-scale commercial poultry production system is a highly intensive production system that involves keeping birds under indoor conditions with a medium to high bio-security level. The existence of better bio-security practices in this production system has reduced chick mortality rates to around 5% (Bush, 2006). Private and public

[1] In Ethiopia, poultry is typically chicken.

large scale intensive poultry farms are mainly dependent on the import of day old chicks from abroad (Alemu et al., 2008). This system, therefore, largely depends on imported exotic breeds that require intensive inputs such as feed, housing, health, and modern management system.

1.1.4 Village poultry input and output market

Village poultry production system in Ethiopia is a low in-put/low out-put farm enterprise where chicken usually scavenge to find their own feed with little or no supplementary input by poultry keepers. In many instances, family poultry production is not the main household income-generating activity, and formal marketing links for production inputs and outputs are generally non-existent (FAO 2014). Village poultry keeping farmers in Ethiopia face large market constraints (Aklilu et al. 2007). The Village poultry are produced and consumed in local areas with poor linkages to urban markets due to distance from urban areas and poor transportation facilities. Consequently, poultry marketing system in rural Ethiopia is primarily characterized by local selling and buying and it usually has two major poultry marketing channels. Farmers either directly sell to consumers or to small retail traders who take the chicken to large urban markets (Kenea et al. 2003). However, the most common market for chicken in rural areas is local communities and farmers rarely have access to poultry products market in urban areas.

Market for poultry products is seasonal and the market opportunities are mainly for those smallholders close to the urban centres as the poultry transport system and infrastructure is not developed (Negassa et al. 2011). Sales and consumption of chicken fluctuates across the months of the year following major social and religious festive periods (Aklilu et al. 2007; Alemu et al. 2008). These patterns cause strong fluctuations in prices of poultry products and farmers need to target periods of the year when price would rise in planning chicken production. Socio-cultural factors also influence the prices of individual birds in markets and local birds are considered to have tastier meat than exotic breeds(Aklilu et al. 2007). The prevailing poultry marketing system in the country also involves risk of disease transmissions and spread. During the marketing, birds are often mixed by traders and hence the risk of disease transmission is obvious. Some of the marketed chickens may be bought as replacement stock by other farmers and there is also the possibility of transportation equipment being contaminated and transmitting disease back to farms (Ayele and Rich 2010).

The poultry value chain in the country is short with very few actors along the chain(Negassa et al. 2011; Ayele and Rich 2010). The major actors involved in the simple chain include farmers, agricultural research stations, agricultural extension services, NGO, consumers and, to some degree, traders. The interaction among these actors is also very limited and often on an *ad hoc* basis (Ayele and Rich 2010). This implies poultry value chain development and strong support and interaction among actors is yet to happen in the country to exploit the potential from village poultry development to improve farmers' livelihood. Feed and veterinary inputs are required to increase flock size (Rushton and Ngongi 1998) and to benefit poor farmers through village poultry development. Smallholder farmers' in rural Ethiopia, however, have very limited access to supplementary feed and veterinary services. Most farmers are even not aware of the availability of public services or service-rendering organizations like the National Veterinary Institute and other sources of veterinary services (Ayele and Rich 2010). Particularly, poultry vaccine service market is missing in rural areas. However, the country produces various poultry vaccines (Anebo et al., 2013). Therefore, village poultry vaccine service is yet to be marketed in rural Ethiopia, but demand for this service has not been explored to inform policy on village poultry disease control.

1.1.5 Constraints to village poultry development

Most of the birds kept under the village production system are indigenous poultry ecotypes. The national statistical agency report of 2013 on livestock and livestock characteristics shows that 97% of the total poultry stock in the country is indigenous, 2.6% are exotic breeds and the remaining are hybrid birds (CSA, 2013). Indigenous chickens are, however, considered to be markedly less productive, being characterised as very slow growing birds which lay fewer eggs.

Research and development on poultry started in Ethiopia in the early 1950s with the establishment of higher learning agricultural institutes. The activities of these institutions mainly focused on the introduction of exotic breeds into the country and the distribution of these breeds. The strategy, which aimed to improve the genetic potential of local birds by the distribution of cockerels, pullets and fertile eggs from birds of exotic origins, has, by and large, not had the expected beneficial effects. Despite more than half a century of efforts to introduce exotic chicken to smallholder farmers, indigenous chicken still contribute about 92% of annual egg production (CSA, 2013). Some reasons identified for the disappointing and often negative responses from farmers include: reduced brooding ability of the cross-bred hens; reduced adaptation of the cross-breeds to low input feeding systems; and, the long term adverse modification of the genetic base of the indigenous chicken population (Tadelle et al., 2000).

The strategy to improve village poultry productivity through the introduction of improved/exotic chicken threatens the genetic resource base of indigenous chickens through the indiscriminate and uncontrolled distribution practices. The distribution of "best performing genotypes" is now being implemented at an increasing rate in the country via distribution of fertile eggs, day-old chickens, crossbred pullets and exotic cockerels by governmental and non-governmental organization. If this trend continues at the current pace, the gene pool of the local breeds could be lost in the near future, before they are even described (Institute of Biodiversity Conservation, 2004).

Indigenous breeds evolved over long periods under the prevailing production systems, and hence they are believed to be well adapted to the local village poultry production environments. The utilisation of indigenous chickens within village production systems makes effective use of local resources but there are considerable opportunities for improvement. The oft-preferred route to higher output and productivity is, therefore, to improve local genetics (Wilson, 2010). This requires development of effective breeding programmes and appropriate conservation programmes. This, in turn, requires prioritization and targeting of traits that have relevance in this production system both effective breeding and conservation programmes. Understanding farmers’ preference for traits of chickens and the relative economic weight they attach to each trait facilitates and informs such breeding and conservation policies.

In addition to a lack of appropriate genetic improvement, village poultry in Ethiopia is constrained by disease, poor management and lack of feed, and predation. Diseases are believed to be the major causes of death of chickens, and infectious diseases are considered to be a real threat to village poultry development (Halima et al., 2007; Zeleke et al., 2005). Disease reduces both number and productivity of chickens (Dessie and Ogle, 2001). Farmers may give up poultry keeping due to the devastating impact of diseases (Dessie and Ogle, 2001). Indeed, the poultry population of Ethiopia declined from an average annual population of 54.4 million during 1980-1989 to 35.3 million during 2000-2008 due to diseases and other factors, though it is now recovering and has more or less stabilised over recent years (Negassa et al., 2011). In spite of the fact that infectious diseases are causing heavy losses and eroding farmers' motivation to use poultry to improve their livelihood, there is little or no tangible effort to improve the access of farmers' to poultry health service or to control poultry diseases. Negassa et al. (2011) calculated that the proportion of livestock vaccinated and treated over the period of 2005/6 to 2008/9 was only 0.2% and 0.6%, respectively.

There is limited information regarding the health of poultry or the socioeconomics of production in Ethiopia. There has been inadequate intervention to minimize the impact of poultry diseases in the country, particularly in village poultry that are kept by resource poor smallholder farmers. Furthermore, the introduction of improved chicken has not been supported by appropriate extension systems and poultry health services. To the author's knowledge among the only poultry health interventions in the country was that of the FAO which aimed to investigate efficacy of a Newcastle disease vaccine (V4) in 1993/95 and which, in 1995, was implemented on station and in trial villages (see Rushton, 1995).

The village poultry production system is semi-subsistent, primarily satisfying the various needs of the farm household. Both the producers and the consumers of village chickens are the local community, and demand for chicken is largely dependent on local situations. Farmers' access to markets and market linkage in the country is also very poor, partly due to poor infrastructure – hence it is difficult for farmers to access urban markets. In addition, consumption and sale of chickens and eggs varies markedly during the year. Usually, there is an increase in price of chickens and eggs due to an increase in consumption during the festive seasons, particularly New Year, Easter and Christmas (Aklilu et al., 2007). There are also times when farmers may be forced to sell birds due to the high unacceptably risk of disease outbreaks, and such periods are often associated with price slumps. Therefore, farmers often manage production and flock size of their chicken to target periods of high demand and dry seasons when diseases outbreak is less likely.

More detailed discussions of the problems of chicken production in Ethiopia are developed in the next four chapters, which report the substantive work of this thesis. In the following section of this chapter the objectives of the study are presented.

1.2 Objectives of the study

The general aim of this study was to inform poultry disease control policy and effective poultry breeding and conservation programmes through evaluation of the value resource poor farmers place on poultry health services, and by identifying their preferred traits of chickens in village poultry production environments.

Specifically, the study intended to address the following objectives:

1. Investigate the role of poultry in rural livelihoods;
2. Identify and value preferred traits of chickens under village poultry production system;
3. Evaluate smallholder farmers' willingness to pay for village poultry vaccination services, and;
4. Elicit preferred attributes of Newcastle disease vaccination programmes in village poultry.

1.3 Thesis outline

This thesis is presented in six chapters; brief descriptions of each chapter are presented here. This chapter provides background to the study and the context in which the research was conducted. Brief methodological approaches, particularly the theoretical background, used in the study are presented in the next section of this chapter. Chapter 2 describes the role of poultry in the livelihoods of rural resource-poor smallholder farmers and highlights how various socioeconomic factors influence how farmers realize and utilize village poultry as a potential farm enterprise. Chapter 3 presents a stated choice analysis of traits of chickens using discrete choice experiment data in order to understand farmers' preference for, and valuations of, traits of chick. Chapter 4 presents farmers' willingness to pay for village poultry vaccine services using the contingent valuation method. In chapter

5, an elicitation of farmers’ preference for possible Newcastle vaccination programmes is presented. This chapter attempted to supplement the study in Chapter 4 by addressing some of the limitations of the contingent valuation method. Chapter 6 provides general discussion and some conclusions from the whole research work presented in this thesis.

1.4 Methodological background

Current economic decisions are largely based on only the direct use values(actual use like for food), although the indirect use values (benefits deriving from ecosystem functions), option and quasi-option values (insurance, future use), bequest value (benefit accruing to any individual from the knowledge that others might benefit from a resource in the future), and existence value (the satisfaction of knowing that a particular asset exists) may often be of equal or greater importance (Hiemstra et al., 2006). Moreover, many of the benefits derived from the existence of well-adapted indigenous animal genetic resources are not transacted in any market. Hence, non-market valuation tools are required to identify the magnitude of these benefits (Scarpa et al., 2003). Many animal health inputs are neither purely private nor purely public (Umali et al., 1994). The use of vaccines and veterinary pharmaceuticals also involves externalities. Village poultry vaccination services are yet not marketed in Ethiopia. Given this public goods nature of vaccination services in Ethiopia, this study uses economic valuation methods to estimate farmers’ preference and willingness to pay (WTP) for poultry vaccine services and poultry genetic resources. WTP and preference studies generally employ either the revealed preference (indirect method) approach or the stated preference approaches (direct method) valuation methods. Revealed preference approaches estimate the preferences for and value of the non-market good or services using actual expenditure data on marketed goods/services where actual market behaviour of consumers is observed. Consumer preferences are, therefore, elicited based on actual scenarios to develop model of choice. Stated preference approaches, on the other hand, rely on the concept that individuals can be induced to reveal their true preferences for non-traded goods through their behaviour in hypothetical markets (Hanley et al., 1998). Stated preference approaches ask consumers what they would be willing to pay for a change in environmental amenity. In this technique, individuals do not actually make any behavioural changes, they only state that they would behave in a particular fashion (Adamowicz et al., 1994).

Both revealed and stated preference methods have advantages and drawbacks. Revealed preference data are said to have high validity because the data reflect real choices and take into account various constraints on individual decisions, such as market imperfections, budgets and time. A drawback of using data from revealed preference survey is that coefficients on attributes in models estimated from choices in actual settings provide only limited predictions of the impact of changing policies (Louviere et al., 2000). The new situation, after the change in the quality or the quantity of the non-market good, may be outside the current set of experiences (or outside the data range). Thus, simulation of the new situation generally involves extrapolation outside the range used to estimate the model (Adamowicz et al., 1994). Collinearity among multiple attributes is also common in revealed preference data, generating coefficients with the wrong signs or implausible magnitudes, and making it difficult to separate attribute effects (Hensher et al., 2005; Louviere et al., 2000). Moreover, data on revealed preferences are rarely collected in developing countries and it is of course impossible to have these data for products and services that are not marketed. Stated preference methods are commonly criticized because they generally fail to take into account certain types of real market constraints and the behaviour they depict is not observed (Louviere et al., 2000; Mitchell and Carson, 1989). However, these methods provide the only means for estimating the value of non-market, public goods, and they are commonly used to elicit values in cases in which the quality change involves a number of attribute changes (Adamowicz et al., 1994).

This study employed a stated preference approach to meet aforementioned objectives. The stated preference applications presented in this study are contingent valuation method (CVM) and discrete choice experiment (DCE). The CVM approach was used to evaluate farmers' WTP for poultry vaccine designed in two scenarios (descriptions of scenarios are given in chapter 4). Understanding farmers' preference for attributes of vaccine programme that determines their decision to use poultry vaccine is not possible using CVM. This part of the study was, therefore, further substantiated by applying DCE approach. To identify and value preferred traits of chicken in village poultry production system, the DCE approach was employed.

1.4.1 Contingent valuation method and discrete choice experiment

CVM uses surveys to measure an economic concept of value and the goal of a CVM study is to measure an individual’s monetary value for some item (Carson and Hanemann, 2005). CVM approach elicits stated preferences from a sample of individuals using either open-ended questions that ask directly for WTP, or closed-ended questions that present a bid or a sequence of bids to the consumer, and ask for a yes or no vote on whether each bid exceeds the subject's WTP (McFadden, 1994). CVM is flexible and this facilitates valuation of a wide variety of non-market goods, including those not currently provided (Carson et al., 2001). Consequently, CVM is widely applied in various disciplines in both developed and developing countries. It is commonly applied in environmental economics (Adamowicz et al., 1998; Asrat et al., 2004; Boxall et al., 1996; Brouwer et al., 2008; Carson et al., 1996), in health economics (Bayoumi, 2004; Johannesson et al., 1993), in transport economics (Jones-Lee et al., 1995; Persson et al., 2001), in basic infrastructure services provision (see for example Whittington et al., 1990) and in other areas of research. Although CVM is the most frequently used non-market valuation technique for non-market goods, debate persists over the reliability of CVM (Carson et al., 2001; Hanley et al., 1998). Venkatachalam (2004) reviewed developments on measures to address the validity and reliability issues arising out of different kinds of biases and other related empirical and methodological issues concerning CVM. The most influential one is that of the National Oceanographic and Atmospheric Administration (NOAA) of the USA guideline on the design of CVM studies for reliable estimate of WTP (Arrow and Solow, 1993). Among the most important aspects of CVM, the guideline suggests that face-to-face interview be used, that dichotomous response format used for elicitation of bids, and ‘no-answer’ option explicitly allowed.

DCE is a relatively new concept in economic valuation literature, but increasingly becoming popular and widely applied across different disciplines. It has been commonly employed in environmental economics, transport economics, health economics, and marketing (see Adamowicz et al., 1998; Boxall et al., 1996; Green and Gerard, 2009; Hanley et al., 1998; Hensher and Greene, 2011). DCE involves a more experimental and involved analysis of choice behaviour (Boxall et al., 1996). DCE method is a generalization of CVM in the sense that rather than asking people to choose between a base case and a specific alternative, DCE asks people to choose between cases that are described by attributes. It employs a series of questions with more than two alternatives that are designed to elicit responses that allow estimation of preferences over attributes (Adamowicz et al., 1998).

DCE has some advantages relative to the CVM. Unlike CVM, DCE relies less on the accuracy and completeness of any particular description of the goods or service, but more on the accuracy and completeness of the characteristics and features used to describe the situation. The experimental aspect of DCE where the choice reflects the trade-offs that individual makes between the attributes of the goods or service allows to value attributes (Adamowicz et al., 1998; Boxall et al., 1996). The multi-attribute evaluation information that is measured by DCE could be elicited using repeated CVM questions. However, a large number of CVM type question would be needed, and it would be difficult to maintain some degree of orthogonality in design and administration of such experiment (Adamowicz et al., 1998).

1.4.2 Theoretical framework

Referendum CVM and DCE share a common theoretical base and both present the respondent with the task of making one choice from a set of alternatives. What makes CE unique is that levels of various attributes of the choice situations are varied in a systematic fashion and that they utilize repeated measures from sampled individuals (Boxall et al., 1996). The referendum CVM usually utilizes two or three repeated choices while DCE typically utilize more choices depending on complexity of situation. DCE share the same random utility model framework as dichotomous choice CVM (Hanemann, 1984). Therefore, the DCE structure and the referendum CVM structure can both be analyzed using random utility model. In this section, however, only a general utility theoretic framework is presented and details are presented under each sections of this study.

In both CVM and DCE, the choice of an alternative which is one of three alternatives in DCE and yes/no in the CVM represents a discrete choice from a set of alternatives. Therefore, both approaches can be analyzed using the random utility modelling. Hence, as an introduction to the methods, general modelling of the CVM and DCE in this study are presented following Hanley et al. (1998) and Adamowicz et al. (1998). Assume that utility depends on choices made from some choice set, C. For any individual n a given level of utility will be associated with any alternative i. Alternative i will be chosen over some other option j if $U_i > U_j$. Utility for any option is assumed to depend on the attributes z of that option which may be viewed differently by different individuals with socio-economic characteristics s that also affect utility. Thus we can write:

$$U_{in} = U(z_{in}, s_n) \tag{1}$$

Utility contains deterministic component,V , and stochastic component, ε. Then (1) can be written as:

$$U_{in} = V(z_{in}, s_n) + \varepsilon(z_{in}, s_n) \tag{2}$$

The probability that individual n will choose option i over other option j is given by:

$$Prob(i|C) = Prob(V_{in} + \varepsilon_{in} > V_{jn} + \varepsilon_{jn}, \text{all } j \epsilon C) \tag{3}$$

Assuming a type I extreme value distribution for the error term, the probability of choosing alternative i becomes:

$$Prob(i) = \frac{\exp \mu V_i}{\sum_{j \epsilon c} \exp \mu V_j} \tag{4}$$

The scalar μ is usually assumed to be equal to 1 implying constant error variance.

The random utility framework also provides theoretical base for referendum CVM method. In this case there are two alternatives in the choice set. Random utility theory can be used to represent this choice in a binary choice model where the individual must choose between two alternatives: the new state, i, and the status quo, j. The probability of an individual choosing alternative i or j are:

$$\Pr(i) = \Pr(\varepsilon_i - \varepsilon_j \leq V_j - V_i) \tag{5}$$

This probability could be estimated assuming the random error term is type logistic or normal distribution.

1.5 Contributors to the thesis

This thesis research is part of the larger research project that works to reduce the impact of infectious disease of poultry in rural Ethiopia. The project has three major components: health; genetics; and, socioeconomics of poultry in Ethiopia. The research presented in this thesis research forms the basis of the socioeconomics part of the project and mainly intends to inform policies for village poultry health and genetic improvement and breeding programme. Accordingly, the research is multidisciplinary and involved people from various backgrounds: economists; epidemiologists: geneticist/breeders; and, biologists. This section, therefore, describes the role of individuals involved in this thesis research and became co-author in one or more of the series of papers organized in thesis chapters.

My supervisors, Dr. Rob Christley and Dr. Supriya Garikipati, contributed to all parts of the research by guiding and helping from inception of the research to final write-up of the thesis. They helped mainly in guiding the designing of survey instruments, in facilitating the survey, in guiding analysis of data and commenting on the write-up of preliminary results to final write-up of the thesis. Dr. Girma T. Kassie, Agricultural Economist, helped in guiding statistical designing of the choice experiments and analysis of choice experiment data. People with poultry health background, Dr Judy Bettridge and Dr Paul Wigley, helped in designing potentially practical hypothetical village poultry vaccine programmes for both contingent valuation and choice experiment survey. Dr. Stacey Lynch, Takele Desta and Judy also cooperated during fieldwork, as both the socioeconomics and health and genetic survey were conducted in parallel. People with genetics and breeding background, Prof. Oliver Hanotte, Takele Desta, and Dr. Tadelle Dessie, contributed in identification of biologically meaningful attributes and attribute levels of chicken for designing choice experiment.

References

Adamowicz, W., Boxall, P., Williams, M., Louviere, J., 1998. Stated preference approaches for measuring passive use values: choice experiments and contingent valuation. American journal of agricultural economics 80, 64-75.

Adamowicz, W., Louviere, J., Williams, M., 1994. Combining revealed and stated preference methods for valuing environmental amenities. Journal of environmental economics and management 26, 271-292.

Aklilu, H., Almekinders, C., Udo, H., Van der Zijpp, A., 2007. Village poultry consumption and marketing in relation to gender, religious festivals and market access. Tropical animal health and production 39, 165-177.

Alemu, D., Degefe, T., Ferede, S., Nzietcheung, S., Roy.D., 2008. Overview and background paper on Ethiopia's poultry sector: Relevance for HPAI research in Ethiopia. DFID Pro-poor HPAI Risk Reduction Strategies Project Africa/Indonesia Region Report No. 1. Washington, DC: International Food Policy Research Institute.

Anebo, Z.G., Teklemichael, K., Bacha, B., Habte, T., Hunde, A., 2013. Evaluation of the newcastle disease antibody level after vaccination regimes in chickens in Debrezeit Agricultural Research Center, Ethiopia. Journal of Veterinary Medicine and Animal Health1, 37-42.

Arrow, K., Solow, R., 1993. Report of the NOAA panel on contingent valuation. National Oceanic and Atmospheric Administration Washington, DC.

Asrat, P., Belay, K., Hamito, D., 2004. Determinants of farmers' willingness to pay for soil conservation practices in the southeastern highlands of Ethiopia. Land Degradation & Development 15, 423-438.

Ayele, G., & Rich, K. M., 2010. Poultry value chains and HPAI in Ethiopia. Africa/Indonesia Team Working Paper 25. Pro-poor HPAI Risk Reduction.

Bayoumi, A.M., 2004. The measurement of contingent valuation for health economics. Pharmacoeconomics 22, 691-700.

Behnke, R., Metaferia, F., 2011. The contribution of livestock to the Ethiopian economy – part II. IGAD LPI Working Paper 02-11. Addis Ababa, Ethiopiai: IGAD Livestock Policy Initiative.

Boxall, P.C., Adamowicz, W.L., Swait, J., Williams, M., Louviere, J., 1996. A comparison of stated preference methods for environmental valuation. Ecological economics 18, 243-253.

Brouwer, R.O.Y., Akter, S., Brander, L., Haque, E., 2008. Economic valuation of flood risk exposure and reduction in a severely flood prone developing country. Environment and Development Economics 14, 397.

Bush, J., 2006. The Threat of Avian Flu Predicted Impacts on Rural Livelihoods in Southern Nation, Nationalities and Peoples Region (SNNPR), Ethiopia. The Food Economy Group, May 2006.

Carson, R.T., Flores, N.E., Martin, K.M., Wright, J.L., 1996. Contingent valuation and revealed preference methodologies: comparing the estimates for quasi-public goods. Land economics, 80-99.

Carson, R.T., Flores, N.E., Meade, N.F., 2001. Contingent valuation: controversies and evidence. Environmental and resource economics 19, 173-210.
Carson, R.T., Hanemann, W.M., 2005. Contingent valuation, in: Mäler, K.G., Vincent, J.R. (Eds.), Handbook of environmental economics, pp. 821-936.

CSA, 2013. Agricultural Sample Survey 2012/13. Volume II. Report on Livestock and livestock characteristics. Statistical Bulletin 570. Addis Ababa.

Dessie, T., Ogle, B., 2001. Village poultry production systems in the central highlands of Ethiopia. Tropical animal health and production 33, 521-537.

Diao, X., 2010. Economic importance of agriculture for sustainable development and poverty reduction: The case study of Ethiopia. A paper presented on Global Forum on Agriculture, Policies for Agricultural Development, Poverty Reduction and Food Security, 29-30 November 2010, OECD Headquarters, Paris.

EEA, 2005. Report on The Ethiopian Economy, Volume IV 2004/05. Ethiopian Economic Association, Addis Ababa, Ethiopia.

FAO, 2004. Livestock Sector Brief, Ethiopia. FAO, Rome, Italy.

FAO, 2011. Food and Agricultural Organization Ethiopia Country Programming Framework 2012-2015. Office of the FAO representative in Ethiopia and to AU and ECA, Addis Ababa, Ethiopia.

FAO , 2014. Decision tools for family poultry development. FAO Animal Production and Health Guidelines 16. Rome, Italy.

GebreMariam, S., Amare, S., Baker, D., Solomon, A., 2010. Diagnostic study of live cattle and beef production and marketing: Constraints and opportunities for enhancing the system. Seattle, WA(USA): Bill & Melinda Gates Foundation and Addis Ababa, Ethiopia: Ethiopian Agricultural Transformation Agency.

Green, C., Gerard, K., 2009. Exploring the social value of health-care interventions: a stated preference discrete choice experiment. Health economics 18, 951-976.

Halima, H., Neser, F.W.C., Marle-Koster, E., Kock, A., 2007. Village-based indigenous chicken production system in north-west Ethiopia. Tropical animal health and production 39, 189-197.

Hanemann, W.M., 1984. Discrete/continuous models of consumer demand. Econometrica: Journal of the Econometric Society, 541-561.

Hanley, N., MacMillan, D., Wright, R.E., Bullock, C., Simpson, I., Parsisson, D., Crabtree, B., 1998. Contingent valuation versus choice experiments: estimating the benefits of environmentally sensitive areas in Scotland. Journal of agricultural economics 49, 1-15.

Hensher, D.A., Greene, W.H., 2011. Valuation of travel time savings in WTP and preference space in the presence of taste and scale heterogeneity. Journal of Transport Economics and Policy (JTEP) 45, 505-525.

Hensher, D.A., Rose, J.M., Greene, W.H., 2005. Applied choice analysis: a primer. Cambridge University Press.

Hiemstra, S.J., Drucker, A.G., Tvedt, M.W., Louwaars, N., Oldenbroek, J., Awgichew, K., Kebede, S.A., Bhat, P., da Silva Mariante, A., 2006. Exchange, use and conservation of animal genetic resources, Food and Agriculture Organization of the United Nations, Rome.

Institute of Biodiversity Conservation, 2004. The State of Ethiopia's Farm Animal Genetic Resources: Country Report. A Contribution to the First Report on the State of the World's Animal Genetic Resources. IBC. May 2004. Addis Ababa, Ethiopia.

Johannesson, M., Johansson, P.O., Kriström, B., Gerdtham, U.-G., 1993. Willingness to pay for antihypertensive therapy — further results. Journal of health economics 12, 95-108.

Kenea, Y., Legesse D., and Alemu, Y., 2003. Poultry Marketing Structure, Spatial Variations and Determinants of Prices in Eastern Shewa Zone, Ethiopia. Proceedings of the 10th annual conference of the Ethiopian Society of Animal Production (ESAP), 21-23 August 2002, Addis Ababa, Ethiopia, p.69-80.

Jones-Lee, M.W., Loomes, G., Philips, P., 1995. Valuing the prevention of non-fatal road injuries: Contingent valuation vs. standard gambles. Oxford Economic Papers, 676-695.

Louviere, J.J., Hensher, D.A., Swait, J.D., 2000. Stated choice methods: analysis and applications. Cambridge University Press.

McFadden, D., 1994. Contingent valuation and social choice. American Journal of Agricultural Economics 76, 689-708.

Mitchell, R.C., Carson, R.T., 1989. Using surveys to value public goods: The contingent valuation method. . Johns Hopkins Press, Baltimore.

MoFED, 2012a. Assessing progress towards the millinium development goals. Ethiopia MDGs report 2012, Addis Ababa, Ethiopia.

MoFED, 2012b. Ethiopia’s Progress Towards Eradicating Poverty: An Interim Report on Poverty Analysis Study (2010/11). Ministry of Finance and Economic Development, Addis Ababa.

NBE, 2012. Annual Report: National Bank Annual Report 2011-2012. National Bank of Ethiopia, Addis Ababa.

Negassa, A., Rashid, S., Gebremedhin, B., 2011. Livestock Production and Marketing. International Food Policy Research Institute – Ethiopia Strategy Support Program II,Working Paper 26.

Nzietcheung, S., 2008. Characterization of poultry production systems and potential pathways for the introduction of highly pathogenic avian influenza in Ethiopia. Mimeo. Nairobi, Kenya: International Livestock Research Institute.

Oxford Poverty and Human Development Initiative, 2014. "Ethiopia Country Briefing", Multidimensional Poverty Index Data Bank. OPHI, University of Oxford. Available at www.ophi.org.uk/multidimensional-poverty-index/mpi-country-briefings.

Persson, U., Norinder, A., Hjalte, K., Gralén, K., 2001. The value of a statistical life in transport: findings from a new contingent valuation study in Sweden. Journal of Risk and Uncertainty 23, 121-134.

Rushton, J., 1995. Assistance to rural women in protecting their chicken flocks from Newcastle disease. A consultant report.

Rushton, J., & Ngongi, S., 1998. Poultry, women and development: old ideas, new applications and the need for more research. World Animal Review, 91(2), 43-49.

Scarpa, R., Ruto, E.S., Kristjanson, P., Radeny, M., Drucker, A.G., Rege, J.E., 2003. Valuing indigenous cattle breeds in Kenya: an empirical comparison of stated and revealed preference value estimates. Ecological Economics 45, 409-426.

Tadelle, D., Alemu, Y., Peters, K., 2000. Indigenous chickens in Ethiopia: genetic potential and attempts at improvement. World's Poultry Science Journal 56, 45-54.

Umali, D.L., Feder, G., Haan, C.d., 1994. Animal health services: Finding the balancebetween public and private delivery World Bank Research Observer 9, 71-96.

UNDP, 2013. Human development report 2013- The Rise of the South: Human Progress in a Diverse World. Accessed on 17-05-2014 at http://www.undp.org/content/dam/undp/library/corporate/HDR/2013GlobalHDR/English/HDR2013%20Report%20English.pdf.

United Nations, 2013. World population policies 2013, New York. Accessed 01-07-2014, at http://www.un.org/en/development/desa/population/publications/pdf/policy/WPP2013/wpp2013.pdf#zoom=100.

Venkatachalam, L., 2004. The contingent valuation method: a review. Environmental impact assessment review 24, 89-124.

Whittington, D., Briscoe, J., Mu, X., Barron, W., 1990. Estimating the Willingness to Pay for Water Services in Developing Countries: A Case Study of the Use of Contingent Valuation Surveys in Southern Haiti. Economic Development and Cultural Change 38, 293-311.

Wilson, R., 2010. Poultry production and performance in the Federal Democratic Republic of Ethiopia. World's Poultry Science Journal 66, 441-454.

World Bank, 2005. Ethiopia - Well-being and poverty in Ethiopia : the role of agriculture and agency. Washington, DC: World Bank. Accessed 06 June, 2014 at http://documents.worldbank.org/curated/en/2005/07/6297093/ethiopia-well-being-poverty-ethiopia-role-agriculture-agency.

Zeleke, A., Sori, T., Gelaye, E., Ayelet, G., 2005. Newcastle Disease in Village Chickens in the Southern and Rift Valley Districts in Ethiopia. International Journal of Poultry Science 4, 507-510

Chapter 2

Poultry in rural Livelihood of smallholder farmers in mixed farming system

Abstract

This research investigates the role of village poultry in the livelihoods of people engaged in crop-livestock mixed farming system of rural Ethiopia. The study is carried out in view of an ever-increasing population with subsequent effects on decreasing landholding size and rising demand for animal protein. A survey questionnaire was administered to a total of 400 sample households from two different areas varying in agro-ecology, socio-culture and market access. The findings of the study reveal that village poultry has a significant socio-economic role to play in peoples' lives, though the extent to which households utilize and benefit from poultry production varies between areas and across households' wealth status. Poultry serve as a ready source of cash to meet the needs for most households in the study areas. Socio-culturally, poultry are used as a gift to relatives, which is more common among poorer households, and poultry are consumed during festive periods in areas where the socio-cultural role of poultry is significant. In areas where there is better market access, farmers realize and utilize poultry as a tradable commodity. However, in areas where there is limited market access, due to both socio-cultural factors and poor market linkage, there was tendency to undermine the potential role of village poultry in rural livelihood. Infectious diseases also have an impact, leading to unutilized potential of benefit from village poultry. Therefore, for the full potential of village poultry in rural livelihood to be realized, there is a need to consider a comprehensive village poultry development programme where market systems and poultry health extension services creates enabling environment for farmers. Hence, efforts to enhance village poultry development may need to go beyond simply providing improved chicken.

Key words: village poultry, livelihood, socioeconomic, diseases

2.1 Introduction

Agriculture is a source of livelihoods for an estimated 86 percent of rural people (World Bank, 2008) and this is particularly true in economically developing countries. Smallholder mixed farming systems are particularly important because of the large number of rural households they feed and provide with livelihoods. In crop-livestock mixed farming systems, smallholder farmers appropriate their resources and engage in different farming activities based on their resource base. The roles of the various farming activities in the livelihood of smallholders have important implications for targeting interventions to enhance livelihood of poor farmers. Livestock form an integral part of mixed farming systems and are central to the incomes of the poor, where they help raise whole-farm productivity and provide a steady stream of food and revenue for households (FAO, 2009). The agricultural sector is the most important sector in the Ethiopian economy. It serves as source of income and employment for the majority of the country's population. About 85% of the people are employed in agriculture, which contributes about 90% of export earnings (FAO, 2011). A subsistence-oriented, smallholder crop-livestock mixed farming system is the most common form of agricultural activity in Ethiopian. Poultry is one of the productive farm assets in rural Ethiopia.

In many high-population-density areas of Africa, average farm sizes have been declining. Such land pressure in economies heavily reliant on agriculture is a major source of rural poverty (World Bank, 2008). The landholding size in Ethiopia, the second most populous country in Africa, is fragmented and is shrinking over time due to unprecedented population growth - from 57 million in 1995 to 91.7 million in 2012; an increase of more than 50% in less than 20 years. Landlessness in rural areas has also resulted in the difficulty of owning and keeping livestock that depend on grazing land and other pasture. Consequently, availability of food from livestock products, which are a source of high-value protein, to rural households is limited. In this rural economic environment, village poultry could play a vital role as a source of valuable animal protein and income.

There is tendency for smaller animals to be kept by small land holders or by the landless. Farmers who only have poultry among livestock species can also be used as a tool for targeting very poor farming households (Dolberg, 2004). The socio-economic importance of poultry is, therefore, fundamental to diversify livelihood options. Livelihood diversification in rural areas of Ethiopia is mainly within agricultural activities and poultry could serve as a viable option. In the limited livelihood diversification that poor households tend to have, livestock constitutes an important source of income (LID, 1999). In such an economic environment, where there are limited livelihood options, poultry could be a target for intervention to enhance rural livelihoods.

In developing countries nearly all families at the village level, even the poor and landless, are owners of poultry (Mack et al., 2005). Village poultry can play a vital role in many poor rural households by providing scarce animal protein in the form of meat and eggs and can be sold to meet essential family needs such as medicine, clothes and school fees (Alders and Pym, 2009; Guèye, 2000). Poultry serves multiple purposes within smallholder communities, apart from those of a strictly economic or nutritious nature; they play important cultural and social roles (FAO, 2010). The village poultry production system is the most common form of production system among poor households in rural areas of developing countries. In Ethiopia, village poultry contributes to more than 90% of the national chicken meat and egg output (Dana et al., 2010b). Village poultry act as a starter that enables people to raise themselves and their families from degrading poverty to a better livelihood (Guèye, 2000) and rural households value the possibility of cash income from poultry keeping (Aklilu et al., 2008). The role of village poultry in rural livelihoods could possibly vary to a great extent as there is considerable variation in farmers' asset base, income, access to market and support services, socio-culture, and agro-ecological characteristics which may shape the farming system.

The gender aspect of village poultry production is important in addressing women's empowerment in livestock-based livelihood enhancement programmes. Smallholder poultry production plays an important role to empower women and to enable the landless poor farmers to move out of poverty, as they require little or no land for production (Garikipati, 2009). Smallholder poultry production is, in many countries, largely controlled by women and the benefits that can be derived from poultry are much larger than their inherent economic value would suggest when human capital formations are accounted for (Dolberg, 2007). Though considered inferior to other household income-generating activities, poultry keeping constitutes an important source of income, mainly for female smallholders (Aklilu et al., 2007). Roles and responsibilities in village poultry production system imply that women have access to poultry, but do always not have full control over the production tools and the benefits gained from them. The gender-disaggregated data that would provide exact figure on women's role, and contributions to this subsistence poultry sub-sector are insufficient (Guèye, 2003). Hence, understanding the role of village poultry to various segments of farmers is fundamental to design a pro-poor and comprehensive village poultry development programme and to target interventions in the sector. Despite its potential role to improve poor people's income and nutrition and viable potential to improve livelihoods for the disadvantaged, village poultry has been relatively neglected by researchers and development practitioners.

Existing literature on village poultry mainly focuses on characterization of production systems (see, for example, Besbes, 2009; Dana et al., 2010a; Dana et al., 2010b; Dessie and Ogle, 2001; Köhler-Rollefson et al., 2009) and disease-related issues (see Alders, 2003; Copland and Alders, 2005; Degefu et al., 2010; Gari et al., 2008; Jenbreie et al., 2012; Rushton et al., 2010; Rushton et al., 2005; Spradbrow, 1993; Zeleke et al., 2005). In contrast, literature on the economic and socio-cultural role of poultry is scant and available literature mainly includes reviews or project reports. These works suffer from a lack of adequate data and methodological problems, and hence are unable to capture the major role of village poultry in livelihoods of smallholder farmers. Dolberg (2007), for example, presented the contribution of village poultry from a review of country-level case studies based on the livelihoods framework. Similarly in an FAO (2010), a sustainable livelihoods framework which emphasized the vulnerability context of rural livelihoods and the need to consider many types of capital in the analysis, was utilized to review how smallholder poultry contributes to households' livelihoods. Reviews by Sonaiya (2007) and Guèye (2000) investigated the role of village poultry in poverty reduction and food security in developing countries and both suggested village poultry have an important role. In Guèye (2003) gender issues related to village poultry are addressed based on review work. In these review studies, the lack of adequate data and the method employed do not enable a full understanding of the major role of village poultry. For example, in most of the works, poultry incomes and consumption for different sections of the community and the socio-cultural role of village poultry have not been examined.

Ellis and Mdoe (2003) investigate patterns of livestock holdings found in villages of Tanzania and find that chicken ownership was more widespread across villages compared to other livestock. Using national level data, Birol et al. (2010) examined the role of poultry in the livelihoods of poultry producers in Sub-Saharan African countries focusing on the impact on livelihoods of highly pathogenic avian influenza (HPAI) outbreaks. They report that poultry production is a livelihood activity mainly important to women and children to meet their immediate cash expenditure needs. This finding is based on national level data and the study focused on the impact of HPAI. The role of poultry in the livelihoods of households of different wealth status and the effect on other socio-cultural factors was not reported in this study. However, there is significant variation in socioeconomic, environmental, ecological and cultural factors within countries which directly or indirectly influences the village poultry system and its role in smallholders' livelihoods.

A study by Rushton and Ngongi (1998) is one of few early studies that looked into socioeconomic aspects of poultry development. They used and proposed a systems analysis approach, considering the wider context instead of only technical issues, to evaluate conditions and market mechanisms required in rural poultry development planning. Some of the more recent studies of the socio-economic aspects of village poultry include Aklilu et al. (2007) which aimed to examine village poultry consumption and marketing in Ethiopia. This study reported that the length of the market chain and price dynamics influences farmers' market access, while sale and consumption of poultry varied among male and female-headed households. Aklilu et al. (2008) further investigated the role of poultry in rural households with respect to ownership and how farmers access poultry. They reported on the importance of 'poultry sharing' arrangements to acquire poultry and found that better-off households were often involved in poultry keeping and had more improved chicken breeds. Their study attempts to assess the role of poultry to farmers of different wealth status, although the wealth ranking method used solely relied on local classifications, and farmers' income was not considered. Hence, an evaluation of the contribution of poultry to households in different wealth groups in relation to other source of livelihood was not possible.

Therefore, the contribution of village poultry to the livelihoods of smallholder poultry keepers remains an inadequately answered question. This paper investigates the economic and socio-cultural roles of poultry in the rural livelihood of farmers in two regions of rural Ethiopia.

2.2 Materials and methods

2.2.1 The study area

This study is part of a larger project working toward reduction of the impact of infectious diseases on village poultry production in Ethiopia focusing on the socio-economic, health and genetic aspect of village poultry. The study was carried out in two rural districts of Ethiopia, Horro and Jarso, where mixed crop-livestock farming systems are the mainstay of the community. The study sites were chosen by the larger project considering the variation in agro-ecology and difference in poultry ecotypes in the two areas. Livestock production is an integral part of semi-subsistent farming practice in both districts. These two districts were purposely selected by the project, considering agro-ecological characteristics of the areas, a difference in socio-culture and variation in poultry ecotypes in the two districts. Horro district is located at about 315 km from Addis Ababa, West Ethiopia (37°01′E to 37°12′E longitudes and 9°55′N to 9°77′N latitudes, recorded for the study areas only). Jarso district is located at about 550 km distance from Addis Ababa, Eastern Ethiopia (42°10′E to 42°16′E longitudes and 9°25′N to 9°41′N latitudes). Afan oromo is native language spoken in both districts and population in both study aites belong to the same ethnic group. The population in Jarso are predominantly Muslim while the population in Horro are Christian (Ethiopian Orthodox and Protestant).

Horro district is relatively humid and has adequate rainfall for farm activity, which is rain-fed. Jarso district is characterized as a semi-arid agro-ecological zone and is considered food deficient, with parts of this distinct falling under the national government food-safety net program. Unpublished data from the respective Offices of Agriculture shows that Horro district’s average annual rainfall is 1685 mm (ranging from 1300 to 1800 mm) and average annual temperature is 19 °C while Jarso district’s average annual rainfall is 700 mm (from 600 to 900 mm) and the average temperature is 21 °C. The variation in rainfall between the two districts would indicate that the ecology and hence the scavenging resource base for chicken are different as seen in scavenging poultry production system in other countries (for example, See Guraratne et al 1993). Farmland in Horro district is mostly covered by cereal crops, including maize, *teff*, wheat, barley, Niger seed, bean and peas. In contrast, most of the farmland in Jarso district is covered by *chat* (*Catha edulis;* which is a stimulant and sold as a cash crop), potatoes, sorghum, wheat and barley in smaller plots. Chat growing and marketing is one of important livelihood in Jarso area. Major livestock species kept by farmers in both districts include cattle, sheep, chickens and goats. Farmers in lowland areas of Jarso also keep camels. Horro district is one of the surplus producing areas in the country while parts of Jarso district are food deficit and falls under government food safety net programme. The difference in food security level in the two districts, in addition to variation agro-ecology, indicated difference in feed resource base in the two sites.

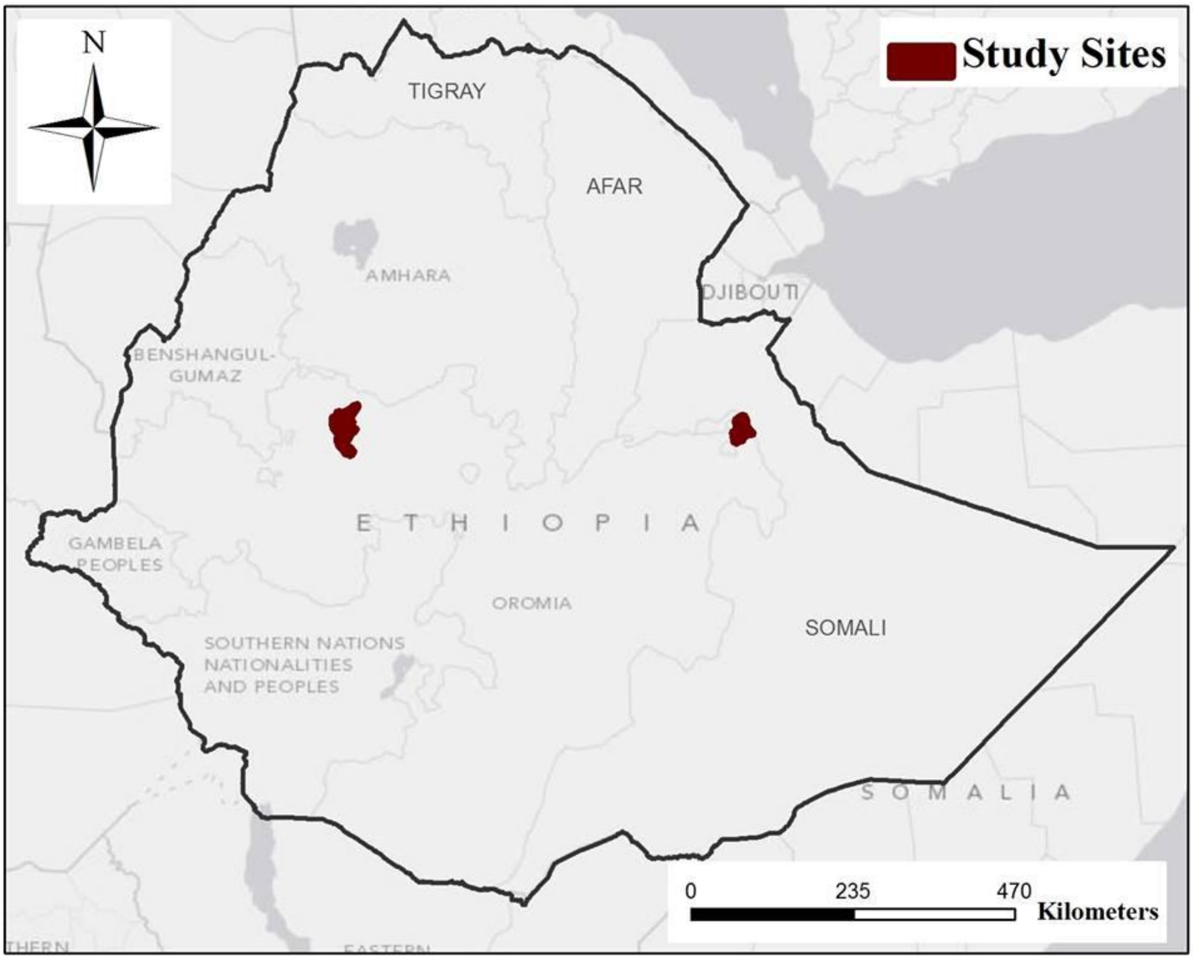

Fig.1 map of the study area

2.2.2 The survey and data management

A structured questionnaire was employed to collect data used in this study. The study and survey were approved by Research Ethics Committee of the University of Liverpool (reference RETH000410). Prior to the formal survey, reconnaissance visits and rapid rural appraisals (RRA) were undertaken in both study sites. These served to raise awareness of the study in these locations, built rapport, aided understanding of the study areas' livelihood options, poultry production environment, opportunities and challenges and informed design of the survey instrument. The questionnaire was piloted in the study sites in February 2011. The formal household survey was undertaken during the periods April to June 2011.The survey was carried out by experienced enumerators fluent in the local languages, trained for this data collection activity and closely supervised by the lead field researcher. The survey included a total sample of 400 poultry-keeping households randomly selected from eight '*Gandas*'[2] from the two districts. Four *Gandas* were included from each district and the survey was administered to 200 households from each district. From each of the eight *Gandas*, 50 households were randomly selected from a comprehensive household list provided by the development agents in each *Ganda*. In each *Gandas*, selection of participants was made by selecting every n^{th} name on the list using a starting point selected at random, to give each household an equal probability of inclusion in the sample.

Socio-economic and demographic data was collected using a structured questionnaire. Detailed data on households' farming practice, land owned, income from all possible sources, households' demographic structure, access to agricultural extension services, all livestock (species) owned, and others were collected. Local wealth ranking exercises were undertaken in both districts during the RRAs in order to supplement the individual data collected through the formal survey.

Analytical tools used for this research included standard descriptive statistics. Quartiles were employed in analysis of households' socio-economic characteristics and to categorize households based on their wealth level. Hence, sample households were categorized into four income group based on income data collected using survey. In addition, ANOVA, chi-square tests and independent sample t-tests were used to assess the statistical significance of comparisons among different wealth groups and between the two study sites. Statistically significant differences in the role of poultry to different household categories and between the two regions were also assessed using the same methods.

[2] *Ganda* is a lower administration structure next to district in the government administration structure. It covers several villages under it. It is roughly equivalent to a council ward in the UK.

2.3 Results and discussions

2.3.1 The sample population

The sampled households' mean family size was similar across the two regions (Table 2.1). The average age of the sampled household head in Horro (~ 43 years) was significantly, but not markedly, older than in Jarso (~ 39 years). Overall, education levels in the two districts were quite low.

About 50% of the heads of households had not had any form of education and 39% of them only had primary-level of education (Table 2.1). This figure is comparable with national data from the Ministry of Finance and Economic development (MOFED, 2013). The sample population from Jarso were educated to a lower level compared with Horro farmers and the difference was statistically significant. This might be due to difference in access to education and peoples' attitude towards modern education in the past.

Table 2.1 Socioeconomic characteristics of sampled households

	Districts		
Variables	**Horro**(*n*=200)	**Jarso**(*n*=200)	**Total**(*n*=400)
Age			
Mean	42.94(15.37)	39.48(13.43)	41.2(14.52)
t- value	2.39		
p-value	0.017		
Family size			
Mean	6.63(2.40)	6.26(2.35)	6.44(2.37)
t- value	1.56		
p-value	0.119		
Education level (%)			
None	37.0	62.0	49.8
Primary(grade 1-4)	42.5	35.5	39.0
Secondary (grade 5-8)	13.0	1.0	7.0
High school(grade 9-12)	7.5	1	4.2
Chi-square	44.84		
p-value	<0.001		

Source: sample survey result; standard deviations given in parenthesis

2.3.2 Assets in rural livelihoods and the position of poultry

Household assets in crop-livestock systems of rural Ethiopia may include: land; livestock and other farm assets; human capital (health and education level); access to institutional support and infrastructure; and social capital. Ownership and access to assets that can be put to productive use is considered as a building block by which the poor can construct their own routes out of poverty (Moser, 1998). Asset accumulation is often observed to involve trading-up assets in sequence: for example, chickens to goats to cattle to land, or cash from non-farm income to farm inputs to higher farm income to land or to livestock (Ellis and Mdoe, 2003; World Bank, 2000). The survey and RRA results considered ownership of, and access, to these assets by different categories of farm household based on income quartiles and study sites. In this study, total annual household income includes income from livestock and crop sales, rental income, salaries/wage from employment (in both farm and non-farm activities), remittances, and other reported income.

During the RRA exercises in both study sites, local farmers in two villages in each district carried out wealth-ranking of farm households in order to characterize households in terms of wealth status relative to local farm households. That is, the wealth-ranking was relative to local norms, rather than trying to categorise households as being, for example below or above a poverty line. The results from RRA wealth ranking exercise are presented in Table 2.2 below. RRA participants in both study area categorized households' wealth status based on land and livestock owned, as these two assets are considered as a store of value and other farm activities depend on land and livestock. This wealth-ranking exercise in the four villages of the two study sites revealed that better-off households in Horro were described by large land size and larger livestock and households with medium wealth were described by owning a larger heads of smaller livestock species. Poor households in this district, however, were described by small land size and larger poultry ownership. Better-off farmers in Jarso district were described by owning better land size, relative to households of poor and medium wealth status, and larger livestock, but no poultry. Poor households in this district owned little or no larger livestock, but owned poultry and very small land size. Generally, poorer households tended to have small holdings of stock in both districts and poultry was owned across all income groups except better-off households in Jarso. Poor farm households in Horro tended to possess roughly similar numbers of poultry and sheep and goats, but fewer cattle, compared to better off households, while poor farm households in Jarso were described having very little of everything. Jarso is one of districts under government food safety net programme and hence local farmers' classification seemed reasonable.

Table 2.2 Household wealth ranking using RRA

Wealth indicators	**Horro** Wealth rank			**Jarso** Wealth rank		
	Better-off	Medium	Poor	Better-off	Medium	Poor
Land(in hectare)	4	2.5-3	0.5-1	0.375	0.25	0.125
Cattle	2-30	3-15	4-5	3-2	1-3	0-1
Sheep and goats	4-20	8-15	5-10	0-6	3-4	0-1
Poultry	5	3-10	2-12	0	5-5	3-3

Source: RRA exercise, 2011

In crop-livestock subsistent mixed farming systems, land and livestock are important resources and hence are important components of differences in household wealth status, as identified during the RRA exercises in these two districts. The relationship of asset holdings to relative success in generating a viable living was further examined by comparing assets across income quartiles. The formal survey data, collected from the two study sites, were used to further explore the ownership of these assets by farm households with different wealth statuses and the role these assets could play in their livelihoods. The distribution of assets across rural farm households in this research is described in reference to asset holding across income quartiles and/or by reference to interval or count distributions of assets. Table 2.3 shows the distribution of mean land holding size and livestock, in terms of tropical livestock units, across income quartiles and the two districts. Tropical livestock unit (TLU) was calculated based on conversion factor given by Storck et al. (1991). Mean land holding size between the two districts was significantly different. The distribution pattern showed average land holding size rose across income quartiles, from lower income quartile to higher income quartile, as expected. The variation in mean holding size across income groups of the whole sample was significant. This implies that the variation in income may be explained in large part by land holding size in both districts. Generally, land holding size in these areas is quite fragmented, as it is in most parts of the country, and households with an average-sized family (6) depend on about 2 hectares and less than 0.5 hectare of land in Horro and Jarso, respectively. When livestock holding distribution across income quartiles was considered (Table 2.3), a significant difference in mean livestock holding was observed. The distribution generally shows that livestock were concentrated at the highest income quartile with variation between the two districts. Households in the highest income quartile had livestock holdings as much as three-times that of the lowest household income group in Horro. Like land holding, livestock holding across income groups in both districts showed a significant difference, implying the role of livestock in an improved rural livelihood. Hence livestock development targeting the poor is one way forward to enhance livelihoods of poor rural farmers in these areas. However, a decision to target which livestock species needs to consider access to land holding structure, the capacity of poor farmers to own and manage livestock, market and socio-cultural conditions.

Table 2.3 Household distribution by mean land size and livestock owned, by district

Variable/sample	Income quartiles				Total *n*=400
	I	II	III	IV	
Land size					
Horro	1.29(0.94)	1.62(1.17)	1.94(1.12)	3.00(2.08)	2.07(1.58)
Jarso	0.37(0.32)	0.43(0.25)	0.50(0.28)	0.67(0.32)	0.47(.31)
All sample	0.67(0.73)	1.02(1.03)	1.33(1.13)	2.07(1.98)	1.27(1.39)
F-value		20.92			
p-value		<0.001			
TLU[a]					
Horro	4.66(3.31)	6.17(4.34)	7.89(3.99)	14.99(9.68)	9.03(0.52)
Jarso	1.72(1.06)	2.38(1.34)	2.92(2.38)	3.75(2.75)	2.53(2.00)
F-value		10.24			
p-value		<0.001			
All sample	2.66(2.47)	4.27(3.72)	5.79(4.19)	10.51(9.47)	5.79(6.30)
F-value		35.91			
p-value		<0.001			

Source: Sample survey result; [a] Tropical livestock unit; standard deviations in parenthesis

The distribution of land across sampled households in the study areas was further explored by reference to interval counts of land ownership (Table 2.4). From the whole sample of farmers in the two districts, only 4% of them had no land at all, while 20% of them had a land size only up to 0.25 hectare. Within districts, landlessness and extreme shortage of land was more pronounced in Jarso and about 37% of sample population had only land size of 0.25 or below and only 3.5% of them had more than one hectare. Though landlessness is reported in Horro, more than 60% of sample households had 1-3.5 hectares of land and 10% of them had more than 3.5 hectares of land. This land holding size may suggest the species of livestock that need to be targeted in an effort to use livestock development to improve the livelihood of rural farmers. However, access to other inputs, institutional support services and markets are also as important as land, as discussed in the next sections.

Table 2.4 Distribution by land area owned (% of households owning specified land size)

Land size owned (in Hectare)	Horro		Jarso		Overall	
	%	Cumulative %	%	Cumulative %	%	Cumulative %
None	8.0	8.0	0.0	0.0	4.0	4
≤0.25	3.0	11.0	36.5	36.5	19.8	23.8
0.26-0.5	4.5	15.5	38.0	74.5	21.2	45
0.6-1.0	14.5	30.0	21.0	95.5	17.8	62.8
1.1-1.5	11.5	41.5	3.5	99.0	7.5	70.3
1.6-3.5	48.5	90.0	1.0	100.0	24.8	95.1
> 3.5	10.0	100.0	0.0	100.0	5.0	100.1
Chi-square			247.82			
p-value			<0.001			

Source: own sample survey result

The patterns of livestock holding found in the two districts' sampled households are reported in Table 2.5. In all study areas, relatively few households owned sheep and goats and most of the sample owned 1 to 5 cattle. For the sample as a whole, 65% of households owned no sheep and 50% owned no goats. However, ownership of livestock varied between districts. A large proportion of households in Horro (63%) owned at least 6 cattle while only about 8% of sample from Jarso had this size of cattle holding. Compared to Horro, a larger proportion of households from Jarso sample owned 1-5 goats and sheep. Poultry flock size in Jarso was relatively small and only few households had greater than 10 chickens while most of them (67%) had 1-5 chicken. Flock size in Horro, on the other hand, was relatively larger and 65% households had more than 5 chicken. The smaller flock size in Jarso could indicate the extreme poverty of households in the district which may be unable to afford to have larger flock sizes. It is also likely that land shortage limited farmers' ability to grow surplus crop and hence they unable to keep and feed large flock size. During RRA exercise, diseases were mentioned as major constraints in Horro whereas predation was the main constraint reported in Jarso and the smaller flock size may, in part, be explained by these factors. However, it is also important to recognise that the socio-culture in Jarso could also influence the market for chicken (but not egg) and hence limit the incentive to keep large flocks. The cultural significance of poultry consumption during festive times and as a 'dish for guest of honour' at occasional times is not as important in the predominantly Islamic region of Jarso as it is in Christian-dominated Horro. The nearest urban market to Jarso is about 57 km from the district, though there are limited markets in nearby districts albeit with poor road networks. The difference in crop production level in the two areas, Horro being one of the surplus crop producing areas in the country, also explains difference in chicken flock size. This suggests incentive and poor enabling environment to keep large flock size in this area, compared to Horro. Therefore, the small flock size in Jarso was possibly due to interrelated socio-economic conditions in the area.

Table 2.5 Distribution of household by ownership of selected livestock species (% of households owning specified livestock)

Livestock ownership range	District				Total (*n*=400)	
	Horro (*n*=200)		Jarso (*n*=200)			
	%	Cumulative %	%	Cumulative %	%	Cumulative%
Cattle						
0	4.0	4.0	10.0	10.0	7.0	7.0
1-5	33.5	37.5	82.5	92.5	58.0	65.0
6-10	30.5	68.0	7.0	99.5	18.8	83.8
11-15	20.5	88.5	0.5	100.0	10.5	94.3
Greater than 15	11.5	100.0	0.0	100.0	5.8	100.0
Sheep						
0	65.5	65.5	64.0	64.0	64.8	64.8
1-5	28.0	93.5	35.0	99.0	31.5	96.3
Greater than 5	6.5	100.0	1.0	100.0	3.8	100.0
Goats						
0	62.5	62.5	37.5	37.5	50.0	50.0
1-5	30.0	92.5	57.5	95.0	43.8	96.3
Greater than 5	7.5	100.0	5.0	100.0	6.2	100.0
Poultry						
1-5	35.0	35.0	67.0	67.0	51	51.0
6-10	25.0	60.0	23.5	90.5	24.2	75.3
11-20	26.5	86.5	8.0	98.5	17.2	92.5
Greater than 20	13.5	100.0	1.5	100.0	7.5	100.0

Source: own survey result

The role of poultry in the livelihood of households was further examined by investigating poultry ownership across income quartiles of sample households in both districts. In poor crop-livestock mixed farming systems, farmers tend to keep an optimum mix of livestock species and grow various crops, considering their resource base and capacity. The size of the poultry flock owned by households possibly varies according to household wealth status, market access, disease prevalence and other constraints. Distribution of poultry owned across income groups is shown in Table 2.6. The general pattern indicated that a larger proportion of sampled households in the higher income quartile owned larger flocks and hence would have greater potential to benefit from poultry related interventions. Over 60% of sampled farmers from Jarso in all the three lower income quartiles owned flock size of 1-5 chicken. A large proportion of households in the lowest income quartile owned 1-5 chickens in both districts and only a few households in this income category owned more than 10 chickens in Jarso. Again, a larger proportion of the sample population from Jarso in all income groups owned small flocks of poultry compared with Horro. The sample population from Jarso had fewer of all the assets considered here. The other important means of livelihood in Jarso area is *khat*, a stimulant cash crop that covers most farm land in Jarso area. In this socioeconomic environment, where there is limited market access, food deficit, and other constraints, farmers tended to focus on *khat* as means of cash income. Farmers in Horro, on other hand, grow staple crops annually and hence may consider poultry as important cash-generating farm enterprise. It is important to consider interrelated socioeconomic condition in a specific area to promote livestock-based livelihood development, as poverty alone is not the only factor to guide which livestock to target. The findings of our may study suggest that an intervention aimed at improving poultry production may be more appropriate for the Horro region.

Table 2.6 Poultry owned by income quartiles (% within income quartiles), by districts

Poultry owned in range	**Income quartiles**			
	I	II	III	IV
Horro				
1-5	46.9 (46.9)	34.0 (34.0)	32.2 (32.2)	32.2 (32.2)
6-10	15.6 (62.5)	34.0 (68.0)	23.7 (55.9)	23.7 (55.9)
10-20	21.9 (84.4)	26.0 (94.0)	28.8 (84.7)	27.1 (83.0)
More than 20	15.6 (100.0)	6.0 (100.0)	15.3 (100.0)	16.9 (100.0)
Jarso				
1-5	79.4 (79.4)	60.0 (60.0)	62.8 (62.8)	59.0 (59.0)
6-10	14.7 (94.1)	34.0 (94.0)	25.6 (88.4)	23.1 (82.1)
10-20	5.9 (100.0)	6.0 (100.0)	4.7 (93.1)	17.9 (100.0)
More than 20	0.0 (100.0)	0.0 (100.0)	7.0 (100.1)	0.0 (100.0)

Source: own sample survey result; Cumulative percentages are given in parenthesis.

Table 2.7 depicts the distribution of mean flock size owned, poultry lost, and poultry consumed in a year by study area. The mean number of poultry owned by the sample population in the two sites showed a statistically significant difference. The mean number of poultry owned by the sample farmers in Horro area was about 11 while that of Jarso was half this. The poultry flock size in both areas was, however, markedly lower than the average flock size reported in other African countries (see, for example, Birol et al., 2010) and the flock size in Jarso is even lower than flock size reported in other parts of Ethiopia (see Aklilu et al., 2008). The consumption of poultry meat in Jarso was found to be very low compared with Horro. As noted above, this can, in part, be explained by socio-cultural difference between the two districts, although consumption of poultry in Horro is also limited as poor farmers tend to sell chicken rather than consume them. The lower consumption of poultry by poor farmers also implies the extreme poverty of farmers. For the poor, the consumption of meat and eggs from their own poultry are considered unaffordable. Once farmers own larger livestock like goats, sheep or cattle, the role of poultry shifts from cash income generation to a consumption of birds and eggs (Aklilu et al., 2008).

Table 2.7 highlights that diseases and predators were reported to cause substantial poultry losses compared with flock size and hence may materially contribute to the small observed flocks. For example, the number of poultry reported to be lost in a year due to diseases in Horro was approximately equivalent to flock size owned at the time of sampling, and the total lost to disease and predation per year was greater than the average observed flock size. This was explained by the short lifespan of poultry, high chick mortality and hence rapid turnover of the poultry population.

Table 2.7 Poultry owned, consumed and lost, by district

Variables	Districts	
	Horro(*n*=200)	**Jarso**(*n*=200)
Poultry owned		
Mean	10.80 (9.03)	5.32(4.71)
t- value	7.61	
p-value	<0.001	
Poultry consumed in 12 months		
Mean	4.00(2.74)	0.74(2.75)
t- value	4.33	
p-value	<0.001	
Poultry lost due to diseases in 12 months		
Mean	10.4(16.65)	2.00(5.62)
t- value	6.81	
p-value	<0.001	
poultry lost in 12 months due to Predators		
Mean	6.00(7.43)	4.00(5.83)
t- value	2.93	
p-value	<0.001	

Source: sample survey result; standard deviations given in parenthesis

The primary role of poultry keeping was explored across the income groups and for the whole sample. Table 2.8 shows the distribution of the primary purposes of poultry keeping and the source of starting stock by different income groups and for the whole sample. For the whole sample, about 73% of the sampled household primarily kept poultry to sell to meet the day-to-day needs of the household, while others keep for consumption and sale. Across income quartiles, a relatively smaller proportion of 'better-off' households kept poultry primarily for sale and a larger proportion of households in this wealth status kept poultry primarily for consumption. This implies poorer households have limited sources of income and hence poultry is important asset to them to generate cash, whereas they serve as a source of protein for relatively 'better-off' households. During the RRA exercise, farmers mentioned that they keep poultry for sale of eggs and chicken to earn small amount of money, that this is important for women and that it generates income continuously throughout the year. The primary purpose of keeping poultry for sale could also be to save their larger animal stock, like goats and sheep, in the face of relatively small expenses. Therefore, in a subsistent crop-livestock farming systems where the producers themselves consume most of the agricultural produce, poultry plays an important role in generating cash.

More than 50% of the whole sample acquired poultry starting stock through purchase from a market, while a sizable proportion acquired starting stock by buying from neighbouring areas (Table 2.8). Farmers in the RRA preferred to buy from neighbouring areas for two main reasons. One reason was that farmers were not sure about the productivity of chickens purchased at a market from a person whom they didn't know. The other reason was that farmers wanted to be sure that the chicken did not come from areas where there had been recent diseases outbreaks and, therefore, that the chicken was not likely to be a host for disease. Hence, they tended to be risk averse and used social relations as a guarantee for acquiring productive and disease free chicken. The role of poultry in strengthening social bonds was reflected by the size of the sample population who acquired starting stock as a gift from relatives/parents (19%). Gifts as a source of starting stock across the four wealth status revealed an interesting pattern. Acquiring starting stock through gifts from relatives was more common among households in the two lowest income quartiles. This may imply the social significance of poultry to poorer households. A gift of poultry may also become a means of enhancing and securing incomes of dependent relatives.

Table 2.8 Primary purpose of poultry keeping and source of staring stock (%)

	Income quartiles				Total
	I	II	III	IV	
Purpose of keeping poultry					
To sell egg and chicken to meet needs of the household	82.0	70.4	72.3	67.4	73.1
For consumption	2.0	9.2	4.0	8.4	5.9
For sale and consumption	16.0	20.4	23.8	24.2	21.1
Chi-square value			6.75		
p-value			0.01		
Source for starting stock					
Bought from Market	47.0	50.0	53.9	52.0	50.8
Bought from neighbour areas	28.0	21.0	28.4	32.7	27.5
Gift from parents/relatives	23.0	27.0	14.7	9.2	18.5
Office of Agriculture/extension	0.0	1.0	2.9	6.1	2.5
Chicken sharing arrangement	2.0	1.0	0.0	0.0	0.8
Chi-square			19.87		
p-value			0.01		

Source: own survey result

Village poultry are generally described as part of the household and they are one of the domains that can be used to address gender issues within a production system. Here we assessed who exerted control over income from sale of eggs and chicken. Although women are generally the main poultry owners and they take care of the birds, previous reports suggest that women usually do not decide the use of poultry and eggs for consumption, selling and exchange (Guèye, 2005). In this study, however, we found that in 59% of the sample, income from sale of eggs and chicken was controlled by women and only in 15% of the sample did men controlled income from sale of egg and chicken (Table 2.9). Furthermore, although women exerted control over income from poultry, the benefit extended to the whole family as women often used the money to buy items for the household. From the RRA it was evident that household members in these study areas shared the different activities required for poultry keeping. Men, for example, were engaged in the construction of chicken housing and, when chickens became sick, were often responsible for attending poultry health services and buying medicine; hence men tended to undertake irregular activities related to poultry keeping. In contrast, women and children were responsible for day-to-day activities of poultry keeping.

Table 2.9 Household member control on income from sale of chicken and egg

	Observation	Percent
Men	57	15.3
Women	219	58.9
Children	27	7.3
Men and women	54	14.5
Women and children	8	2.2
Men and children	7	1.9
Total	372[a]	100.0

Source: own sample survey result; [a] 28 observations were missing for this particular variable.

For successful asset accumulation, when starting from small farm enterprises, like poultry keeping, the breadth of opportunity to construct such asset accumulation pathways is critical for the achievement of rising prosperity over time (Ellis and Mdoe, 2003). During the RRA exercise, farmers identified disease, predators, lack of poultry health service, limited access to improved breeds of chicken tolerant of local conditions, and a lack of market linkage as major constraints to poultry production in these areas. These findings were further explored using survey data. Table 2.10 shows sampled households' access to poultry health services and improved chickens in the two districts. About 68% of the total sampled households had no access to poultry health service. As expected, households with better wealth levels have relatively better access to poultry health services compared with households in the lowest income quartile. Very limited/no access to animal health service in areas where farmers' major challenge was diseases constrained poor farmers' ability to enhance poultry based livelihood. As noted from Table 2.7 (above), farmers annually lose, on average, as many birds to disease as their entire flock size at any one time.

Table 2.10 Access to poultry health service and improved chicken by wealth status (%)

Variable	Income quartiles				Total
	I	II	III	IV	*n*=400
Access to poultry health service					
Yes	15.0	38.0	36.0	40.0	32.2
No	85.0	62.0	64.7	59.2	67.8
Own improved chicken /exotic					
Yes	9.0	7.0	10.8	12.2	9.8
No	91.0	93.0	89.2	87.8	90.2

Source: own sample survey result

Farmers' access to institutional support services, in terms of access to improved chickens, was also further explored using survey data (Table 2.10). Only a few households (10%) had improved chickens in their flock. Among households across different income quartiles, better-off households had better access to improved chickens compared with households in the lower income quartiles. These results suggest that accessing agricultural extension support services is more of a challenge for poor households and they may find it more difficult enhancing their livelihoods using poultry extension service. It is likely that better-off households would be the ones to potentially benefit from future village poultry development, unless interventions are well designed and target poor households. It was evident during the RRA that farmers in these regions had concerns over the ability of improved breeds to adapt to the local production system. Comparing Rhode Island Red with local indigenous chickens, Dana et al. (2010b) also found that farmers claimed the exotic breed was poor in disease and stress tolerance and in the ability to escape predators prevalent in their village conditions. This implies that, in order to realize livelihood enhancement based on poultry and for the village poultry sector to supplement other farm enterprise, farmers' access to adaptable and acceptable improved poultry breeds and health services are important.

2.4 Conclusion

The research investigated the role of village poultry in a crop-livestock mixed farming system of rural Ethiopia using Rapid Rural Appraisal and survey data collected from two distinct with different agro-ecological zones. The study was conducted to explore the current role of village poultry and to better understand their potential to enhance rural livelihoods in a view of ever-increasing population, resulting in declining landholding sizes and a rising demand for animal protein. The study revealed that the poultry plays important economic and social roles, in spite of the challenges this farm enterprise faces. However, the degree to which smallholder-farming households currently utilize and benefit from poultry through consumption, as source of income from sale of egg and chicken, and as a gift to relatives to strengthen social bond varies across regions and wealth statuses. It was found that consumption of poultry is relatively more important in Horro area which is likely due to the socio-cultural significance of poultry during festive periods and similar occasions in this area. Consequently, Horro farmers had better access to markets, compared to sampled farmers from Jarso, where consumption of poultry is not as common.

Households in the upper income quartile had relatively better potential to benefit from poultry production, as indicated by larger flock sizes owned by this category of households and better access to extension service. Yet poultry production was important to poor households who rarely own larger stock and hence have limited access to animal protein and cash income from the sale of other livestock products. The study also revealed that village poultry have vital socio-cultural importance. It was found that households use poultry as a gift to relatives and friends, in addition to sales of eggs and chickens and consumption during festive periods. Receiving poultry as a gift from relatives and friends is more common among household in lower income group. This suggests the social importance of poultry to strengthen social bond in the community, particularly among poorer households.

The study also revealed that the primary purpose of keeping poultry for most rural households was to sell eggs and chickens to meet the cash needs of the household. This may indicate the role village poultry could play to meet financial needs of farmers.

Poultry production activities in these parts of rural Ethiopia are shared among household members, but day-to-day management of chickens is still the work of women and children. Previous studies suggest that women usually do not decide on the use of income from sale of egg and chicken despite their role in production activities (Guèye, 2003). In this study, however, it was found that income from the sale of egg and chicken are mainly controlled by women and the benefit extends to the whole family as women often use the money to buy items for the household. This suggests that poultry could be an ideal livelihood option to contribute to empowerment of poor women and to improve households' access to animal protein and income from sale of egg and chicken.

Analysis of households' access to and ownership of major agricultural resource base indicated that land and livestock ownership are concentrated in households in upper income group. It was found that landlessness is more pronounced in Jarso district, compared with Horro district, and households in the Jarso area owned little larger livestock. This may suggest that poultry, which need little or no land, would be an important livestock to target in this area to improve households' livelihoods. However, farmers in Jarso area tended to pay less attention to poultry, despite the poor resource base. This is likely due, in part, to the fact that farmers in this area grow, as a cash crop, *khat* which would generate cash income. Moreover, socio-cultural factors and limited market access made poultry less important in this area. Therefore, poultry-based livelihood enhancement programmes in this area needs to take into account interrelated socioeconomic factors if meaningful and sustainable change is sought.

The study also indicated that village poultry production operates under a wide range of hindering factors. It was found that infectious diseases are major bottlenecks to village poultry production in rural Ethiopia, though the extent of this problem may vary between different areas. Predators, likely exacerbated by poor management practices, are also major hindering factors. The study also revealed that poor market linkage and limited or no access to input services, particularly poultry health services and a lack of adaptable improved chicken breeds, were also major impediments to village poultry development, and that access to these service is unequal across wealth distributions. This suggests that for the potential role of village poultry in rural Ethiopia to be realized, a comprehensive village poultry development programme is required. Such a programme would likely require strengthening of the institutional capacity of extension services to provide necessary and adequate services based on the needs of farmers, and improvement of the marketing aspects of poultry, enabling actors in both input and output market in the poultry sector, to link farmers to markets.

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References

Aklilu, H., Almekinders, C., Udo, H., Van der Zijpp, A., 2007. Village poultry consumption and marketing in relation to gender, religious festivals and market access. Tropical animal health and production 39, 165-177.

Alders, R., 2003. Success story on the control of Newcastle disease in village chickens using thermotolerant vaccines. Asia Pacific Association of Agricultural Research Institutions (APAARI), FAO-RAP, Bangkok.

Aklilu, H., Udo, H., Almekinders, C., Van der Zijpp, A., 2008. How resource poor households value and access poultry: Village poultry keeping in Tigray, Ethiopia. Agricultural Systems 96, 175-183.

Alders, R., Pym, R., 2009. Village poultry: still important to millions, eight thousand years after domestication. World's Poultry Science Journal 65, 181-190.

Besbes, B., 2009. Genotype evaluation and breeding of poultry for performance under sub-optimal village conditions. World’s Poultry Science Journal 65, 260-271.

Birol, E., Asare-Marfo, D., Ayele, G., Mensa-Bonsu, A., Ndirangu, L., Okpukpara, B., Roy, D., Yakhshilikov, Y., 2010. Investigating the role of poultry in livelihoods and the impact of avian flu on livelihoods outcomes in Africa. International Food Policy Research Institute (IFPRI).

Copland, J.W., Alders, R.G., 2005. The Australian village poultry development programme in Asia and Africa. World's Poultry Science Journal 61, 31-38.

Dana, N., Dessie, T., van der Waaij, L.H., van Arendonk, J.A., 2010a. Morphological features of indigenous chicken populations of Ethiopia. Animal Genetic Resources Information 46, 11-23.

Dana, N., van der Waaij, L.H., Dessie, T., van Arendonk, J.A., 2010b. Production objectives and trait preferences of village poultry producers of Ethiopia: implications for designing breeding schemes utilizing indigenous chicken genetic resources. Tropical animal health and production 42, 1519-1529.

Degefu, H., Balcha, M., Yohannes, M., Getachew, M., 2010. Seroprevalece of Infectious Bursal Disease in backyard chickens of Oromia regional state, Ethiopia. Veterinary Research 3, 89-93.

Dessie, T., Ogle, B., 2001. Village poultry production systems in the central highlands of Ethiopia. Tropical animal health and production 33, 521-537.

Dolberg, F., 2004. Review of household poultry production as a tool in poverty reduction with focus on Bangladesh and India, FAO Pro-Poor Livestock Policy Initiative Working Paper No. 6.

Dolberg, F., 2007. Poultry production for livelihood improvement and poverty alleviation, Proceedings of the International Conference Poultry in the Twenty-first Century: avian influenza and beyond, held, pp. 5-7.

Ellis, F., Mdoe, N., 2003. Livelihoods and rural poverty reduction in Tanzania. World Development 31, 1367-1384.
FAO, 2009. The State of Food and Agriculture. Livestock in the balance, Rome.

FAO, 2010. Smallholder poultry production – livelihoods, food security and sociocultural significance, in: Kryger, K.N., Thomsen, K.A., Whyte, M.A., Dissing, M. (Eds.), FAO Smallholder Poultry Production Paper No. 4, Rome.

FAO, 2011. Food and Agricultural Organization Ethiopia Country Programming Framework 2012-2015. Office of the FAO representative in Ethiopia and to AU and ECA, Addis Ababa, Ethiopia.

Gari, G., Tilahun, G., Dorchies, P., 2008. Study on Poultry Coccidiosis in Tiyo District, Arsi Zone. International Journal of poultry science 7, 251-256.

Garikipati, S., 2009. Landless but not assetless: female agricultural labour on the road to better status, evidence from India. The Journal of Peasant Studies 36, 517-545.

Guèye, E., 2003. Gender issues in family poultry production systems in low-income food-deficit countries. World's Poultry Science Journal 4, 185-195.

Guèye, E., 2005. Gender aspects in family poultry management systems in developing countries. World's Poultry Science Journal 61, 39-46.

Guèye, E.F., 2000. The role of family poultry in poverty alleviation, food security and the promotion of gender equality in rural Africa. Outlook on Agriculture 29, 129-136.

Jenbreie, S., Ayelet, G., Gelaye, E., Kebede, F., Lynch, S.E., Negussie, H., 2012. Infectious bursal disease: seroprevalence and associated risk factors in major poultry rearing areas of Ethiopia. Tropical animal health and production 45, 75-79.

Köhler-Rollefson, I., Rathore, H.S., Mathias, E., 2009. Local breeds, livelihoods and livestock keepers' rights in South Asia. Tropical animal health and production 41, 1061-1070.

LID, 1999. Livestock in poverty focused development. Livestock in Development, Crewkerne, U.K. accessed 29-01-2014 at http://www.theidlgroup.com/documents/IDLRedbook_000.pdf.

Mack, S., Hoffmann, D., Otte, J., 2005. The contribution of poultry to rural development. World's Poultry Science Journal 61, 7-14.

MOFED, 2013. Development and Poverty in Ethiopia, Addis Abab, Ethiopia. accessed on 28-01-2014 at http://www.mofed.gov.et/English/Resources/Documents/Development%20and%20Poverty%20in%20Ethiopia(1995-96)(2010-11).pdf.

Moser, C.O., 1998. The asset vulnerability framework: reassessing urban poverty reduction strategies. World development 26, 1-19.

Rushton, J., Viscarra, R.E., Taylor, N., Hoffmann, I. and Schwabenbauer, K., 2010. Poultry sector development, highly pathogenic avian influenza and the smallholder production systems. Perspectives in Agriculture, Veterinery Science, Nutrition and Natural resources, CABI.2010 5No 030

Rushton, J., Viscarra, R., Guerne Bleich, E. and Mcleod, A., 2005. Impact of avian influenza outbreaks in the poultry sectors of five South East Asian countries (Cambodia, Indonesia,Lao PDR, Thailand, Viet Nam) outbreak costs, responses and potential long term control. World Journal of Poultry Science 61, 491-514

Rushton, J., Ngongi, S., 1998. Poultry, women and development: old ideas, new applications and the need for more research. World Animal Review 91, 43-49.

Sonaiya, E., 2007. Family poultry, food security and the impact of HPAI. World's Poultry Science Journal 63, 132-138.

Spradbrow, P.B., 1993. Newcastle Diseases in village chickens. in: Poultry Science reviw 5,57-96.

Storck, H., Emana, B., Adenew, B., Borowiecki, A., W/Hawariat, S., 1991. Farming systems and farm management practices of small holders in the Hararghe highlands. In Farming systems and resource economics in the tropics, V 11. Wissenschaftsverlag Vauk, Kiel, Germany.

World Bank, 2000. World development report 2000/2001: attacking poverty .Oxford University Press, New York.

World Bank, 2008. world development report 2008. Agriculture for Development. World Bank, Washington, DC.

Zeleke, A., Sori, T., Gelaye, E., Ayelet, G., 2005. Newcastle Disease in Village Chickens in the Southern and Rift Valley Districts in Ethiopia. International Journal of Poultry Science 4, 507-510

Chapter 3

Understanding farmers' preference for traits of chicken in Ethiopia

Abstract

Traditional poultry production plays an irreplaceable role in the sustenance of livelihoods in rural Ethiopia. Ironically, however, much has been done to replace indigenous poultry breeds with exotic genetic resources regardless of the importance producers and consumers attach to the attributes of these resources. This study aims at informing policy to establish effective indigenous poultry breeding and conservation programmes. Discrete choice experiment (DCE) was employed to generated data. Designing of the DCE involved identification, definition and measurement of attributes of adaptive, socio-cultural, and productive importance considering the multiple functions of village chicken. Random parameter logit regression was used to analyse the data and derive the worth of traits of chicken. The results show that important traits of chicken to farmers are mothering ability, diseases resistance and meat and eggs taste. These findings question the appropriateness, at least, in the prevailing production system, of the Ethiopian national government's effort to improve productivity in village poultry by targeting specialized egg layer improved chicken. The findings also suggest that poultry breeding programmes aiming to provide readily acceptable breed technology by farmers need to prioritize traits of adaptive and socio-cultural importance instead of focusing on egg productivity only. The key implication is that the unique qualities of the indigenous poultry breeds need to be carefully identified and valued before resorting to those that proved to be successful in different production systems.

Key words: Economic value, discrete choice experiment, poultry genetic resources

3.1 Introduction

Livestock are an important component of the livelihoods of many poor households. Village poultry plays vital role in rural and national economy of developing countries. Though generally considered secondary to other agricultural activities by smallholder farmers, poultry production makes an important contribution to supplying local populations with additional income and high quality protein. Village poultry plays significant role in poverty alleviation, food security and the promotion of gender equality in developing countries (Guèye, 2000). Nearly all families in developing countries at the village level, even the poor and landless, are owners of poultry. In Ethiopia, in particular, poultry production is an integral part of the mixed crop-livestock farming system practiced by most rural households. The total poultry population in the country is estimated to be 50.38 million out of which 96.9%, 2.56 %, 0.54% are indigenous, exotic and hybrid, respectively (CSA, 2013).

Smallholder poultry production makes use of indigenous genetic resources, which are adapted to a specific harsh environment where resources are often limited and where challenges imposed by climatic conditions, pathogens and predators are severe. They are also often utilized for several purposes simultaneously (FAO, 2010). Indigenous chickens in Ethiopia provide major opportunities for increased protein supply and income for smallholders because they require low capital investment, have a short generation interval and a high rate of productivity (Aklilu et al., 2007; Halima et al., 2007). They also play a supplementary role in relation to other crop-livestock activities by providing cash. However, indigenous chicken breeds are claimed to be slow grower and poor producer of small sized egg. Despite these disadvantages, indigenous birds are also characterized by many advantages such as good egg and meat flavour, hard egg shells, high dressing percentages, and especially low cost with little special care required for production. They are, therefore, well suited to the very limited input that mainly poor producers can provide (Guèye, 1998).

Introduction of exotic breeds to smallholder farmers have been in practice for a couple of decades to improve productivity of poultry subsector in Ethiopia. Increased productivity of the village poultry subsector by using exotic breeds in Ethiopia, however, failed to become a sustainable option mainly because this strategy recurrently faced the problem of birds not being adopted widely by the rural farmers due to several socioeconomic and environmental challenges (Teklewold et al., 2006). It is important to make every effort possible to ensure that novel interventions in farming practices are successful as failures are long remembered and are likely to inhibit the acceptance of further new ideas (Guèye, 2000). A possible intervention to improve village poultry production is to target indigenous breeds based on need and preference of smallholder farmers. Horst (1988) argued that the genetic resource base of the indigenous chickens in the tropics is rich and should form the basis for genetic improvement and diversification to produce a breed adapted to local conditions. Similarly, Wilson (2010) argued that the oft-preferred route to higher output and productivity is to improve the local genetics followed by changes in management.

Previous attempts to introduce exotic chicken mainly aimed to enhance productivity in a village production environment. However, the purposes of raising livestock go beyond their output functions and include other significant socio-economic and socio-cultural roles (Drucker and Anderson, 2004). Non-income functions of livestock keeping are particularly important for many of the poor (Anderson, 2003). In developing countries, especially in low-input smallholder production systems, the most valuable livestock attributes are often those that successfully guarantee multifunctionality, flexibility and resilience in order to deal with variable environmental conditions (Scarpa et al., 2003a). Poultry in Ethiopia, especially in villages, are kept for a multiplicity of reasons. In addition to yielding animal protein and providing a surplus for sale to generate small amounts of cash they are reared for sacrificial and cultural reasons. Hence, the genetic resource base of indigenous chicken is crucial to meet the multiple production objectives of households.

Development policy in the past focused on introduction of higher-yielding exotic breeds to improve productivity of village poultry to achieve food and nutrition security. The introduction of exotic breeds and other social and economic pressures have exposed locally adapted indigenous breeds to the risk of extinction and could lead to a loss of potentially valuable genetic diversity (Rege and Gibson, 2003). The extensive unplanned distribution of exotic chicken breeds by both government and nongovernment organizations has resulted in dilution of the indigenous genetic stock in developing countries. If this trend continues, the gene pool of the indigenous chickens could be lost in the near future (Faustin et al., 2010). Widespread and indiscriminate distribution of exotic chicken threatens genetic resource base of indigenous chicken in Ethiopia. Governmental and non-governmental interventions have yet to cause serious erosion of the local gene pool but the danger of losing valuable adaptive and production traits does exist (Wilson, 2010).

The management of animal genetic resources requires many decisions that would be easier to make if information on the economic value of populations, traits and processes were available (Scarpa et al., 2003a). Among many uses, economic valuation of animal genetic resources (AnGR) is essential to guide decision makers, providing rational bases for priority setting for breed improvement programmes and for conservation programmes (Rege, 1999; Roosen et al., 2005). Valuation studies for animal genetic resources are of particular interest in those contexts in which animal genetic resources are an input into the production process particularly when this production can improve the livelihoods of poor rural household (Scarpa et al., 2003a). Markets provide important information about values and preference for traded goods and services. Many of the benefits derived from the existence of well-adapted indigenous AnGR are, however, not transacted in any market. Hence, non-market valuation tools are required to identify the magnitude of these benefits (Scarpa et al., 2003b).

Stated preference-based valuation is widely used in identifying preferred traits of livestock and economic valuation of animal genetic resources. Early study on AnGR valuation by Sy et al. (1997) used ordered probit regression model to evaluate the preferences of cattle producers in Manitoba, Canada employing conjoint analysis method. Similarly, Tano et al. (2003) used conjoint analysis to evaluate the preferences of farmers for cattle traits in Burkina Faso. Since its application in valuation of the hairless creole pigs genetic resources in Mexico by Scarpa et al. (2003a), recent studies commonly employ choice experiment and more advanced econometric methods in AnGR valuation in both developed and developing economies. For example, Ouma et al. (2007) used mixed logit and latent class models to examine preferences for traits of cattle focusing on heterogeneity among cattle keepers using choice experiment data from Kenya and Ethiopia. In their study to estimate the value that society places on changes to the size of the badger population in England and Wales, Bennett and Willis (2008) also used a similar approach. Likewise, Loureiro and Umberger (2007) used choice experiment and multinomial conditional logit model to explore consumer preferences for meat attributes in the US. Ruto et al. (2008) used choice experiment and latent class model to value cattle traits in Kenya, while Kassie et al. (2009) used choice experiment and random parameter logit to value preferred traits of cattle in Central Ethiopia. Similarly, Faustin et al. (2010) employed choice experiment survey and mixed logit model to investigate preferred traits of chicken in rural Benin.

The objective of this study is to identify preferred traits of indigenous chicken and to derive the worth of these traits to village poultry keepers in rural Ethiopia where production system is semi-subsistent. With an increasing demand for animal protein and in the face of interventions to increase productivity using exotic breed/cross breed, understanding farmers' preference for traits of chicken has important implication for the state of poultry genetic resources in the country. The increasing incidence of poultry diseases both globally and locally due to climate and other changes has also important implication in terms of demand for the particular traits of indigenous poultry that make it more adaptive to the environment. We employ discrete choice experiment where farmers trade-off productive and adaptive traits, and traits with cultural significance. This study, therefore, will inform the breeding programmes for improvement of indigenous chicken in Ethiopia and conservation plans to maintain genetic pool for future use.

3.2 Methods

3.2.1 Discrete choice experiment: Design and application

Discrete Choice experiment (DCE) is an increasingly used stated preference method for non-market valuation. DCE method has a theoretical grounding in Lancastrian consumer theory (Lancaster, 1966), which supposes agents derive utility from the properties or characteristics (attributes as in valuation literature) of the goods instead of goods as a direct object of utility, and an econometric base in random utility theory (see Luce, 1959; McFadden, 1974) as the random utility framework in dichotomous choice contingent valuation models (Hanemann, 1984). DCE arose from conjoint analysis, but differs from the typical conjoint method in that individuals are asked to choose from alternative bundle of attributes instead of ranking or rating them. Thus DCE are consistent with random utility theory (Adamowicz et al., 1998). In DCE, respondents are presented with series of alternatives and asked to choose the most preferred one. Respondents' preferences for an alternative are then based on the utility derived from the combination of attributes.

Unlike contingent valuation method, DCE enables estimation of values of attributes and provides the opportunity to identify marginal values of attributes rather than value of the good as whole only (Bateman et al., 2002; Hanley et al., 1998). The DCE approach is essentially a structured method of data generation (Hanley et al., 1998) and hence, it is a significant improvement over other popular stated preference based methods such as contingent valuation. Originally, DCE has been used in the transport economics (see Hensher and Truong, 1984) and marketing (see, Louviere and Woodworth, 1983) literature, but increasingly applied in other research areas, including: environment (see Adamowicz et al., 1998; Campbell, 2007; Drake, 1992; Hanley et al., 1998); food safety and quality (see Loureiro and Umberger, 2007; Tonsor et al., 2005); and in other related disciplines. There is also a growing literature in application of DCE in valuation of animal and plant genetic resources (see, for example, Birol et al., 2006; Kassie et al., 2009; Ouma et al., 2007; Ruto et al., 2008; Scarpa et al., 2003a; Tano et al., 2003).

3.2.2 Attribute identification and DCE designing

Designing a DCE requires careful definition of the attributes and attributes levels determination as well as generation of statistically efficient and practically manageable DCE design (Hanley et al., 1998; Kassie et al., 2009). Hensher et al. (2005) also advises that as much time as possible is spent in identifying and refining attributes, attribute levels and attribute labels to be used before proceeding to the formal design of DCE. This study involved a series of procedures to determine attributes of chicken and attribute levels used in DCE design. Rapid rural appraisal (RRA) and informal study and review of existing literature were used. RRA was conducted and informal discussion was undertaken with local farmers to identify potential attributes of chicken and determine attribute levels in two local areas of Horro district in January, 2011. Discussants were asked to list attributes of chicken they would consider when buying poultry[3] and to rank them according to their importance. Findings from this study was supplemented by a study on production objectives and preferences using PRA by Dana et al. (2010) in Ethiopia. The attributes,

[3] In Ethiopia, poultry is typically chicken.

attribute levels, and attribute level labels used to describe each attribute used in DCE were determined after thorough discussion and in consultation with poultry breeders and geneticists. Additionally, two focus group discussions were conducted in October, 2012 in two villages of Horro to further examine how farmers would understand the levels of traits of birds we considered in our choice experiment.

The final attributes considered in designing of the DCE included traits with cultural significance, productive traits and adaptive traits. Plumage colour is a trait of poultry with cultural significance. Three attribute levels were used for this trait; predominantly white, predominantly black and predominantly red. During the focus group discussion, we learned that farmers had a range of views regarding plumage colour of chicken. While predominantly black plumage colour is disliked by some in connection with ceremonial use of chicken, others believed chicken with black plumage colour were less vulnerable to predators compared with birds with white plumage colour. Productive traits considered in the DCE design were: number of eggs per clutch; body size; and mothering ability. For number of egg per clutch, typical values for the minimum, average, and maximum number of eggs per clutch that a given hen would normally lay was used as trait levels. Trait levels for ‘body size’ was presented using the usual local expression and had three levels; small, medium, and large. Mothering ability is the capacity to incubate, hatch optimum proportion of eggs set for hatching and look after chicks. From the two rounds of focus group discussions, we learned that farmers would normally set proportion of laid eggs for hatching. On average farmers would set twelve eggs for hatching by a given hen at a time and they would either eat or sell the remaining eggs. This was due to hen’s inability to incubate a larger number of eggs and hence this would result in eggs being infertile. Accordingly, ‘mothering ability’ had three levels with maximum number of eggs set for hatching twelve; ‘Hatch and raise 4 chicks from 12 eggs’, ‘Hatch and raise 8 chicks from 12 eggs’, and ‘Hatch and raise 12 chicks from 12 eggs’. Diseases resistance is an adaptive trait considered in the DCE design. This had two trait levels; ‘rarely gets sick’, ‘often gets sick and may die’. Meat and eggs taste was also included in the experiment as farmers realized differences in taste of meat and egg between local and exotic/ cross breed chicken. It had two attribute levels; poor and good. We used three levels for price of chicken; ETB 40, ETB 55 and ETB 70: these are averages of minimum, average and maximum price of matured chicken obtained during the focus group discussions immediately prior to conduct of the survey for piloting and local market observation by the researchers. Throughout all profiles, the age of the hypothetical chicken was uniformly set at the age of five to six months, which is average maturity age in that specific area. The summary of attribute and attribute levels used in this DCE is given in Table 3.1.

Table 3.1 Attributes and attributes levels included in the DCE

Attributes	**Attribute levels**	**Reference level**
Plumage colour	Predominantly white	
	Predominantly black	Predominantly red
	Predominantly red	
Egg per clutch	12	
	16	Used as continuous
	20	
Body size	Small	
	Medium	Medium
	Big	
Mothering ability	Poor: Hatch 4 and raise chicks from 12 eggs	
	Moderate: Hatch and raise 8 chicks from 12 eggs	Moderate
	Good: Hatch and raise12 chicks from 12 eggs.	
Diseases resistance	Good: Rarely gets sick	
	Poor: Often gets sick and may die	Poor
Meat and egg taste	Poor	Poor
	Good	
Price	ETB 40	Used as continuous
	ETB 55	
	ETB 70	

We used SAS software macros to combine identified attributes and attribute levels to generate generic chicken profiles where breeds of poultry were not included. There are 972 (i.e. $3^5 * 2^2$) possible ways to combine the selected attributes and attribute levels to generate profiles. However, full-factorial design like this is too cost-prohibitive, tedious (Kuhfeld, 2010) and cognitively demanding for respondents to make meaningful choice for most practical situations. Consequently, fractional factorial experimental design which focuses on orthogonality is commonly used in resource valuation studies (Rose and Bliemer, 2004). Therefore, an orthogonal fractional-factorial experimental design (Hensher et al., 2005; Kuhfeld, 2010) was used to generate profiles based on the attributes and attribute levels in this study. The design was obtained based on common measures of design efficiency, D-efficiency and A-efficiency. D-Efficiency maximizes the determinant of the information matrix, while A-Efficiency attempts to minimize the sum of the variances of estimated coefficients (Kuhfeld, 2010). The final design had an optimal combination of fairly high D-Efficiency, 99.64, and A-Efficiency, 99.7. The design generated 36 chicken profiles, which was considered to be too many judgments for an individual respondent to make. Therefore, these profiles were randomly grouped into 18 chicken choice sets, each choice sets having two profiles, and blocked into three. Hence, each respondent could be presented with six choice sets. An opt-out option was included into the choice sets to avoid forced choice so that the DCE was consistent with utility maximization and demand theory (Bateman et al., 2002). Accordingly, respondents were presented with six choice sets, each containing three alternatives: two chicken profile and opt-out option. Choice sets were supplemented by visual aid (pictures) to help communicate information about attribute levels.

3.2.3 The survey

The formal survey was conducted in Horro district of Ethiopia as part of a larger project working on reducing the impact of infectious diseases on village poultry production in Ethiopia. This study was approved by the University of Liverpool Committee on Research Ethics (reference-VREC76). Horro district is located at about 315 km west from Addis Ababa. The predominant agricultural practice in this area is a mixed crop-livestock farming system and livestock production is an integral part of the semi-subsistent farming. Farm activity in Horro district is rain-fed and staple crops occupy the farmland which serves as grazing land in dry season during the cropping season. The district receives an average annual rainfall of 1,685 mm (ranging from 1,300 to 1,800 mm) and the annual average temperature is 19 °C (ranging from 14 to 24 °C).

The formal survey was conducted in February and March, 2013. The survey was conducted by well-trained and experienced enumerators who were postgraduate students from Haramaya University and Addis Ababa University with keen interest to learn DCE under close supervision of the researchers. The enumerators had good understanding of livestock development and extension. Training of enumerators included the principles of DCE, introduction to the study, and simulated interviews among enumerators. Prior to the formal survey, the questionnaire was extensively piloted and pre-tested among individuals and in focus group discussions during early January, 2013.

The pilot survey for the DCE showed that communicating attribute and attribute levels was workable and that respondents could complete the choice exercise at ease. Following the feedback from pilot survey, only minor changes were made. The order of the questionnaire presentation was re-arranged by bringing some demographic questions to the beginning to help get respondent attention for the choice task. The DCE household survey was carried out in four '*Gandas'*, lowest administrative unit in government structure consisting of several villages, selected by the project from two different market channels in the district. Sample respondents were randomly selected from the list of households provided by agricultural development agents. This DCE survey was administered on 450 farmers drawn by employing sampling with probability proportional to the population size of each *Ganda*.

3.2.4 Econometric model

The random utility framework is the theoretical basis for integrating behaviour with economic valuation in the DCE. The basic assumption of random utility theory is based on the premise that agents behave rationally choosing the alternative that would yield the highest utility. Random parameter logit (RPL), also called mixed logit, is a highly flexible and computationally practical approach to discrete response analysis model that can approximate all random utility models if the right mixing functions are employed (McFadden and Train, 2000; Train, 2003). It resolves the limitations of standard logit by allowing for random taste variation, unrestricted substitution patterns, and correlation in unobserved factors over time (Hensher et al., 2005; Train, 2003). RPL model is again appealing for its ability to determine the possible source of any heterogeneity through interaction of each random parameter with other variables that one may suspect to be possible source of preference heterogeneity (Hensher et al., 2005). Following the random utility framework, the decision-maker faces a choice among alternatives in set J, a profile of chicken with different trait levels, in each T choice situation. The utility of person n from chicken profile j in choice situation t is

$$U_{njt} = \beta'_n x_{njt} + \epsilon_{njt} \quad (1)$$

where x_{njt} is a vector of observed variables related to chicken traits and respondents socio-economic characteristics and interactions of chicken traits and respondents' socioeconomic characteristics, β_n is a vector of coefficients of these variables for each n representing that person's taste and it varies over decision-makers in the population, with density $f(\beta_n/\theta)$ where θ are the parameters of this distribution. ϵ_{njt} is an unobserved random term that is independent and identically distributed (iid) extreme value type 1 across respondents, independent of β_n and x_{njt}. The probability that person n chooses chicken profile i in choice situation t, conditional on β_n, is a conditional logit:

$$L_{nit}(\beta_n) = \frac{e^{\beta\prime_n x_{nit}}}{\sum_{j=1}^{J} e^{\beta\prime_n x_{njt}}} \quad (2)$$

The conditional logit, however, assumes that the taste parameters are homogeneous across respondents and sufficiently capture information on utility weights attached to the traits and trait levels. Unobservable heterogeneity cannot be captured within this framework. Its basic assumption of iid random terms also results in the more restrictive assumption of independence of irrelevant alternatives (IIA) (Hensher et al., 2005).

The unconditional choice probability is integral of $L_{nit}(\beta_n)$ over all values of β_n, which depends on the parameter distribution of β_n:

$$P_{nit}(\theta) = \int L_{nit}(\beta_n) f(\beta|\theta) d\beta_n \quad (3)$$

The goal here is to estimate $\boldsymbol{\theta}$, the population parameters, that describe the distribution of individual parameters. Exact maximum likelihood estimation is not possible since unconditional probability for the sequence of choices cannot be calculated analytically.

The probabilities are approximated through simulation for any given value of $\boldsymbol{\theta}$ (McFadden and Train, 2000; Train, 2003). The simulated probabilities are inserted into the log-likelihood function to give a simulated log-likelihood:

$$SLL = \sum_{n=1}^{N} \sum_{j=1}^{J} d_{nj} ln \frac{1}{R} \sum_{r=1}^{R} \frac{e^{\beta_n^r x_{nit}}}{\sum_{j=1}^{J} e^{\beta_n^r x_{njt}}} \quad (4)$$

Where $d_{nj} = 1$if individual n chose j and zero otherwise and $\beta_n^r = 1, 2, \dots R$ are random draws from the density $f(\beta_n/\theta)$.

Another important result in this study is the implicit prices attached to the traits and trait levels in the DCE. Using Delta method, trade-offs between chicken attributes and money price, the marginal willingness to pay (WTP), are computed as:

$$WTP = -1 * \left({}^{\beta_k}\!/_{\beta_p} \right) \quad (5)$$

where β_k is the estimated coefficient for an attribute or attribute level and β_p is the coefficient of the chicken profile price. The marginal WTP, or implicit price, for changes in an attribute provides a measure of the relative importance that respondents attach to attributes within the chicken profiles.

3.3 Results and discussions

3.3.1 Farmers' characteristics

Farmers' basic demographic characteristics and the codes used in the random parameter logit estimation are reported in Table 3.2, below. The average age of the respondent farmers was about 42 year. The mean family size was more than 6 persons. On average, farmers had one child below five years and the average number of children below 17 was more than 3 in the research sample. Data were also collected on religion of the respondent, as religion is believed to influence farmers' preference for traits of chicken. More than 55% of responding farmers were followers of Ethiopian Orthodox Christianity, about 38% of them were evangelical Christians, and the remaining were followers of other religions (including traditional and Muslim). About 38% of farmers had attended elementary school and 16% of them had attended high school and 12% of them could read and write; however, a significant proportion of farmers (31%) had no any form of education. About 80% of respondents were male farmers and 20% were female. This large disparity was observed due to the fact that we targeted head of the household for whom the list of farmers were available for sampling.

Table 3.2 Respondents' descriptive statistics and code used in random parameter logit model

Variables	Code /unit	Descriptive
Age	Years	Mean=41.62 (SD=14.87)
Family size	Number of persons in the family	Mean=6.43(SD= 2.24)
Children below 5 years	Number of children	Mean= 1.1 (SD= 0.9)
Children below 17	Number of children	Mean= 3.6 (SD= 2.0)
Ethiopian Orthodox	1 if religion is orthodox 0 otherwise	55.3%
Protestant	1 if religion is protestant 0 otherwise	37.8%
Other religion followers	(-1)reference level	6.8%
Education	1= illiterate	31.3%
	2= read and write	12.0%
	3 = elementary	37.8%
	4 = secondary	16.0%
	5 = above secondary	2.9%
Sex	Male	80.4%
	Female	19.6%

3.3.2 Empirical result

Attributes of chicken and attribute levels together with codes used in model estimation are given in Table 3.1. Following Hensher et al. (2005), effects coding was used for DCE traits to measure nonlinear effects in the trait levels to avoid confounding in the grand mean. At exploratory estimation stage, the utility parameters for all attributes, except for price, were entered as random parameters assuming various distributions. For the final model estimation, however, a few attributes were treated as non-random as their standard deviations were insignificant suggesting invariant preference for these attributes across respondents. Accordingly, attributes for mothering ability was entered as non-random while all other attributes were entered as random assuming normal distribution. Following Revelt and Train (1998), price was treated as non-random (fixed) to facilitate WTP calculation so that the WTP for each attribute is distributed in the same way as the attribute's coefficient. Hence, the mean and standard deviation of WTP is the mean and standard deviation of the attribute coefficient scaled by the inverse of the fixed price coefficient. The fixed cost coefficient restriction also facilitates estimation (Scarpa et al., 2008). Recent studies employing RPL in valuation and preference analysis also used similar approach (see for example Faustin et al., 2010; Otieno et al., 2011).

The simulated maximum likelihood estimates for the random parameter logit (RPL) model is reported in Table 3.3. The model was estimated using NLOGIT version 5 and estimates were obtained utilizing 200 Halton draws for the simulations. The model was highly statistically significant ($x_{21}^2 = 2569.13$ and p<0.001) and the overall-model-fit was adequate with pseudo R^2 of 0.43. The model results shows that all traits were highly significant determinants of choice and the signs of all attributes were as expected. Disease resistance and good meat and egg taste were statistically significant at 5% level while all other traits were significant at 1% level. The constant variable in the model result represents the opt-out option in the alternatives provided for choice. It had negative and statistically significant mean coefficient indicating respondents preferred to choose from the two alternatives associated with various trait levels instead of opting out.

As expected, price has negative and significant mean coefficient implying a lesser likelihood of choosing chicken profiles with higher prices. Farmers preferred chicken with predominantly white plumage colour, as indicated by positive and statistically significant coefficient. The predominantly black plumage colour was, however, not preferred as indicated by negative and significant coefficient. As this trait is mainly of cultural importance, the explanation may be the fact that farmers in the area use poultry for ceremonial purpose during various festive periods where plumage colour plays important role. Consequently, chicken with white plumage colour is preferred during most holidays (example, for New Year), and chicken with predominantly black plumage colour is generally believed to cause misfortune. This result is consistent with a previous study that analyzed preference for chicken traits in Africa (Faustin et al., 2010).

The trait 'egg per clutch' had a positive mean parameter indicating farmers' preference for hens that lay larger numbers of egg per clutch, which is not unexpected. Likewise, large body size, good mothering ability, and good meat and egg taste had positive coefficients and were significant indicating preference for these traits. Chicken that were characterised by poor mothering ability and small body size were not preferred, as indicated by negative and significant coefficients of the respective traits. The result also revealed that farmers prefer chicken with good disease resistance, as indicated by the positive and significant coefficient. Mothering ability, disease resistance and meat and egg taste were typical attributes of indigenous breeds of poultry which previous attempts to enhance productivity of village poultry sector, through distribution of exotic chicken, in Ethiopia have failed to consider.

Table 3.3 Random parameter logit model results using simulated likelihood estimation

Variable	Coefficient	Standard Error
Random parameters in utility functions		
Predominantly black plumage colour	-0. 214***	0. 077
Predominantly white plumage colour	0. 422***	0. 126
Egg per clutch	0. 122***	0. 022
Small body size	-0. 528***	0. 093
Large body size	0. 219***	0. 069
Good meat and egg taste	0. 254**	0. 108
Disease resistance	0. 279**	0. 129
Non-random parameters in utility functions		
Poor mothering ability	-1.444***	0. 127
Good mothering ability	1.004***	0. 106
Price	-0. 013***	0.005
Constant	-2.380***	0. 431
Heterogeneity in mean parameters		
Predominantly white *Orthodox	-0. 434***	0. 138
Meat and egg taste * Education	0. 064*	0. 038
Disease resistance * Age	0. 006**	0.003
Standard deviation of random parameters		
Predominantly black plumage colour	0. 047	0. 312
Predominantly white plumage colour	0. 941***	0. 279
Small body size	0.001	0. 293
Large body size	1.374***	0. 204
Good meat and egg taste	0. 027	0. 232
Disease resistance	0. 138	0. 564
Number of respondents	450	
Number of observations	2,700	
Number of Halton draws(R)	200	
Log likelihood function	-1681.689	
Restricted log likelihood	-2966.253	
$x^2(df = 21)$	2569.127	
McFadden Pseudo R-square	0.433	

The magnitudes of parameter estimates reveals that good mothering ability, the ability to hatch and look after the optimum proportion of eggs set for hatching, are the most important traits in chicken profile choice among rural farmers, while eggs per clutch was the least. This finding is interestingly contrary to the previous efforts by the government to enhance village poultry productivity by introducing improved poultry breeds which mainly specialize in egg laying. This is likely due to the lack of market for eggs and poor linkage to urban markets in these areas. Hence, farmers in rural Ethiopia keep poultry primarily for local sale of live birds targeting various national and religious festive periods (New Year, Christmas, and Easter). Under the prevailing production system farmers completely rely on mother hens to incubate and hatch eggs, in contrast to the situation for commercial poultry farms. Therefore, farmers are rational in their choice given prevailing production system and poor market for egg in rural Ethiopia. The weight attached to mothering ability which is an important trait of the indigenous chicken, may imply farmers' interest in preserving the local genetic pool, though the risk of losing this genetic resource is always there due to poorly planned interventions.

Disease resistance was also found to be very important, second only to white plumage colour. Previous studies on preference for traits of chicken and other livestock species similarly report the importance of disease resistance (see Faustin et al., 2010; Kassie et al., 2009; Ouma et al., 2007). The importance of the trait 'disease resistance' may be a consequence of the economic importance of poultry diseases in rural Ethiopia and lack of poultry health services. The magnitude of the parameter for white plumage colour indicates that the cultural significance of plumage colour which is even more important than trait of productive importance. Guèye (2000) also reported that white feathered chickens are in great demand for use in medical cures in Somalia, in the Mandara tribe of north Cameroon and in Zambia. Meat and egg taste was also identified as a very important influential trait in chicken profile choice – again more so than the productive traits (egg per clutch and body weight). Guèye (2000), from review of studies in Senegal and Nigeria, also reported that eggs and chicken meat from indigenous stocks are preferred by African consumers to those derived from commercial flocks of imported stocks.

Preference heterogeneity was examined based on the mean and standard deviations of the random parameters and mean coefficients of the interaction terms. Random parameters in the model were interacted with socio-economic variables (Table 3.2) to investigate the possible sources of heterogeneity around the mean. Although all possible interactions were tried in preliminary estimation, only significant ones were used in the final model estimation by eliminating insignificant once progressively and the results are reported in Table 3.3. Statistically significant estimates for derived standard deviations for random parameters in the final model suggest existence of heterogeneity in the parameter estimates over the sample population. The estimated means and standard deviations of each of the random taste parameters gives information about the share of the population that places positive values or negative values on the respective attributes or attribute levels (Train, 2003). In our estimation result, the standard deviation of ‘predominantly white plumage colour’ was statistically significant with mean parameter of 0.422 and standard deviation of 0.941, such that 67% of respondents preferred chicken profiles with predominantly white plumage colour while 33% of the respondents preferred chickens with predominantly red plumage colour. Large body size was also significant with mean 0.219 and standard deviation 1.374; hence 57% of the respondents preferred chicken profile with large body size.

Chicken with predominantly white plumage colour was not preferred by followers of Orthodox religion. This could be due to the cultural significance of chicken with predominantly red plumage colour (the base attribute level) during various festive seasons among respondents with Orthodox religious background. Parameter estimate for interaction variable between ‘good meat and egg taste’ and ‘education level’ is positive and significant. This implies as education level increases, preference for chicken with ‘good meat and egg taste’ increases. One possible explanation for this finding may be that more educated farmers may better recognise the good meat and egg taste of local chicken and want to keep chicken with this trait. The model also revealed that, as respondent age increases, preference for diseases resistant chicken increases. Animal health services in rural Ethiopia are very limited and older farmers may not have had experience of poultry health service use, or recognise the limitations of this service and may therefore place greater value on disease resistant chicken, adapted to the local environment.

3.3.3 Willingness to pay estimates for chicken traits

Welfare estimates, willingness to pay (WTP) and willingness to accept, represent the marginal rate of substitution between prices and traits levels of the chicken profiles used in the DCE. The absolute magnitudes of WTP needs to be interpreted carefully due to the volatility of chicken prices based on different seasons of the year, as price increases following festive periods or price fall following the wet season when diseases outbreak is highly likely. In this study, therefore, marginal WTP for changes in an attribute provides a measure of the relative importance that respondents attach to attributes within the chicken profiles. Marginal WTP estimates from RPL model result, together with their confidence intervals, are presented in Table 3.4.

Table 3.4 Willingness to pay estimates for traits of chicken in ETB[a]

Traits	Marginal WTP	Confidence interval (95%)	
		Minimum	Maximum
Predominantly black plumage colour	-12.10	-23.13	-1.07
Predominantly white plumage colour	25.61	4.63	46.60
Egg per clutch	6.91	2.43	11.40
Small body size	-29.23	-48.22	-10.23
Large body size	12.37	2.70	22.05
Good meat and egg taste	14.33	0.15	28.51
Diseases resistance	15.50	-0.42	31.41
Poor mothering ability	-81.48	-124.92	-38.04
Good mothering ability	56.56	27.10	86.01

[a] ETB is Ethiopian Birr , USD$1 ≈ 18.5 ETB during the survey year.

Estimates of the willingness to pay for trait parameters indicated that chicken with good mothering ability provided a welfare gain of ETB 57, and the welfare loss from chicken with poor mothering ability was about ETB 82. This finding is consistent with Faustin et al. (2010), who found that the chicken trait of mothering ability was highest valued trait followed by disease resistance, in Benin. A more striking result from WTP estimates is the value attached to plumage colour, a trait that is of socio-cultural importance. Chicken with predominantly white plumage colour was valued at ETB 26, more than chicken with predominantly red plumage colour. Predominantly black plumage coloured chicken, however, was valued ETB 12 lower than predominantly red chicken. Despite variation in magnitude, this finding supports findings in other African countries (see Faustin et al., 2010) and signifies the cultural roles of poultry. Cattle trait valuation studies also find that black-coated animals attract a negative premium, as black-coated animals are considered susceptible to trypanosomosis (see, for example, Kassie et al., 2011). Disease resistance is another chicken trait highly valued by the sample population and valued at ETB 16 higher than susceptible chicken. This finding is consistent with valuation studies in chicken and other livestock species in developing countries (see Faustin et al., 2010; Kassie et al., 2009; Ouma et al., 2007). On the basis of marginal WTP estimates, farmers' preference for traits of chicken for prioritization can generally be put in an order as; good mothering ability, white plumage colour, diseases resistance, good meat and egg taste, large body size and larger number of eggs per clutch.

3.4 Conclusion

This study analysed preferences for indigenous poultry traits elicited using discrete choice experiment. Random parameters logit model that caters for observed and unobserved heterogeneities in preference for traits was used to estimate the taste parameters. The results of the study revealed that in this semi-subsistent farming system, where chicken are kept for multiple purposes under low/no input, adaptive traits are of considerable importance to farmers. Traits related to socio-cultural purposes of poultry production were particularly preferred and had values exceeding traits of production performance; i.e., egg production performance and body size. A more interesting result was the finding that adaptive traits and traits of mothering ability, measured by ability to hatch optimum proportion of incubated eggs and looking after chicks, were ranked above traits of egg production performance of chicken. This was likely due to the fact that poultry keeping in rural Ethiopia is semi-subsistence oriented and farmers have limited access to markets and hence place less value on egg production. This finding is contrary to Ethiopian government's ongoing efforts to enhance productivity of village poultry by introducing commercial and specialized egg layer improved chicken. This effort is likely to be driven by traditional economic analysis that focuses on egg and meat production with little or no attention to the adaptive and socio-cultural importance of chicken. This suggests the need to revisit the national strategy to enhance village productivity and rural livelihood. Interestingly, meat and egg taste, a typical attribute of indigenous chicken, was also among the highly preferred and valued traits of chicken. This is an incentive for farmers to keep indigenous chicken and an opportunity to preserve local genetic pool at farm level.

The findings also revealed the existence of heterogeneity in preferences for the attributes considered in this study. Farmers' religious background was found to be a source of preference heterogeneity. Chicken with predominantly white plumage colour were not preferred by followers of the Ethiopian Orthodox Christianity, reflecting the socio-cultural significance of chicken with predominantly red plumage colour. Disease resistant chicken were preferred by older respondents and this could be because older farmers have more risk aversive behaviour and lack access to animal health services. Similarly, farmers with higher education level preferred chicken profile with good meat and egg taste.

This research identified the most preferred and valued traits of chicken to smallholder farmers. These findings give important insight into the reasons for the unsuccessful adoption of improved chicken, despite long term effort made by government to introduce such birds, mainly aimed at enhancing egg production in rural Ethiopia. These results also have important implications for the need to better understand smallholder farmers' preferences, as they have multiple production objectives in the prevailing production and marketing system. Hence, an effective and sustainable breeding programme that aims to improve rural livelihood through enhancing village poultry productivity needs to maintain traits of chicken important to smallholder farmers. Specifically, traits of chicken like mothering ability, disease resistance, plumage colour, meat and egg taste, and body size should be prioritized in effective chicken breeding programmes. On the other hand, the risk of loss of the indigenous chicken genetic pool necessitates a conservation programme to preserve socio-culturally and economically important genetic resources. Therefore, for a successful and effective breeding and conservation programme, these identified traits of chicken need to be maintained.

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References

Adamowicz, W., Boxall, P., Williams, M., Louviere, J., 1998. Stated preference approaches for measuring passive use values: choice experiments and contingent valuation. American journal of agricultural economics 80, 64-75.

Aklilu, H.A., Almekinders, C.J., Udo, H.M., Van der Zijpp, A.J., 2007. Village poultry consumption and marketing in relation to gender, religious festivals and market access. Tropical animal health and production 39, 165-177.

Anderson, S., 2003. Animal genetic resources and sustainable livelihoods. Ecological Economics 45, 331-339.

Bateman, I.J., Carson, R.T., Day, B., Hanemann, M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Özdemiroḡlu, E., Pearce, D.W., Sugden, R., Swanson, J., 2002. Economic valuation with stated preference techniques: a manual. Edward Elgar Publishing Ltd Cheltenham, UK.

Bennett, R.M., Willis, K.G., 2008. Public values for badgers, bovine TB reduction and management strategies. Journal of Environmental Planning and Management 51, 511-523.

Birol, E., Smale, M., Gyovai, Á., 2006. Using a Choice Experiment to Estimate Farmers' Valuation of Agrobiodiversity on Hungarian Small Farms. Environmental and Resource Economics 34, 439-469.

Campbell, D., 2007. Willingness to Pay for Rural Landscape Improvements: Combining Mixed Logit and Random-Effects Models. Journal of Agricultural Economics 58, 467-483.
CSA, 2013. Agricultural sapmle survey: Report on livestock and livestock characterstics. Central statistical agency, Addis Ababa, Ethiopia.

Dana, N., van der Waaij, L.H., Dessie, T., van Arendonk, J.A., 2010. Production objectives and trait preferences of village poultry producers of Ethiopia: implications for designing breeding schemes utilizing indigenous chicken genetic resources. Tropical animal health and production 42, 1519-1529.

Drake, L., 1992. The non-market value of the Swedish agricultural landscape. European Review of Agricultural Economics 19, 351-364.

Drucker, A.G., Anderson, S., 2004. Economic analysis of animal genetic resources and the use of rural appraisal methods: lessons from Southeast Mexico. International Journal of Agricultural Sustainability 2, 77-97.

FAO, 2010. Chicken genetic resources used in smallholder production systems and opportunities for their development, in: Sørensen, P. (Ed.), Smallholder Poultry Production Paper 5. Food and Agricultural Organization of the United Nations, Rome.

Faustin, V., Adégbidi, A.A., Garnett, S.T., Koudandé, D.O., Agbo, V., Zander, K.K., 2010. Peace, health or fortune?: Preferences for chicken traits in rural Benin. Ecological Economics 69, 1848-1857.

Guèye, E., 1998. Poultry plays an important role in African village life. World Poultry 14, 14-17.

Guèye, E., 2000. The role of family poultry in poverty alleviation, food security and the promotion of gender equality in rural Africa. Outlook on Agriculture 29, 129-136.

Halima, H., Neser, F.W.C., Marle-Koster, E., Kock, A., 2007. Village-based indigenous chicken production system in north-west Ethiopia. Tropical animal health and production 39, 189-197.

Hanemann, W.M., 1984. Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses. American Journal of Agricultural Economics 66, 332-341.

Hanley, N., Wright, R., Adamowicz, V., 1998. Using Choice Experiments to Value the Environment. Environmental and Resource Economics 11, 413-428.

Hensher, D.A., Rose, J.M., Greene, W.H., 2005. Applied choice analysis: a primer. Cambridge University Press.

Hensher, D.A., Truong, T.P., 1984. valuation of travel time savings from direct experimental approach. Journal of Transport Economics and Policy 19, 237-261

Horst, P., 1988. Native fowl as reservoir for genomes and major genes with direct and indirect effects on production adaptability, Conference on 18th World Poultry Congress, 4–9, Nagoya, Japan.

Kassie, G., Abdulai, A., Wollny, C., 2011. Heteroscedastic Hedonic Price Model for Cattle in the Rural Markets of Central Ethiopia. Applied Economics 43, 3459-3464.

Kassie, G.T., Abdulai, A., Wollny, C., 2009. Valuing Traits of Indigenous Cows in Central Ethiopia. Journal of Agricultural Economics 60, 386-401.

Kuhfeld, W.F., 2010. Marketing research methods in SAS, Experimental Design, Choice, Conjoint, and Graphical Techniques. Cary, NC, SAS-Institute TS-722. Available at http://support.sas.com/techsup/technote/mr2010.pdf.

Lancaster, K.J., 1966. A new approach to consumer theory. The journal of political economy 74, 132-157.

Loureiro, M.L., Umberger, W.J., 2007. A choice experiment model for beef: What US consumer responses tell us about relative preferences for food safety, country-of-origin labeling and traceability. Food Policy 32, 496-514.

Louviere, J.J., Woodworth, G., 1983. Design and analysis of simulated consumer choice or allocation experiments: an approach based on aggregate data. Journal of marketing research, 350-367.

Luce, D., 1959. Individual Choice Behaviour. John Wiley, New York

McFadden, D., 1974. Conditional Logit Analysis of Qualitative Choice Behaviour, in: Zarembka, P. (Ed.), Frontiers in Econometrics. New York: Academic Pres.

McFadden, D., Train, K., 2000. Mixed MNL models for discrete response. Journal of applied Econometrics 15, 447-470.

Otieno, D.J., Ruto, E., Hubbard, L., 2011. Cattle Farmers' Preferences for Disease-Free Zones in Kenya: An application of the Choice Experiment Method. Journal of Agricultural Economics 62, 207-224.

Ouma, E., Abdulai, A., Drucker, A., 2007. Measuring heterogeneous preferences for cattle traits among cattle-keeping households in East Africa. American Journal of Agricultural Economics 89, 1005-1019.

Rege, J., 1999. Economic Valuation of Animal Genetic Resources: Proceedings of an FAO/ILRI Workshop: Held at FAO Headquarters, Rome, Italy 15-17 March 1999. Full text by ILRI.

Rege, J., Gibson, J., 2003. Animal genetic resources and economic development: issues in relation to economic valuation. Ecological Economics 45, 319-330.

Revelt, D., Train, K., 1998. Mixed logit with repeated choices: households' choices of appliance efficiency level. Review of economics and statistics 80, 647-657.

Roosen, J., Fadlaoui, A., Bertaglia, M., 2005. Economic evaluation for conservation of farm animal genetic resources. Journal of Animal Breeding and Genetics 122, 217-228.

Rose, J.M., Bliemer, M.C., 2004. The design of stated choice experiments: The state of practice and future challenges. Institute of Transport Studies Working Paper.

Ruto, E., Garrod, G., Scarpa, R., 2008. Valuing animal genetic resources: a choice modeling application to indigenous cattle in Kenya. Agricultural Economics 38, 89-98.

Scarpa, R., Drucker, A.G., Anderson, S., Ferraes-Ehuan, N., Gómez, V., Risopatrón, C.R., Rubio-Leonel, O., 2003a. Valuing genetic resources in peasant economies: the case of 'hairless' creole pigs in Yucatan. Ecological Economics 45, 427-443.

Scarpa, R., Ruto, E.S.K., Kristjanson, P., Radeny, M., Drucker, A.G., Rege, J.E.O., 2003b. Valuing indigenous cattle breeds in Kenya: an empirical comparison of stated and revealed preference value estimates. Ecological Economics 45, 409-426.

Scarpa, R., Thiene, M., Train, K., 2008. Utility in Willingness to Pay Space: A Tool to Address Confounding Random Scale Effects in Destination Choice to the Alps. American Journal of Agricultural Economics 90, 994-1010.

Sy, H.A., Faminow, M.D., Johnson, G.V., Crow, G., 1997. Estimating the values of cattle characteristics using an ordered probit model. American Journal of Agricultural Economics 79, 463-476.

Tano, K., Kamuanga, M., Faminow, M.D., Swallow, B., 2003. Using conjoint analysis to estimate farmer's preferences for cattle traits in West Africa. Ecological Economics 45, 393-407.

Teklewold, H., Dadi, L., Yami, A., Dana, N., 2006. Determinants of adoption of poultry technology: a double-hurdle approach. Livestock Research for Rural Development 18(3) available at http://www.lrrd.cipav.org.co/lrrd18/3/tekl18040.htm

Tonsor, G.T., Schroeder, T.C., Fox, J.A., Biere, A., 2005. European Preferences for Beef Steak Attributes. Western Agricultural Economics Association - WAEA.
Train, K., 2003. Discrete Choice Methods with Simulation. Cambridge University Press, Cambridge.

Wilson, R., 2010. Poultry production and performance in the Federal Democratic Republic of Ethiopia. World's Poultry Science Journal 66, 441.

Chapter 4

Farmers’ willingness to pay for village poultry vaccine service in Ethiopia: prospect to enhance rural livelihood

Abstract

This research examines farmers' willingness to pay for village poultry vaccine programme using data from 400 household heads from two districts of Ethiopia. The study applied contingent valuation method to elicit farmers' willingness to pay for village poultry vaccine services. Two hypothetical vaccine programmes were designed for Newcastle disease and Gumboro disease. Both parametric and non-parametric approaches were employed in data analysis. The results show that farmers recognise the benefits of the vaccine programme and that many would be willing to pay for it. Results from non-parametric estimates produced households' mean willingness to pay of Ethiopian Birr (ETB) 80 up to ETB 87 per year based on vaccine programme type. This implies the potential and prospect to reduce impact of infectious poultry diseases and enhance rural livelihood through village poultry. The result from exponential probit reveals that farmers' willingness to pay for village poultry vaccine service is influenced by age, education level, and region of respondents. Our results suggest that younger and better-educated farmers and farmers from Horro district are more likely to pay for village poultry vaccine services.

Key words: willingness to pay; poultry; vaccine; Newcastle and Gumboro disease

4.1 Introduction

In many developing countries, livestock in mixed crop-livestock farming systems are of crucial importance to both household and national economies. Family poultry constitute an important component of the agricultural and household economy in the developing world (Gueye 2002). Rural poultry production is an important agricultural activity in almost all developing communities in Africa, providing animal protein in the form of meat and eggs, as well as being a reliable source of petty cash. In Ethiopia, village chickens provide major opportunities for increased protein supply and income for smallholders (Aklilu et al. 2007; Halima et al. 2007) because they require low capital investment, have a short generation interval and a high rate of reproduction. However, the village poultry production system in Ethiopia is characterised by small flock sizes, low input and output and is substantially impacted by disease.

Whether the livestock sector attains its full productive potential is heavily influenced by the availability and quality of animal health services. Poor health in animal herds and flocks, however, constrains livestock development in many countries (Umali et al. 1994). Infectious and parasitic diseases affecting livestock remain important constraints to profitable livestock operations in many developing regions (Delgado et al. 1999). This adversely affects animal welfare and often has major impacts upon human health and public perception of livestock production. The costs of existing endemic diseases are estimated to be 35% to 50% of the turnover of livestock in the developing world (Whitelaw and Sang 2005). In Ethiopia, poultry diseases are considered to be the most important factor responsible for reducing both the number and productivity of chickens. In the year 2010/11 alone, some 42.3 million poultry died of diseases and other causes according to agricultural sample survey on livestock and livestock characteristics (CSA 2011). There has been neither a policy to control village poultry diseases nor adequate information available to policy makers, despite continued high prevalence and severe impact of infectious diseases among village chicken populations in the country.

Studies indicate that poultry diseases such as Newcastle disease, Infectious bursal disease, and coccidiosis are endemic in village poultry and believed to cause huge economic losses to village poultry keepers in rural Ethiopia (Dessie and Ogle 2001; Gari et al. 2008). Findings from recent studies suggest that Newcastle disease and IBD are widespread in rural Ethiopia (Degefu et al. 2010; Jenbreie et al. 2012; Zeleke et al. 2005) and hence these diseases, both of which are known to cause high mortalities, are important bottlenecks to village poultry development. Well-tested vaccines exist that can be used as a preventive measure in less than optimal field conditions, and applied even without injection, and they enable individual farmers to protect their flocks (McLeod and Rushton 2007). Studies on application of vaccines in village poultry in developing countries also show possibility to effectively control Newcastle disease (see Msoffe et al. 2010; Wambura et al. 2000; Copland and Alders 2005).

The National Veterinary Institute of Ethiopia produces a variety of vaccines for poultry diseases. However, village poultry producers have no/limited access to these vaccines, despite their efficacy in reducing chicken mortality (see Copland and Alders 2005). Despite the potential marketability of these vaccine services, they are yet to be marketed in the country. Contingent valuation method (CVM) is a widely used stated preference approach to value non-market goods (Mitchell and Carson 1989). It is widely applied in areas of environmental economics (Hanemann 1984; Loomis et al. 2000). It is also applied in other areas of research, such as development economics and health economics (Johannesson et al. 1991; Merrett 2002). Valuation methods are increasingly being applied in livestock research for valuation of indigenous livestock breed traits and disease resistance (Kassie et al. 2009; Ouma et al. 2007; Scarpa et al. 2003a); however, application of valuation techniques to evaluate willingness to pay for livestock vaccines and related services to inform disease control policy is quite limited. A study by Swallow and Woudyalew (1994) which estimates WTP for tsetse fly control in Ethiopia using CVM is among the few valuation studies employed in livestock disease control. A more recent work is that of Bennett and Balcombe (2012) who used both CVM and choice experiment to assess cattle farmers' WTP for a bovine tuberculosis cattle vaccine in England and Wales.

Provision of animal health service, at least at recovery cost, is indispensable for sustainability of intervention. Community participation, by devoting their financial and time resource, is crucial for success and sustainability of such projects. In this study, therefore, we are interested in evaluating smallholders' interest and willingness to pay (WTP) for periodic vaccination of village poultry. Both parametric and non-parametric approaches were used to evaluate farmers' willingness to pay using data collected through contingent valuation survey. This study aims to contribute to the body of knowledge in the area of livestock disease control policy under a low-input-low output production system by employing a stated preference valuation method to estimate WTP for vaccine services. Therefore, this study gives important insight in an effort to reduce impacts of infectious diseases in village poultry production system across developing countries.

4.2 Materials and methods

4.2.1 The contingent valuation method and designing process

Contingent valuation method is a survey-based technique for eliciting preferences for non-marketed goods in a form which allows one to estimate how survey respondents trade-off private consumption for a non-marketed good in monetary terms (Carson 1998). A vaccination service might be deemed to be a private good and potentially marketable. In the context of the Ethiopian livestock health service system, however, vaccination of village poultry has never been tried and it is not part of veterinary services provided by the government. Umali et al. (1994) also noted that many animal health inputs are neither purely private nor purely public. The use of vaccines and veterinary pharmaceuticals involves externalities. Vaccination programmes are private goods whose consumption produces externalities. Vaccinations protect animals from disease and the farmer who owns the vaccinated animal(s) is the sole beneficiary of the procedure where no one else is able to benefit from the service during that time. The externality arises because the procedure may reduce the risk of exposure of other animals (and humans in the case of zoonoses) to the disease. In village poultry production system where chickens from different households scavenge together, externality and spill-over effects are obvious. Therefore, village poultry vaccination involves (positive) externality and the vaccine is a new product yet to be marketed. CVM is widely used in economic valuation of non-marketed goods as it uses choice and consumer preference as its underlying logic of valuation.

CVM is used in wider areas of disciplines in developed countries and it has also been applied in developing countries mainly to elicit individuals' preferences for the basic infrastructural projects such as water supply and sanitation (e.g. Merrett 2002; Whittington et al. 1990). Despite the wider use of CVM, there is concern regarding reliability and validity of the responses. According to Carson et al. (1996), however, the majority of WTP estimates for use values based on CVM pass the test of the validity involving comparisons of values derived from actual behaviour methods. Brouwer et al. (2008) in their study on economic valuation of flood risk exposure and flood control in developing countries also carried out a test-retest six months after the original survey showed that the stated WTP values are reliable.

Selection of elicitation format is one of the contentious aspects of CVM. While dichotomous-choice is likely the most favoured format, open-ended, multiple-bounded and payment card are also possible elicitation techniques. In addition to being less realistic and harder to answer, the open-ended format creates incentives which are different from those in the closed-ended format. With the open-ended format there are strategic reasons for stating less than one's full value which is not the case in closed-ended format (Hanemann 1994). Close-ended valuation question is typically desirable to valuing hypothetical public good (Arrow and Solow 1993; Hanemann 1984; Mitchell and Carson 1989). Therefore, we used a close-ended elicitation framed as a dichotomous choice. In order to make the contingent valuation questionnaire more reliable, 'don't know' responses option was included in addition to 'Yes/No'. The close-ended elicitation question was followed by debriefing question to check respondents' understanding and acceptance of the aspects of the scenarios presented to them. The wordings (in English) of the scenarios read to the respondents are given in the Appendix. These were read to the respondents in Afan Oromo, a language spoken in both study areas.

For contingent valuation to work, the non-marketed good must be well defined, the scenario must provide a plausible means of provision, and there must exists a plausible mechanism for making the trade-off between the consumption of private goods and the non-marketed good of interest (Carson 1998). Similarly, Hanemann (1994) addressed areas[4] including sampling, instrument development, formulation of the valuation scenario, questionnaire structure, and data analysis to enhance the credibility of a survey and make it more likely to produce reliable results. In this study the design of contingent valuation process involved a number of steps to ensure that the hypothetical scenario we developed

[4] See Hanemann (1994) for good summary of all these aspects.

were understandable and meaningful from smallholder farmers' perspective, workable in the existing production system and able to produce reliable willingness to pay estimate.

Prior to formally designing the scenarios, an interdisciplinary project team conducted two focus group discussions in January 2011 in each of the two districts to explore the village poultry production system and existing animal health services and to see how farmers understand and respond to scenarios. The focus groups consisted of 15-20 farmers in each village. Findings of these group discussions were used to further develop the scenario and describe the programme. The interdisciplinary team (consisting of epidemiologists, microbiologists, poultry breeders and geneticists, and economists) worked together to develop improved contingent valuation scenarios in consultation with local Livestock Agency experts. The National Veterinary Institute was also consulted on the country's capacity to produce the vaccines that were included in the programme. The vaccine products we considered in the programme included Newcastle diseases vaccine (thermo-stable) and Gumboro vaccine. The vaccine programme was designed for these two diseases based on prevalence rate in village poultry in the country. We relied on past studies (see Zeleke et al. 2005; Degefu et al. 2010; Jenbreie et al. 2012) and field observation by animal health experts to identify these prevalent and important infectious diseases in the village poultry. Two scenarios were designed: one scenario was designed to deliver the vaccination service through village animal health extension workers, whereas the other scenario included training of farmers to vaccinate their birds themselves. Considering the village poultry production system, periodic outbreak of diseases and to attain optimum control of the diseases, both scenarios were designed to deliver vaccine services three times a year. Detailed descriptions of the two scenarios were finally developed for pre-test.

The final draft scenarios were pre-tested on individual farmers in February 2011. Further changes were made mainly on sequence of the scenarios and other parts of the questionnaire. The questionnaire was arranged in three sections and the two scenarios were presented to respondents in random order. The first section contained a statement of consent for the respondent and some warm-up questions to elicit demographic data of the respondent and information regarding the respondent's knowledge about poultry heath and health services. The second section contains the two contingent valuation scenarios and related questions. In this section, four different bid levels, the proposed price for the vaccine service scenario, were filled in each of the two scenarios. The bid levels used in scenario one were Ethiopia Birr[5] (ETB) 65, 95, 125, and 155 and for the second scenario the bid levels were ETB 55, 85, 110, and 135. These Bid amounts were chosen based on results from the focus group discussion, pilot survey and in consultation with the National Veterinary Institute on vaccine cost data. The third section recorded respondents' general socioeconomic data.

4.2.3 Theoretical framework

Farmers' decision process is modelled using a random utility framework following Hanemann (1984) and Haab and McConnell (2003). In our contingent valuation (CV) scenarios we have two choices, either to accept the vaccine program or no, so that indirect utility for respondent j can be represented as;

$$u_{ij} = u_i(y_j, \boldsymbol{z}_j, e_{ij}) \qquad (1)$$

Where subscript $i = 0$ denotes the choice to use *status quo* production system where vaccine is not used and the subscript $i = 1$ denotes the decision to use poultry vaccine technology. The determinants of utility are y_j, the j^{th} respondent's income, $\boldsymbol{z}_j$, an *m*-dimensional vector of household characteristics and attribute of choice, and e_{ij}, a component of preference known to the individual respondent but not observable by the researcher. The utility function is written with only the subscript i and the random component of preferences change. A quality attribute, q^i, can be used as indicator to the change in utility. Then *status quo* utility would be: $u_{0j} = u_i(y_j, \boldsymbol{z}_j, q^0, e_{ij})$ and the utility for the with vaccination scenario would be: $u_{1j} = u_i(y_j, \boldsymbol{z}_j, q^1, e_{ij})$.

Based on this model, consumer j answers yes to the c_j required payment which will make utility at least as great as it would be without using poultry vaccine. Mathematically, this can be represented as:

$$u_0(y_j, \boldsymbol{z}_j, e_{0j}) \leq u_1(y_j - c_j, \boldsymbol{z}_j, e_{1j}) \qquad (2)$$

[5] Birr is the currency of Ethiopia; 1 USD ≈ 17 ETB during survey period

We can only make a probability statement about the ‘Yes’ and ‘No’ as the random component of preferences are not observable. The probability that of a yes response is the probability that the respondent thinks that he/she is better off in using the vaccine technology with the required payment. This probability is

$$P(yes) = \Pr(u_0(y_j, \boldsymbol{z}_j, e_{0j})) \leq \mathrm{P}(u_1(y_j - c_j, \boldsymbol{z}_j, e_{1j})) \qquad (3)$$

With this theoretical framework and probability statement, we can specify an empirical model that we could fit for the type of elicitation format we employed for this study.

4.2.4 Statistical model

A number of statistical procedures are available to model single bounded discrete response contingent valuation. Parametric models are the most commonly used statistical tools. The use of a parametric distribution to approximate the distribution of WTP in a sample represents a fairly large assumption (Bateman et al. 2002). When the pattern of responses is well behaved (i.e. change in line with demand theory), the estimates of willingness to pay (WTP) will not be sensitive to the choice of distributional assumptions for the unobserved random component of preference or functional form of the preference function (Haab and McConnell 2002). Indeed, it has been shown that some statistics, the means in particular, are quite sensitive to the particular distributional assumptions made by the analyst. When the objective is to estimate the mean and median values of the WTP distribution, the analyst can turn to an alternative estimation framework, a non-parametric estimation (Bateman et al. 2002).

When samples are sufficiently large to minimise random error, the proportion of observed ‘No’ responses to each bid should increase as the offered price increases. However, this assumes that responses are in line with demand theory, and hence in practice this is not guaranteed and non-monotonic empirical distribution functions for some of the offered prices are often observed. Randomness in response often leads to non-monotonic distribution of ‘No’ response. One of the available options in this case is to impose a monotonicity restriction on distribution-free estimators and apply the Turnbull distribution free estimator (Haab and McConnell 2002). As can be seen in the next section, the responses to the discrete response to contingent valuation in our data had a similar problem and we applied this method as a remedy. We present the derivation of Turnbull estimator following Haab and McConnell (1997).

Respondents are asked to pay c_j amount of money where $j = 0, 1, \dots M$ and $c_0 = 0$; $c_j > c_k$. Let p_j be the probability that the respondent's willingness to pay (WTP) is in the interval c_{j-1} to c_j. This can be expressed as $p_j = p(c_{j-1} < WTP \leq c_j)$ for $j = 1, \dots M + 1$. It is assumed that $c_{M+1} = \infty$. The cumulative distribution function is written as: $F_j = p(WTP \leq c_j)$ for $j = 1, \dots M + 1$, where $F_{m+1} = 1$. Then $p_j = F_j - F_{j-1}$ and $F_0 = 0$. Here p_j can be considered as the response to price increase and they should be positive because a higher proportion of respondents should answer 'No' at a higher price.

The log-likelihood function in terms of the probability mass point $(p_1, p_2, \dots p_M, p_{M+1})$ is

$$\mathrm{L}(p|\, Y, N, T) = \sum_{j=1}^{M} \left[N_j \, ln \left(\sum_{i=1}^{j} p_k \right) + Y_j ln \left(1 - \sum_{i=1}^{j} p_k \right) \right] \tag{4}$$

Where N_j = number of respondents who respond 'No' to c_j and Y_j= number of respondents who respond 'Yes' to c_j.

This equation constrains the sum of p_j to one. However, $p_j$must be non negative and fall within the unit interval to constitute a valid density function. The first order condition for the problem, (4), takes the form

$$\partial L / \partial p_i = \sum_{j=i}^{m} \left(N_j / \sum_{k=1}^{j} p_k - Y_j / (1 - \sum_{k=1}^{j} p_k) \right) \leq 0 \,, \qquad p_i \geq 0 \,, \qquad p_i ln \, \partial L / \partial p_i = 0$$

To find the solution to the likelihood maximization problem, the set of first-order conditions must be solved recursively. By construction, the maximum likelihood problem ensures that $p_1 > 0$ so long as $N_1 \neq 0$. Therefore, the first order condition for p_1 hold with equality so long as at least one respondent responded 'No' to c_1 . With this assumption, solve for p_1 by assuming for the moment that $p_1 \neq 0$. The first two first order conditions now hold with equality and can be differenced. The Turnbull estimator treats each group of individual offered the same bid as a series of independent Bernoulli trials.

The probability that willingness to pay falls below the bid amount, when proportion of 'No' response to c_i is greater than proportion of 'No' response to c_{i-1}, is the binomial probability given as;

$$F_j = N_j/(N_j + Y_j) \qquad (5)$$

When proportion of 'No' response to c_{i-1} is greater than proportion of 'No' response to c_i, the unconstrained maximum likelihood estimate for p_j will be negative. We need to impose a non-negativity constraint and the Kuhn-Tucker solution to the problem of a binding non negativity constraint for p_j is to combine j^{th} and $(j-1)^{th}$ cells. Then, defining $N_j^* = N_j + N_{j-1}$ and $Y_j^* = Y_j + Y_{j-1}$, P_j could be estimated as;

$$P_j = N_j^*/(N_j^* + Y_j^*) - \sum_{k=1}^{j-2} p_k \qquad (6)$$

If P_j is still negative, then this process is repeated until a position P_j is nonnegative. This pooled adjacent violator algorithm (PAVA[6]) technique was used to obtain cumulative density function (CDF) and probability density function (PDF) to calculate distribution free lower bound willingness to pay.

The variance of the P_j can be calculated manually as:

$$V(P_j) = F_j(1 - F_j)/(N_j + Y_j) + F_{j-1}(1 - F_{j-1})/(N_{j-1} + Y_{j-1}) \qquad (7)$$

The central tendency measure of welfare in the Turnbull estimator is a lower bound approximation to expected willingness to pay. The conservative nature of this nonparametric approach and the ease with the estimation and welfare calculation are attractive features (Haab and McConnell 1997). The lower bound willingness to pay and its variance can be calculated from the expression,

$$E_{LB}(WTP) = \sum_{j=1}^{M} c_j * p_{j+1} \qquad (8)$$

[6] A detail of this technique and the procedure to correct potential problem of discrete choice data in mean and median WTP estimation is also given in Bateman et al., (2002).

$$V(E_{LB}(WTP)) = \sum_{j=1}^{M} V(F_j)(c_j - c_{j-1})^2 \quad (9)$$

The principal drawback to nonparametric approaches lies in the difficulty in making inferences based on parameters (Haab and McConnell 1998). In the parametric approach, on the other hand, evaluating mean WTP from different distributional assumption may give very different values. One important guideline in estimating average WTP is to use bid function rather than utility difference model (Bateman et al. 2002). According to Haab and McConnell (1998) also, one solution to problems with the random utility model is to specify choice in terms of the willingness to pay function. When unrestricted parametric estimate provide either negative or too high expected WTP, a reasonable strategy ought to be a conservative approach. A conservative approach, when there are concerns about the distribution of response data, is to calculate the sample mean using the Turnbull lower bound and then estimate an exponential willingness to pay function and calculate its median (Haab and McConnell 2002). In this study, therefore, we used Probit exponential willingness to pay function to estimate median WTP and to estimate the effect of bid prices and respondents' socioeconomic characteristics on willingness to pay. The exponential willingness to pay with linear combination of attributes and additive stochastic preference term is

$$\boldsymbol{WTP_j = \exp(\gamma z_j + \eta_j)} \quad (10)$$

Where η_j is a stochastic error with mean zero and unknown variance, σ^2. The probability that individual j responding 'Yes' for an offered bid c_j is equivalent to the probability of the random willingness to pay function is greater than the offered bid:

$$\begin{aligned} P(yes_j) &= P(WTP_j > c_j) \\ &= P(\exp(\gamma \mathbf{z}_j + \eta_j) > c_j) \\ &= P(\eta_j > \ln(c_j) - \gamma \mathbf{z}_j) \end{aligned} \quad (11)$$

Normalizing by the unknown standard errors, σ, to standardize the stochastic error the probability is

$$P(WTP_j > c_j) = P(\theta_j > \beta \ln(c_j) - \gamma^* \mathbf{z}_j) \quad (12)$$

Where $\theta_j = \eta_j/\sigma$, $\beta = 1/\sigma$ and $\gamma^* = \gamma/\sigma$.

Assuming the error term, η_j , is normally distributed with mean zero and constant variance, σ^2, a probit model can be estimated. A median willingness to pay can be obtained from estimated probit model using the expression

$$MD_\eta\left(WTP\middle|\mathbf{z}_j,\gamma\right) = exp(\gamma\mathbf{z}_j) \tag{13}$$

The exponential willingness to pay was estimated using probit regression model. The bid levels were randomly presented to respondents and the socioeconomic variables were used as covariates in the estimated model. Most of the variables used in the model are presented in Table 1. In addition to these variables, *region* of the respondent was also included in explanatory variables, with value 1 if Horro and 0 if Jarso. We included this variable to account for differences in agro-ecology and socio-culture of the two study areas. Farmers' perception of effectiveness of the proposed vaccine programme was also among the covariates used in the model. This indicates whether respondents believe the vaccine programme would protect their chicken from disease or not. This variable was a dummy variable with value 1 if respondents '*believe*' that the vaccine programme would protect their chicken from diseases and 0 otherwise.

4.2.5 The study area

This study is part of a larger project working on reducing the impact of infectious diseases on village poultry production in Ethiopia. It was conducted in Horro and Jarso districts, where mixed crop-livestock farming system is the mainstay of the community. These two districts were selected by the project considering agro-ecological characteristics of the areas and variation in poultry ecotype in the two districts. Horro is relatively humid area while Jarso is semi-arid. Horro is one of the surplus (crop) producing areas in the country while some parts of Jarso district fall under the government food safety net programme. Horro is located about 315 km west of Addis Ababa, West Ethiopia and Jarso is located about 550 km east of Addis Ababa. Livestock production is an integral part of semi-subsistent farming practice in both districts. Farmland in Horro is occupied by staple crops (wheat, *teff*, barley, beans and maize) during cropping season and in Jarso it is predominantly covered by *chat/khat* which is a main source of cash income throughout the year. *Chat (Catha edulis)* is a stimulant perennial crop grown mainly for cash income and consumption in some parts of Ethiopia. Chat growing and marketing is one of important livelihood in Jarso area. Vegetables and cereal crops like wheat, barley and sorghum are also important crops for farmers in Jarso. The population in Jarso are predominantly Muslim while the population in Horro are Christian (Ethiopian Orthodox and Protestant).

4.2.6 The survey

This study was approved by the University of Liverpool Committee on Research Ethics (reference RETH000410). A pilot household survey was conducted in Horro in February 2011 and included 19 farmers. The final survey was undertaken during the periods April to June, 2011. The survey was conducted by enumerators trained for this survey and the researchers in close supervision. The survey was administered to a total of 400 poultry keeping households randomly selected from eight '*Gandas*'[7] (as in government administration structure) which covers several villages. Thus, the total sample comprised of 200 households from each of the two districts of rural Ethiopia. A multistage sampling technique was applied to select sample households. Initially, the two districts were selected purposefully by the project considering difference in ecotype of poultry and agro-ecological and social differences between the two sites. Then four Gandas were considered from each district which gave eight Gandas from the two sites. Finally, 50 households were randomly selected from each of the eight Gandas using household lists provided by the development agents in each village. The four different bid amounts in the scenarios were randomly allocated across these respondents. The two scenarios were also presented to respondents in random order. Out of the 400 farmers surveyed for the two WTP elicitation scenarios, seven observations answered 'Don't know' to both scenarios and 17 respondents to scenario one only and 11 respondents on scenario two only answered 'Don't know'. These observations were excluded from the analysis as their responses were indeterminate. This gives us 379 useable observations from the two sites.

[7] 'Ganda' is the lowest administration unit in government administration structure. Ganda has several village centres under it.

4.3 Results and discussion

4.3.1 Sample Characteristics and WTP responses

Descriptive statistics of the socioeconomic variables for the survey respondents are presented in Table 4.1 below. The average age of survey respondents was 41 and average family size was about 6 with an average land holding of 1.3 hectare. The majority of the survey respondents (93%) were male. This was not unexpected as head of households are responsible for decisions related to finance and our survey targeted heads of the households. About 51% of the respondents had some formal education. The average number of poultry owned by survey respondents was 8 and average number of poultry lost due to diseases in a year was 6. On average, survey farmers had owned poultry for about 8 years. The Livestock asset base of the sample households measured by Tropical Livestock Unit (TLU[8]) was about six, on average.

Table 4.1 Summary statistics for socioeconomic characteristics (N=379)

Variable name	Descriptions	Mean/proportion	Standard Deviations
Gender	0 if female; 1 if male	93%	
Age	Age of the household head (years)	41.09	14.66
Family size	Number of people living with the household	6.43	2.39
Education level	0= None 1= has education	51%	
Total land size	Land size owned by the household in hectares	1.27	1.40
Poultry owned	Total number of poultry owned	8.06	7.76
Poultry lost	Total number of poultry lost in 12 months due to diseases	6.17	13.33
TLU	Tropical livestock unit using standard conversion factors	5.79	6.47

[8] TLU is a standard conversion used to convert livestock of different species and age into a single measurement unit.

We used a three-point scale rating (good, bad, and worst) to elicit respondents' perception about extent of poultry diseases problem in the area. This is presented in Table 4.2 together with data regarding farmers' access to animal health service and poultry production technical support from agricultural extension workers. The majority of the farmers perceived that the general condition of poultry disease was in either bad or worst situation. About 34% of the survey respondents perceived that the extent of rural poultry diseases problem was bad while 33% of the survey respondents believe that it was in the worst condition. Most of the survey respondents perceived that the proposed vaccine programme would be effective in controlling poultry diseases in both scenarios, scenario one (86%) and scenario two (87%). Only a limited proportion of respondents had access to poultry production extension service and about 75 %of respondents had access to animal health services, although 42% of them did not have access to a poultry health service.

Table 4.2 Farmers' access to support services and perception about problem of poultry diseases and effectiveness of the vaccine programmes

Descriptions	Respondents' perception /access to services	No.	Percent
Perception about poultry diseases in the area (N=379)	Good	122	32.2
	Bad	129	34.0
	Worst	128	33.8
Believe the vaccine programme would control poultry diseases effectively - programme 1	Yes	324	85.5
	No	55	14.5
Believe the vaccine programme would control poultry diseases effectively - programme 2	Yes	331	87.3
	No	48	12.7
Access to animal health service (N=379)	Yes	284	74.9
	No	95	25.1
Animal health clinic giving poultry curative health service (N= 284)	Yes	165	58.1
	No	119	31.4
Access to extension support on poultry production (N=379)	Yes	129	34
	No	250	66

Out of the whole sample, 64% and 70% of respondents were willing to pay for the vaccination programme in programme 1 and programme 2 respectively (Table 4.3). We speculate that this enthusiastic response from farmers could possibly be due to the severity of poultry diseases they experience, which often leads to loss of the whole flock. It may also be due to the expectation of benefits from chicken production as demand for egg and chicken is growing in pre-urban areas over the last few years. Generally, there was a negative relationship between increase in bid amount and respondents' willingness to pay for vaccine services in both scenarios (Table 4.3). For programme 1, which was designed to deliver a vaccine service by village veterinary technicians, the 'yes' response falls from 80% to 54% as bid amount increases from ETB 65 to ETB 125 and then, unexpectedly and inexplicably, it rises to 59% for bid amount of ETB 155. The negative relationship for this programme is statistically significant at the 0.01 level of confidence for this scenario. For programme 2, which was designed to deliver a vaccine service by trained farmers, 'yes' response falls from 77% to 62% as bid amount increases from ETB 55 to ETB 110 and then it similarly rises to 72% for bid amount of ETB 135. The negative relationship for this scenario is not statistically significant. A possible explanation for this unexpected result is that farmers may use higher price as a signal for better quality vaccine service.

Table 4.3 Farmers' willingness to pay responses to the two programmes

Programme 1				Programme 2			
Bid	Yes	No	Percentage(Yes)	Bid	Yes	No	Percentage(Yes)
65	75	20	78.9	55	73	22	76.8
95	61	35	63.5	85	66	30	68.8
125	50	42	54.3	110	57	35	62.0
155	57	39	59.4	135	69	27	71.9
Total	243	136	64.1		265	114	69.9
χ^2_3		13.85				5.18	
p-value		0.003				0.159	

4.3.2 Econometric result

Estimates for exponential willingness for the two vaccination programmes using STATA version 12 is presented in Table 4.4 together with their mean marginal effects. The model result is in line with demand theory and it indicates that respondents behave as a rational consumer when faced with increase in cost. The model results show that whether respondents believe the proposed vaccine programmes would effectively protect their chicken from disease or not, age, education level, and region of the respondents are important in determining their willingness to pay. The Hosmer-Lemeshow goodness-of-fit test for the model was performed. Hosmer-Lemeshow x_6^2 was 1.67(p=0.95) and 2.13 (p=0.91) for estimated models of programme 1 and programme 2, respectively, which is consistent with the models fitting reasonably well. Additionally, the corresponding likelihood-ratio tests indicate the overall significance of the coefficients in the two models.

As expected, the coefficient on 'Lbid', log of the randomly assigned price levels to respondents, is negative and statistically significant in programme 1 ($p< 0.01$). In programme 2 also the coefficient is negative and statistically significant ($p<0.1$). The negative sign denotes that the more the respondents are asked to pay, the lower the probability that respondents would be willing to pay for poultry vaccine service. Thus, if the bid amount goes up by 10%, the probability of the respondent paying for the poultry vaccine service will decrease by 0.022 and 0.009 for programme 1 and programme 2, respectively. The coefficient on '*believe'* variable, which stands for whether respondents believe the vaccine programme would protect their chicken from diseases or not, is positive and statistically significant at 0.01 level of confidence for both programme. The positive sign indicates those who believe the vaccine programme would protect their chicken from disease are more likely to pay more. The probability that farmers who believe the vaccine would protect their chicken would be willing to pay, controlling for other factors, is 0.618 in programme 1 and 0.695 in programme 2. This suggests that it is important to increase awareness of the efficacy of vaccine technology among village poultry keepers in order to ensure a wider uptake of vaccine technology. Likewise, the need to design an effective vaccination programme that could maintain a high level of efficacy is crucial.

The effects of the socio-demographic covariates are also as expected. The region, age, and education level of the household are important in determining farmers' willingness to pay for poultry vaccine service. The variable *Age* is negative and statistically significant ($p<0.1$) in programme 1 indicating older farmers are less likely to be willing to pay. This is in agreement with previous studies on farmers' willingness to pay for extension services and weather-index based insurance service in developing countries(Hill et al. 2013;

Oladele 2008). An increase in age of the respondent by one year decreases the probability that a respondent would be willing to pay by 0.003, on average. This is fair as older farmers are normally reluctant to adopt new technologies. The variable *education* has positive and statistically significant marginal effect at mean for programme 1 indicating educated respondents are more likely to be willing to pay. This finding is consistent with Holloway and Ehui (2001) in their study on willingness to pay for extension service and (Asrat et al. 2004) on their study on willingness to pay for soil conservation practise reported similar result. This could possibly be due to educated farmers' better ability to access and process information and recognize the risks of poultry diseases. It is also likely that educated farmers understand the importance of poultry vaccine and are aware of the possibility to reduce the impact of infectious poultry diseases.

The coefficient on *region*, a variable indicating region of respondents, is positive and statistically significant at ($p<0.1$) for both programmes indicating farmers from Horro area are more likely to be willing to pay than those in Jarso. The marginal effect at mean for region denotes the probability that farmers would be willing to pay in Horro is higher by 0.094 in programme 1 and 0.141 in programme 2. One possible explanation could be the difference in economic and cultural importance of chicken in the two regions. Horro farmers have relatively better access to markets and chickens have comparatively better market value, as chicken meat has higher cultural significance in Horro compared to Jarso. Farmers in Jarso grow a perennial crop, *Khat*, which generates cash through the year that could possibly meet their financial need, while farmers in Horro grow staple crops and may rely on small ruminants and poultry for cash needs. During the focus group discussion and field work also we observed poultry diseases are reported to be more important in Horro. Therefore, the regional difference in willingness to pay for poultry vaccine service may be due to a combination of socioeconomic factors. It is, therefore, important to carefully consider generalization of the findings, as diversity in the micro and macro environments under which farmers keep poultry are likely to influence their WTP. The total number of poultry owned by the household is also statistically significant (at 10% level) in programme 1 and it positively influences farmers' willingness to pay, as expected.

Table 4.4 Probit estimates for exponential willingness to pay model and Median WTP

Variables	Programme 1 Coefficient (SE)	Programme 1 Marginal effect (SE)	Programme 2 Coefficient (SE)	Programme 2 Marginal effect (SE)
Constant	2.383**		-0.091	
	(1.109)		(1.221)	
ln(Bid)	-0.828***	-0.219***	-0.392*	-0.092*
	(0.247)	(0.059)	(0.233)	(0.054)
Believe	2.330***	0.618***	2.971***	0.695***
	(0.288)	(0.062)	(0.441)	(0.089)
Family size	-0.014	-0.004	-0.009	-0.002
	(0.034)	(0.009)	(0.035)	(0.001)
Age	-0.011*	-0.003*	-0.008	-0.002
	(0.005)	(0.002)	(0.006)	(0.001)
Male	-0.144	-0.038	-0.250	-0.059
	(0.299)	(0.079)	(0.351)	(0.082)
Education	0.348**	0.092**	0.241	0.056
	(0.175)	(0.046)	(0.184)	(0.043)
Region	0.353**	0.092**	0.605***	0.142***
	(0.169)	(0.046)	(0.181)	(0.042)
Total Poultry	0.019*	0.005*	0.004	0.001
	(0.011)	(0.003)	(0.012)	(0.003)
Log likelihood	-179.27		-159	
Likelihood-Ratio test, χ^2_8	96.61		66.47	
Pseudo R^2	0.28		0.31	
N	379		379	

4.3.3 Willingness to pay estimates

Mean and median WTP estimates for the two vaccine programmes are presented in Table 4.5. Parametric and non-parametric approaches were used to estimate farmers' willingness to pay for poultry vaccine services. The result from the estimates revealed that a lower bound households' willingness to pay for poultry vaccine service in programme is ETB 87.4 (95% confidence interval ETB 80.97 - 93.82) and that of programme 2 is ETB 80 (95% confidence interval ETB 74.32- 85.68) per year. Median WTP was calculated from estimation result of exponential probit model using equation (13) and given in Table 5. The farmers' median WTP for vaccine programme 1 is about ETB 159 and that of programme 2 is ETB 384. Both Mean and median WTP indicates cost per household and household keep quite different flock size. Hence, WTP should be carefully interoperated as Households WTP might be underestimated for households with small flock size.

Table 4.5 Mean and median WTP assessed using parametric and non-parametric methods

Measure	Programme	WTP (ETB)	95% confidence interval[a]	
			Lower bound (ETB)	Upper bound (ETB)
Mean	Programme 1	87.4 (3.28)	80.97	93.82
	Programme 2	80.0 (2.90)	74.32	85.68
Median	Programme 1	159.4	128.37	271.94
	Programme 2	384.6	195.33	3093.4

Note: Standard errors given in parentheses for mean WTP. [a] *Krinsky and Robb (95%) confidence interval was used for median WTP.*

4.4 Conclusion

This research investigated smallholder farmers' willingness to pay for village poultry vaccine, Newcastle Diseases and Gumboro vaccine, in crop-livestock mixed farming system of Ethiopia. Both parametric and non-parametric methods were employed in analysis of the data collected through contingent valuation survey. The results indicate that a considerable proportion of interviewed farmers were willing to pay for the proposed poultry vaccine programmes. The estimated mean and median WTP also reveal that farmers are willing to pay for a village poultry vaccine service and appreciate the benefits of the vaccine technology. This indicates the existence of potential interest for vaccine use by farmers and the possibility to design and implement poultry diseases control programmes. Therefore, there is a potential and prospect to reduce impacts of infectious poultry diseases and enhance rural livelihood through village poultry development. Livestock diversification plays significant role in ensuring household food security (Megersa et al. 2014) and hence this study highlights the possibility to contribute to ensure food security by reducing the impact of infectious diseases in rural poultry in the country.

This paper also identifies characteristics of the respondent that would likely influence farmers' WTP for village poultry vaccines. Results of the probit estimation show that WTP for poultry vaccine service is influenced by age, education level of the respondent, respondents' perception about effectiveness of the vaccine and region of the respondent. Educated respondents are more likely to pay for poultry vaccine service compared with uneducated farmers and older farmers are unlikely to be willing to pay. This may suggest the need for awareness creation on the risk of poultry diseases and available options to control them. Farmers who perceived the vaccine service would effectively protect their chickens from diseases were more likely to respond that they would pay for vaccine service. This possibly suggests that a vaccine programme that intends to control village poultry diseases needs to maintain an acceptable level of efficacy to build farmers' confidence towards the service. A more interesting result is the influence of respondents' region. Farmers from Horro, a more staple crop growing area with limited cash crops, are more likely to be willing to pay compared with farmers from Jarso, a cash crop (*Khat*) growing area. It is, therefore, vital to consider the relative importance of chickens in a given area and the relative importance of chicken diseases compared to predators (as the case in Jarso) to design a village poultry vaccine programme that aims to benefit village poultry keepers.

This study provides important insight to inform policies in areas of reducing impact of infectious disease in village poultry. The case study from Ethiopia could be useful in other developing countries with similar production system and socioeconomic environment. Complete generalization of the findings, however, need to be considered carefully. Further research in other parts of developing world might be helpful for comprehensive generalization of findings.

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References

Aklilu, H.A., Almekinders, C.J., Udo, H.M., Van der Zijpp, A.J., 2007. Village poultry consumption and marketing in relation to gender, religious festivals and market access. Tropical animal health and production 39, 165-177.

Arrow, K., Solow, R., 1993. Report of the NOAA panel on contingent valuation. National Oceanic and Atmospheric Administration Washington, DC.

Asrat, P., Belay, K., Hamito, D., 2004. Determinants of farmers' willingness to pay for soil conservation practices in the southeastern highlands of Ethiopia. Land Degradation & Development 15, 423-438.

Bateman, I.J., Carson, R.T., Day, B., Hanemann, M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Özdemiroḡlu, E., Pearce, D.W., Sugden, R., Swanson, J., 2002. Economic valuation with stated preference techniques: a manual. Edward Elgar Publishing Ltd Cheltenham, UK.

Bennett, R., Balcombe, K., 2012. Farmers' Willingness to Pay for a Tuberculosis Cattle Vaccine. Journal of Agricultural Economics 63, 408-424.

Brouwer, R.O.Y., Akter, S., Brander, L., Haque, E., 2008. Economic valuation of flood risk exposure and reduction in a severely flood prone developing country. Environment and Development Economics 14, 397.

Carson, R.T., 1998. Valuation of tropical rainforests: philosophical and practical issues in the use of contingent valuation. Ecological Economics 24, 15-29.

Carson, R.T., Flores, N.E., Martin, K.M., Wright, J.L., 1996. Contingent Valuation and Revealed Preference Methodologies: Comparing the Estimates for Quasi-Public Goods. Land Economics 72, 80-99.

Carson, R.T., Hanemann, W.M., 2005. Contingent valuation, in: Mäler, K.G., Vincent, J.R. (Eds.), Handbook of environmental economics, pp. 821-936.

Copland, J.W., Alders, R.G., 2005. The Australian village poultry development programme in Asia and Africa. World's Poultry Science Journal 61, 32-37.

CSA, 2011. Agricultural sample survey: Report on livestock and livestock characterstics. Central Statistical Agency, Addis Ababa, Ethiopia.

Degefu, H., Balcha, M., Yohannes, M., Getachew, M., 2010. Seroprevalece of Infectious Bursal Disease in backyard chickens of Oromia regional state, Ethiopia. Veterinary Research 3, 89-93.

Delgado, C., Rosegrant, M., Steinfeld, H., Ehui, S., Courbois, C., 1999. Livestock to 2020 : the next food revolution, Food, Agriculture, and the Environment Discussion Paper. International Food Policy Research Institute, Washington, D.C.

Dessie, T., Ogle, B., 2001. Village poultry production systems in the central highlands of Ethiopia. Tropical animal health and production 33, 521-537.

Gari, G., Tilahun, G., Dorchies, P., 2008. Study on Poultry Coccidiosis in Tiyo District, Arsi Zone. International Journal of poultry science 7, 251-256.

Gueye, E.F., 2002 Employment and income generation through family poultry in low-income food-deficit countries World's Poultry Science Journal 58 501-517.

Haab, T.C., McConnell, K.E., 1997. Referendum Models and Negative Willingness to Pay: Alternative Solutions. Journal of Environmental Economics and Management 32, 251-270.

Haab, T.C., McConnell, K.E., 1998. Referendum Models and Economic Values: Theoretical, Intuitive, and Practical Bounds on Willingness to Pay. Land Economics 74, 216-229.

Haab, T.C., McConnell, K.E., 2002. Valuing environmental and natural resources: The econometrics of non-market valuation: New Horizons in Environmental Economics. Edward Elgar Publishers, Cheltenham, UK.

Halima, H., Neser, F.W.C., Marle-Koster, E., Kock, A., 2007. Village-based indigenous chicken production system in north-west Ethiopia. Tropical animal health and production 39, 189-197.

Hanemann, W.M., 1984. Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses. American Journal of Agricultural Economics 66, 332-341.

Hanemann, W.M., 1994. Valuing the Environment Through Contingent Valuation. The Journal of Economic Perspectives 8, 19-43.

Hill, R.V., Hoddinott, J., Kumar, N., 2013. Adoption of weather-index insurance: learning from willingness to pay among a panel of households in rural Ethiopia. Agricultural Economics 44, 385-398.

Holloway, G.J., Ehui, S.K., 2001. Demand, supply and willingness-to-pay for extension services in an emerging-market setting. American Journal of Agricultural Economics 83, 764-768.

Jenbreie, S., Ayelet, G., Gelaye, E., Kebede, F., Lynch, S.E., Negussie, H., 2012. Infectious bursal disease: seroprevalence and associated risk factors in major poultry rearing areas of Ethiopia. Tropical animal health and production 45, 75-79.

Johannesson, M., Jonsson, B., Borgquist, L., 1991. Willingness to pay for antihypertensive therapy--results of a Swedish pilot study. Journal of health economics 10, 461-473.

Kassie, G.T., Abdulai, A., Wollny, C., 2009. Valuing Traits of Indigenous Cows in Central Ethiopia. Journal of Agricultural Economics 60, 386-401.

Loomis, J., Kent, P., Strange, L., Fausch, K., Covich, A., 2000. Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey. Ecological Economics 33, 103-117.
McLeod, A., Rushton, J., 2007. Economics of animal vaccination. Revue scientifique et technique (International Office of Epizootics) 26, 313-326.

Megersa, B., Markemann, A., eacute, Angassa, A., Valle, Z., aacute, rate, A., 2014. The role of livestock diversification in ensuring household food security under a changing climate in Borana, Ethiopia. Food Security 6, 15.

Merrett, S., 2002. Deconstructing households' willingness-to-pay for water in low-income countries. Water Policy 4, 157-172.

Mitchell, R.C., Carson, R.T., 1989. Using surveys to value public goods: the contingent valuation method. Rff Press.

Msoffe, P.L., Bunn, D., Muhairwa, A.P., Mtambo, M.M., Mwamhehe, H., Msago, A., Mlozi, M.R., Cardona, C.J., 2010. Implementing poultry vaccination and biosecurity at the village level in Tanzania: a social strategy to promote health in free-range poultry populations. Tropical animal health and production 42, 253-263.

Murungweni, C., Wijk, M., Giller, K., Andersson, J., Smaling, E., Murungweni, C., van Wijk, M.T., Giller, K.E., Andersson, J.A., Smaling, E.M.A., 2014. Adaptive livelihood strategies employed by farmers to close the food gap in semi-arid south eastern Zimbabwe. Food Security 6, 313.

Oladele, O.I., 2008. Factors determining farmers' willingness to pay for extension servics in Oyo State, Nigeria Agricultura Tropica Et Subtropica 41, 4.

Ouma, E., Abdulai, A., Drucker, A., 2007. Measuring heterogeneous preferences for cattle traits among cattle-keeping households in East Africa. American Journal of Agricultural Economics 89, 1005-1019.

Scarpa, R., Drucker, A.G., Anderson, S., Ferraes-Ehuan, N., Gómez, V., Risopatrón, C.R., Rubio-Leonel, O., 2003a. Valuing genetic resources in peasant economies: the case of 'hairless' creole pigs in Yucatan. Ecological Economics 45, 427-443.

Swallow, B.M., Woudyalew, M., 1994. Evaluating willingness to contribute to a local public good: Application of contingent valuation to tsetse control in Ethiopia. Ecological Economics 11, 153-161.

Umali, D.L., Feder, G., Haan, C.d., 1994. Animal health services: Finding the balancebetween public and private delivery World Bank Research Observer 9, 71-96.

Wambura, P.N., Kapaga, A.M., Hyera, J.M., 2000. Experimental trials with a thermostable Newcastle disease virus (strain I2) in commercial and village chickens in Tanzania. Preventive veterinary medicine 43, 75-83.

Whitelaw, C.B., Sang, H.M., 2005. Disease-resistant genetically modified animals. Revue scientifique et technique (International Office of Epizootics) 24, 275-283.

Whittington, D., Briscoe, J., Mu, X., Barron, W., 1990. Estimating the Willingness to Pay for Water Services in Developing Countries: A Case Study of the Use of Contingent Valuation Surveys in Southern Haiti. Economic Development and Cultural Change 38, 293-311.

Zeleke, A., Sori, T., Gelaye, E., Ayelet, G., 2005. Newcastle Disease in Village Chickens in the Southern and Rift Valley Districts in Ethiopia. International Journal of Poultry Science 4, 507-510

Chapter 5

Eliciting preferences for attributes of Newcastle disease vaccination programme for village poultry in Ethiopia

Abstract

Newcastle disease (NCD) is one of the most important poultry diseases directly affecting the livelihoods of poor farmers across developing countries. Literatures show that innovations in NCD vaccine development for village poultry and field trial results are promising. Yet, designing and implementation of NCD vaccination is not part of village poultry extension programmes in many developing countries. Understanding the preferences for and relative importance of the different attributes of potential innovations to prevent NCD will be crucial in designing acceptable and sustainable prevention programmes. This research employed discrete choice experiment approach to elicit farmers' preference for attributes of NCD vaccination programme for village poultry in rural Ethiopia. The choice experiment was conducted on a total of 450 smallholder farmers. Random parameter logit model was estimated to measure the relative importance of attributes of NCD vaccine to farmers. The results show that famers prefer a vaccine programme that has better capacity to reduce the severity of NCD, one that can be delivered by animal health development agents, and that could be administered as liquid mixed with water. Results from simulations on changes in attribute levels revealed that reduction in severity of NCD diseases and delivery of vaccine by animal heath extension affect farmers' preferences more than other attributes.

Key words: poultry, Newcastle disease, Vaccine, preference, choice experiment

5.1 Introduction

Livelihoods in rural Ethiopia depend on an intricate set of small on-farm and off-farm enterprises. By virtue of its low start-up capital requirement and undemanding of sophisticated management skill, poultry is arguably the most widely spread livestock enterprise in rural Ethiopia. Village poultry production could potentially provide food and income and is an important component of food security for the rural poor. However, infectious and parasitic diseases affecting poultry remain important constraints to poultry production and to realizing the potential of this farm enterprise in contributing to food security in many developing countries. Consequently, their importance is undermined and limited.

Poultry diseases and poor management of chicks have been emphasised the major limitations to chicken production (Henning et al., 2009). Newcastle disease (NCD) is considered the most important poultry disease worldwide (FAO, 2014). In countries where NCD is prevalent, outbreaks of this disease regularly result in mortality of 50 to 100% for birds in areas affected by outbreaks. In developing countries where NCD is not endemic, outbreaks may occur less frequently but potential losses due to the disease make vaccination mandatory (Copland and Alders, 2005a). In rural Ethiopia, NCD is widespread (Anebo et al., 2013; Degefa et al., 2004; Dessie and Ogle, 2001; Zeleke et al., 2005) and believed to cause high mortalities, and hence it is a real challenge to village poultry development.

Food security and food safety can hardly be attained and/or maintained while poultry die in vast numbers annually from preventable diseases such as NCD. This is especially the case when family poultry producers remain disengaged from national animal health services (Alders, 2014). Efforts are required in improving and continuous provision of good quality nutrition, genetic material and the animal health system in order to achieve the productive potential of poultry and make the enterprise a way out of poverty to smallholder rural households. Quality nutrition and improved genetic material introduction will certainly play an indispensable role on transforming the traditional village poultry production in Ethiopia as well as in other developing countries. Nonetheless, to improve the production and productivity of the traditional poultry production system in Ethiopia due emphasis and priority needs to be given to efficient and acceptable poultry health services. There are vaccines that can be used as a preventive measure in less than optimal field conditions, and they offer the means for individual farmers to protect their flocks (McLeod and Rushton, 2007). Sustainability of effective NCD vaccination programmes largely depends on designing well informed policy based on prevailing production systems, poultry keepers' preference for vaccine technology and willingness to pay for the service.

5.1.1 NCD vaccine development and implementations in village poultry

Newcastle disease in intensive poultry industries can be controlled by repeated applications of suitable vaccines. The process is expensive and requires good vaccines, proper storage conditions for the vaccines and a high level of technical expertise. The control methods that are effective for commercial poultry are neither feasible nor affordable in rural villages (Ideris et al., 1990). The control of NCD in village flocks has been a challenge for decades due to the specific problems associated with vaccinating multi-age flocks containing relatively low numbers of chickens that frequently scavenge for much of the day in locations with no or unreliable vaccine storage conditions (Alders and Spradbrow, 2001). The challenge has been to develop an effective NCD control programme for the family poultry sector that was sustainable, both economically and socially (Alders, 2003). This had to be achieved in the absence of a viable cold chain to support the distribution of potent vaccines (Alders, 2014) and overcome the difficulty of delivering small quantities of vaccine, suitable for village flocks (Bensink and Spradbrow, 1999). Initial NCD control research efforts and activities, therefore, focussed on the development of NCD vaccine that was suitable for use in difficult rural conditions where the cold chain is often absent or unreliable (Alders and Spradbrow, 2001). In circumstances where the cold chain is weak or absent, the only reliable option is the use of thermotolerant NCD vaccines (Alders, 2003).

Attempts over the past few decades to improve the control of NCD in village poultry have included development of NCD vaccines that have thermotolerance and hence are suitable for village poultry. The heat tolerant V4 (Spradbrow et al., 1988) vaccine against NCD has been developed to control NCD in village chickens in tropical countries. Implementation of this vaccine brought a promising result in some African countries (Alders and Spradbrow, 2001). Later in an effort to develop NCD vaccine, I-2 NCD vaccines, a seed virus similar to V4-HR, that could be made available to laboratories in developing countries (Bensink and Spradbrow, 1999) was developed. The I-2 NCD vaccine produced in freeze-dried form will maintain its activity for eight weeks when stored below 30°C (Alders, 2003), and hence may be suitable for village poultry systems. Studies on the application of these vaccines in village poultry across developing countries have demonstrated that it is possible to effectively control NCD (see Copland and Alders, 2005b; Msoffe et al., 2010; Wambura et al., 2000).

More recently Lal et al. (2014) reported the development of low-dose, fast-dissolving tablet vaccines, each containing up to 50 doses of vaccine and weighing about 50 mg, that could maintain virus stability for more than six months at 4°C. This fast-dissolving tablet vaccine format allows for compact and cost-effective packaging and hence it could provide a promising option to control NCD in village poultry across developing countries. Despite the development of thermostable NCD vaccines for village poultry and the need to control NCD in village chickens, it has been difficult to achieve a sustainable control programme. It became apparent that to make NCD control activities sustainable, attention had to be given to the social and economic implications of NCD control in communities (Copland and Alders, 2005a). Implementation of a successful and sustainable NCD control programme requires economic sustainability, based on the commercialisation of the vaccine and vaccination services and delivery of effective extension materials and methodologies among others (Alders et al., 2010).

The application of suitable NCD vaccines in the developing world has greatly reduced the impact of this disease in family poultry (FAO, 2014). However, implementation of NCD vaccine programmes in village chicken in developing countries, particularly in sub-Sahara African countries, is limited. One of few examples of implementation of an effective NCD control programme in African countries is that of Mozambique, which resulted in increased chicken stocks, increased purchasing power for the poor to meet basic needs, improved households' food security and access to nutritious food and increased decision-making power for women (Bagnol, 2001; Woolcock et al., 2004).

No adequate scientific documentation exists on village level implementation and impact of NCD vaccination schemes in Ethiopia. It is, however, believed that the country has promising innovations in vaccine technologies and there is a capacity to produce millions of doses of NCD vaccines (Anebo et al., 2013). NCD vaccinations have routinely been provided to commercial poultry producers, but there is no comprehensive policy to control NCD in village poultry, which is by far the most important poultry sector in the country. To the best of our knowledge, only few studies have been reported about implementation of NCD vaccination in village poultry production systems in the country. Trial of V4 vaccine conducted in 1993 and 1995 (Rushton, 1995) ,both on-station and on the field, is the early application of NCD vaccine in Ethiopia. The result from this trial, particularly result from on-station, was encouraging. Evaluation of I-2 vaccine in village poultry in three districts of Amhara region of Ethiopia (Nega et al., 2012) is the other related work . Result from the study shows that antibody titer response to I-2 vaccine was 90.4%. It is therefore imperative for Ethiopia, a country where egg and chicken are predominantly supplied from village poultry, to have a well-thought and well-designed policy on NCD control that gives due emphasis to village poultry. Like any other public policy, NCD prevention policies and resultant interventions can be meaningful when they address the needs of the target community. When designed based on public interest, the interventions will be quickly adopted and hence welfare impacts happen. Formulation of effective NCD control programmes that are desirable to farmers requires detailed understanding of the key aspects of possible vaccine programmes that influence farmers' opinions towards the disease and the prevention interventions. However, attributes of a vaccine programme that influence farmers' choice of possible vaccine services in Ethiopia remain unknown, as the service is not yet marketed or tested.

5.2 Using Choice Experiment to elicit preference for attributes of NCD vaccination programmes

The fact that NCD preventive vaccines are yet to start highlights the need for identifying preferred attributes of such programs and relative importance of such attributes to farmers. This study, therefore, aims at evaluating farmers' preference for attributes of possible NCD vaccine programmes. This part of the study is aimed to supplement a study (Chapter 4) that evaluates farmers' willingness to pay for village poultry vaccine in rural Ethiopia. It was designed to generate more detailed information and farmers' preferences for a village poultry vaccine, particularly for an NCD vaccine, by using a Choice Experiment approach which enables us to understand preferences for attributes of a vaccine programme. This

contrasts with the contingent valuation approach, which helps to evaluate farmers' willingness to pay for the vaccine programme (as a whole product/service).
Hypothetical vaccination programmes generated from statistical combination of the different features of such programmes were used to elicit preferences of farmers. The choices of the hypothetical profiles enable the investigation of farmers' preferences for aspects (attributes) of NCD vaccine programmes and hence help inform policy to control NCD in village poultry. Stated preference-based valuation methods are commonly used in evaluating preference and willingness to pay for non-market goods and services. Of stated preference approaches, the choice experiment method is most appropriate to investigate preferences mainly when the objective is to evaluate preference for attributes of product/service rather than the product as a whole.

Choice experiment-based attribute valuation has been commonly used to value quality changes in environmental services and their characteristics (Adamowicz et al., 1998; Garrod et al., 2014). It has also been increasingly used in studies related to livestock production, mainly in the valuation of indigenous animal genetic resources, including traits of socio-economic importance and resistance to diseases. Scarpa et al. (2003), for example, used a choice experiment valuation method to estimate the preference of households for a traits of Creole pigs in Mexico. Zander and Drucker (2008) used choice experiment approach to value local cattle breeds in East Africa, while Kassie et al. (2009) used a similar method to value traits of indigenous cows in central Ethiopia. However, literatures related to the use of stated preference approaches in the area of livestock disease control are scant. Examples of early application of stated preference valuation methods in livestock diseases control include a work by Swallow and Woudyalew (1994), who used contingent valuation method to evaluate farmers' willingness to pay for tsetse control in Ethiopia. A more recent use of stated preference approach in livestock disease control literature is that of Bennett and Balcombe (2012) who employed both contingent valuation and choice experiment method to estimate farmers' willingness to pay for a cattle tuberculosis vaccine in England and Wales. Otieno et al. (2011) used a choice experiment method to investigate Kenyan farmers' preference for attributes of a disease-free zone.

In this study we employ the choice experiment to evaluate the relative weight farmers would attach to route of administration, delivery mechanism, the possible capacity of the NCD vaccine programme to reduce the severity of the disease and vaccine efficacy. This information will be helpful to design an effective NCD disease control programme that is readily acceptable by farmers and hence help in commercialization of the vaccine to ensure sustainability of NCD control programmes in village poultry.

5.3 Materials and methods

5.3.1 The study area

The study was undertaken as part of a large research project working on reducing the impact of infectious diseases on village poultry in rural Ethiopia. It was conducted in the Horro district of Central Western Ethiopia. The district was selected purposely for poultry's potential contribution to the livelihoods of rural households and the challenges poultry producers are facing due to diseases including NCD. The mainstay of life in the district is mixed crop-livestock farming system. Crop and animal farm activities in Horro district are entirely rain-fed. Staple crops mainly cover farmland in this area and livestock depend on this farmland for grazing during the dry season. The district receives average annual rainfall of 1,685 mm (ranging from 1,300 to 1,800 mm) and annual temperature of 19°C (ranging from 14 to 24°C). Major livestock species kept by farmers in this area include cattle, sheep, poultry, and goat, while the main crops grown include wheat, teff, maize, barley, and beans.

5.3.2 Discrete choice experiment designing and survey

Discrete choice experiments (DCE) is based on the characteristics theory of value (Lancaster, 1966; Rosen, 1974) and random utility theory (McFadden, 1974). Lancasterian theory of demand postulates that consumers not only derive utility from goods *per se*, but from the complex of different characteristics embodied in the product or service. The random utility assumes that farmers' choose vaccine programs which they perceive will provide the maximum utility and this perceived utility has deterministic (measurable) and random components. The DCE method has, therefore, the advantage that the utility of hypothetically marketed good/service is divided into its components or attributes. Consumers in real markets make decisions among competing alternatives. Participants in DCE survey are asked to make a choice between alternatives with different attribute level combinations. Survey methods that ask consumers to make choices from experimental choice sets enable researchers to learn about consumer preferences for products and attributes that do not yet exist in real markets (Carson et al., 1994).

The discrete choice experiment survey reported here involved several steps of designing processes. This process began with the collection of expert opinion on the attributes and attribute levels of potential NCD vaccination programmes. Then, further discussion was made with experts in the area of poultry health, and the literature was also used to validate attributes and attribute levels together with their definitions so that they could be used in the final processing of choice profiles and the survey. Two focus group discussions were also conducted in the study area, involving farmers and livestock agency workers of the district to gauge the practicality of communicating identified attributes and attribute levels to farmers. The discussions helped to identify five attributes and their levels for the choice experiment. The attributes were the route of vaccine administration, delivery mechanism, efficacy level, reduction in severity, and price. In village poultry, a possible route of NCD vaccine administration could include using an aerosol spray, giving the vaccine with feed and giving the vaccine with water. Hence, this attribute had three levels in the experimental design. NCD vaccine can be delivered in a number of ways in village poultry. Two ways were considered for this study based on past experience and literature. These were delivery by a veterinary technician (Development Agent in the village working on animal health) and delivery by trained farmers. Possible efficacy levels of the vaccine scenarios were given three attribute levels, based on findings from past studies. Efficacy in this study refers to effectiveness of the vaccine measured by proportion of chicken that develop immunity to NCD. Reduction in severity, which refers to a reduction in mortality of birds due to NCD once it has occurred, was also given three attribute levels in the experimental design. The final attribute of the vaccine profiles was the cost of the vaccine, which is for three vials of vaccine per annum, as the whole vaccine programme was designed to be administered three times a year for optimal control of the disease, considering the village poultry production system.

For analysis of data, the monetary attribute; the cost of NCD vaccine for three times in a year, was included in the models as a continuous variable with their actual levels. All other attributes of the designed NCD vaccine programme were treated as discrete variables. Therefore, for each attribute in the DCE with levels L, we created $L - 1$ discrete variables to measure nonlinear effects in the trait levels confounding effect in the grand mean, as suggested by Hensher et al. (2005). A summary of attributes and attribute levels used in the final designing process is presented in Table 5.1.

Table 5.1 Attributes and attribute levels in the choice experiment

No.	Vaccine Attribute	Attribute level	Reference level
1	Efficacy	1. 30 %	
		2. 50 %	50 percent
		3. 70 %	
2	Delivery mechanism	1. By vet. technician	By trained farmer
		2. By trained farmers	
3	Route of administration	1. With water	
		2. With feed	Aerosol spray
		3. Aerosol Spray	
4	Reduction in severity after outbreak	1. 20 %	
		2. 40 %	40 percent
		3. 60 %	
5	Price of vaccine	1. ETB 60.00	Used as continuous
		2. ETB 80.00	
		3. ETB 100.00	

Experimental designs commonly used in valuation studies are orthogonal fractional factorial designs that aim to ensure statistical independence among the attributes. Preserving orthogonality at any cost can lead to decreased efficiency (Kuhfeld, 2010). However, the aim of experimental design is to create an efficient design that maximises the information in the experiment. Therefore, the use of information-efficient designs have been recommended (Kuhfeld, 2010) as these capture the maximum amount of information by minimizing the asymptotic joint confidence sphere surrounding the parameter estimates, although it is not necessarily orthogonal (Kanninen, 2002). Following Kuhfeld (2010) the more comprehensive experimental design approach, information-efficient and D-efficient, which generated a statistically efficient design with an SAS algorithm was employed in this study. The unlabeled DCE was designed to produce NCD vaccine programme profiles using the identified characteristics/attributes of vaccine. There are 162 (3^4*2) possible ways to combine the five selected vaccine attributes and their levels (see Table 5.1) to produce vaccine programme profiles. Using all of the possible profiles is cognitively too challenging for respondents to produce a meaningful choice exercise for most practical situations. Therefore, 36 profiles were created out of the 162 possible combinations by applying the SAS algorithm D-efficiency criterion. The final design had a D-efficiency of 99.8, suggesting that the variance matrix should generate reliable estimates. These profiles were randomly classified into 18 vaccine profiles, each choice set having two profiles, and blocked into three. Hence each respondent was presented with six choice sets. An opt-out option was included to each choice set to avoid forced choice, so that the DCE is consistent with utility maximization and demand theory (Bateman et al., 2002). Accordingly, respondents were presented with six vaccine choice sets, each containing three alternatives: two vaccine profiles and opt-out option. Choice sets were supplemented by visual aids (pictures) to help communicate information about attribute levels.

The study was approved by the University of Liverpool Committee on Research Ethics (reference-VREC76) and the survey was conducted accordingly. The DCE survey information statement read to farmers described that the survey would involve choice of hypothetical NCD vaccine programmes that would be administered three times yearly (i.e. the cost of vaccine service is for three doses or vials of NCD vaccine) among other things. Prior to the formal survey, the questionnaire was extensively piloted and pre-tested among individuals and in focus group discussions during early January 2013. The pilot survey for the DCE indicated that communicating attribute and attribute levels was workable and respondents could complete the choice exercise. Following the feedback from pilot survey, logical ordering of the questionnaire presentation was re-arranged to maximise respondent attention for the choice task. The formal survey was conducted in February and March 2013.This DCE survey was administered to 450 farmers drawn from a list of farm households in the four '*Gandas'*(the lowest administrative unit in government structure consisting of several villages), provided by local development agents, employing sampling with probability proportional to size. The four '*Gandas'* were selected by the project from two different market channels in the district. The survey was conducted by well-trained and experienced enumerators in close supervision with the researchers.

5.3.3 Analytical framework

Common discrete choice models used in the empirical analysis of the discrete choice experiment data, based on the random utility theory, are conditional logit and random parameter logit models. We apply the random parameter logit (RPL) model in the analysis presented here. The RPL provides a flexible and computationally practical econometric method for analysing the results from CE surveys and discrete choice model derived from random utility maximisation (McFadden and Train, 2000; Train, 2003). It overcomes the three limitations of conditional logit by allowing for random taste variation (and hence explicitly accounting for heterogeneity in preferences), unrestricted substitution patterns and correlation in unobserved factors that affect individual utility (Train, 2003).

In random parameter logit (RPL) models, the stochastic component of utility is segmented additively into two parts: one part is potentially correlated over alternatives and heteroscedastic over individuals and alternatives and the other part is independent and identically distributed (IID) over alternatives and individuals (Hensher and Greene, 2003):

$$U_{nit} = \beta_n' x_{nit} + [\eta_{nit} + \varepsilon_{nit}], \tag{1}$$

where U_{nit} is the utility that individual n obtains from alternative i in time (choice situation) t; β_n is a vector of parameters of variables for person n representing the individual's preference; x_{nit} is a vector of observed explanatory variables that relate to attributes of the vaccine programme and respondents' socio-economic characteristics, and interactions of attributes and respondents' socioeconomic characteristics; η_{nit} is a random term with zero mean whose distribution over individuals and alternatives depends in general on underlying parameters and observed data relating to alternative i; and ε_{nit} is a random term with zero mean that is IID over alternatives, and does not depend on underlying parameters or data.

The RPL logit class of models assumes a general distribution for η_{nit}. This can take a number of distributional forms such as normal, log-normal, uniform or triangular (Hensher and Greene, 2003; Hensher et al., 2005; McFadden and Train, 2000). Denote the density of η_{nit} by $f(\eta_{nit}|\Omega)$, where Ω are the fixed parameters of the distribution. For a given η_{nit}, the conditional probability for alternative i over alternative j, given the set of alternatives A, is logit, as the remaining error term is IID extreme value:

$$L_{nit}(\beta_n|\eta_{nit}) = \frac{\exp(\beta_n' x_{nit}+\eta_{nit})}{\sum_{J\in A}\exp(\beta_n' x_{nit}+\eta_{nit})}, \tag{2}$$

where L_{nit} is the logit probability. The unconditional choice probability becomes the integral of L_{nit} over all values of L_{nit} weighted by the density of η_{nit}, since η_{nit} is not given:

$$P_{nit}(\beta_n|\Omega) = \int_{nit} L_{nit(\beta_n|\eta_{nit})} f(\eta_{nit}|\Omega)\eta_{nit} d\beta_n. \tag{3}$$

This is a random parameter logit where the probabilities do not exhibit the questionable independence from irrelevant alternatives property.

In this class of models, estimation of individual-specific preferences is possible by deriving the individual's conditional distribution (Hensher and Greene, 2003). These conditional parameter estimates are the mean of the parameters of the subpopulation of individuals who made the same choices. Hence we identify mean and standard deviation estimates for the sub-population (Hensher et al., 2005). Using Bayes Rule, the conditional choice probability can be defined as (Hensher and Greene, 2003):

$$H_{nit}(\beta_n|\Omega) = \frac{L_{nit}(\beta_n)g(\beta_n|\Omega)}{P_{nit}(\beta_n|\Omega)}, \tag{4}$$

where $L_{nit}(\beta_n)$ is now the likelihood of an individual's choice if they have the specific β_n; Ω is the set of parameters in the underlying distribution of β_n and $g(\beta_n|\Omega)$ is the distribution in the population of β_n. Following (Train, 2003), $P_{nit}(\Omega)$ is the choice probability function defined in open form as:

$$P_{nit}(\Omega) = \int_{\beta_n} L_{nit}(\beta_n) g(\beta_n|\Omega) d\beta_n. \tag{5}$$

These choice probabilities cannot be calculated exactly because the integral does not have a closed form in general. The integral is approximated through simulation. For a given value of the parameters Ω, avalue of $\beta_n$is drawn from its distribution. Using this draw, the logit formula (2) for $L_{nit}(\beta_n)$ is calculated. This process is repeated for many draws, and the mean of the resulting $L_{nit}(\beta_n)$'s is taken as the approximate choice probability giving Equation (5).

$$SP_{nit}(\Omega) = (1/R)\sum_{r=1}^{R} L_{nit}(\beta_n) \,, \qquad (6)$$

where R is the number of replications or draws of β_n, $\beta_n$is the r th draw, and SP_{nit} is the simulated probability that an individual chooses alternative i in a choice situation t. Hensher *et al*. (2005) suggest trying a range of draws starting from as low as 25 and going up until well-behaved models are fitted, to determine the number of draws for the simulation. In the present study we used 100 Halton draws.

5.4 Results and discussions

The utility parameters for NCD vaccine programme attributes were entered as random parameters assuming a normal distribution for attribute levels of 'reduction in severity' and 'delivery mechanism' and triangular distribution for attribute levels of 'efficacy' and ' route of vaccine administration', while the cost attribute was specified as fixed. The results from the simulated maximum likelihood estimates of random parameter logit (RPL) model, based on the analysis of DCE data obtained from 450 farmers survey, are reported in Table 5.2. The model was estimated using NLOGIT version 5. The overall explanatory power of the model was fairly high with a pseudo-R^2 of 0.43. The intercept in the model result representing the opt-out option in the alternatives provided for choice had a negative, and statistically significant, mean coefficient. This indicates a strong reluctance to opt-out such that respondents preferred to choose from the two alternatives associated with various trait levels.

Result from RPL indicates that efficacy level of the NCD vaccine programme was statistically significant and higher efficacy level (70%) had positive mean coefficient, but lower efficacy level had negative mean coefficient suggesting farmers exhibited a preference for an efficacious NCD vaccine, as expected. The route of vaccine administration was also statistically strongly significant and had a positive mean coefficient for NCD vaccine that would be given with water, while it had a negative mean coefficient for NCD vaccine that would be given with feed. This may suggest farmers would prefer NCD vaccine that could be administered via water and the likelihood for a larger uptake, by farmers, of a vaccine that could be given with water. NCD vaccine programme that uses a veterinary technician (animal health development agent) for delivery of a vaccine was also statistically significant and had a positive mean coefficient. This may imply farmers' preference for NCD vaccine programme that uses a veterinary technician for delivery of the vaccine over NCD vaccine service that would be administered by trained farmers. The RPL model result also revealed that reduction in severity (the capacity of the NCD vaccine to reduce mortality of chicken during an outbreak of the disease) was also statistically significant. Vaccine programmes with a reasonably greater capacity to reduce the severity of the disease had a positive mean coefficient, suggesting farmers' preference for this kind of NCD vaccine programme. The model result also revealed that farmers considered the price levels low for most of vaccine programme profiles, as indicated by a statistically insignificant price coefficient. Estimation of the RPL with various distributional assumptions and treatment of price as categorical variable were tried, to get a result where price would be significant. However, price was found to be statistically insignificant under all appropriate distributional assumptions and finally it was treated as a continuous and non-random variable. Nonetheless, price coefficient had a negative sign, as expected. A significant drawback of the statistically insignificant price variable RPL is the fact that estimation of economic worth of attributes of vaccine programmes is impossible. However, the relative importance of the attributes can be observed from estimated coefficients of the model result.

The respective magnitudes of the parameter estimates of the RPL result convey important implication regarding the relative importance of attributes to respondents. The magnitude of the parameter estimates in our model showed that the most preferred attribute of a vaccine programme is the vaccine's capacity to reduce the severity of NCD disease during an outbreak in terms of the proportion of chickens surviving the outbreak. This might be due to the fact that smallholder farmers in the study area occasionally lose a substantial proportion (at times 100%) of their poultry flock due to infectious poultry diseases in the event of NCD outbreak. Therefore, it is intuitive that farmers attach the highest weight for a NCD vaccine programme to a reduction in disease severity. The estimated parameters of the model result also indicate that the vaccine delivery mechanism, vaccine delivery by a veterinary technician, was the next most preferred attribute of an NCD vaccine. Although not assessing a specific animal health service (in contrast to the current research), Irungu et al. (2006) reported that community-based animal health workers were preferred to veterinarians and assistant animal health workers in Kenya due to their accessibility to farmers. In our study area, veterinary technicians (also called animal heath development agents) live in the village within the community and hence it was likely that accessibility was not a concern when farmers made their choices. It was also possible that farmers had limited confidence in trained farmers, as most farmers in the study area are illiterate (descriptive statistics of farmers' education level and other socio-economic variables are given in Chapter 3). Therefore, it is important to consider a multitude of the local conditions, rather than focusing on addressing access alone, as farmers' confidence in service providers would hugely affect the uptake of the vaccine technology. The third most preferred attribute was the route of administration. Farmers largely preferred and attached higher weight to NCD vaccine that could be given with water. This may suggest the need to consider acceptable routes of vaccine administration to ensure wider adoption of NCD vaccine technology by village poultry keepers. Vaccine efficacy was not their priority as revealed in this study. This could likely be due to the fact that they are experiencing sizeable loss of their poultry flock and hence keen to reduction in mortality of chicken. Hence, it is not unlikely that they do not see efficacy important if they have vaccines that reduce mortality of the disease already. The other explanation could be that farmers are less informed about the impact of diseases on chicken productivity and hence they valued reduction in severity of the disease.

Generally, the important attributes of NCD vaccine programme in village poultry, ordered according to their weight to farmers, are: the vaccine's capacity to reduce severity during an outbreak, the vaccine delivery mechanism, the route of vaccine administration and efficacy. It is, therefore, advisable to consider a range of important attributes of NCD vaccine programme in designing a policy to control NCD in village poultry so that any vaccine programme will be readily acceptable to farmers. This will help bring reasonable impact and help efforts to enhance rural livelihoods of farmers in developing countries.

Table 5.2 Random parameter logit model result for NCD vaccine programme attributes using simulated likelihood estimation

Variables	Coefficient	Standard Errors
Random parameters in utility functions		
Vaccine Efficacy		
30 percent efficacy level	-0.132*	0.067
70 percent efficacy level	0.178**	0.074
Route of administration		
With water	0.374***	0.082
With feed	-0.133***	0.078
Vaccine delivery by		
Veterinary technicians	0.581***	0.093
Reduction in severity after outbreak		
20 percent of chicken would survive	-1.652***	0.128
60 percent of chicken would survive	1.709***	0.140
Non-random parameters in utility functions		
Price of vaccine	-0.0007	0.003
Constant	-4.084***	0.337
Standard deviation of random parameters		
30 percent efficacy level	0.441	0.451
70 percent efficacy level	0.012	0.291
With water	1.493***	0.418
With feed	0.023	0.346
Veterinary technicians	0.474**	0.204
20 percent of chicken would survive	0.097	0.125
60 percent of chicken would survive	0.097	0.126
Number of respondents	450	
Number of observations	2,700	
Number of Halton draws(R)	100	
Log likelihood function	-1681.689	
Restricted log likelihood	-2966.253	
$x^2(df = 21)$	2569.127	
McFadden Pseudo R-squared	0.433	

The coefficients for the attributes of vaccine delivery by veterinary technician (animal health development agent) and vaccine administration with water have highly significant standard deviations (Table 5.2). This implies that not all farmers attach equal weight to these vaccine attributes. The estimated means and standard deviations of the normally distributed coefficients could provide information about the share of the population that places positive values or negative values on the respective attributes or attribute levels (Train, 2003). Considering attributes with statistically significant standard deviation estimates in the model result, 87% of farmers had a positive preference for vaccine service that would be administered by veterinary technician while 13% of respondent had negative preference for this vaccine attribute.

5.4.1 Simulations of changes in NCD vaccine attribute levels

We have also employed profile simulation programme to investigate the marginal effect of change in attribute levels on the choice of alternatives. The simulation programme can be used to predict the set of choices for the sample and then examine how those choices would change if the attributes of the choices changed. Therefore, policy implications of changes in attribute levels in the present study were drawn from simulations with different attribute level scenarios assigned to each alternative. Various scenarios of vaccine profiles were identified by fixing attributes at different levels in each profile. The simulation results indicated the marginal effect of an attribute level on choice, which identifies the attributes most preferred and hence important to farmers.

The result for simulated changes in proportion of NCD vaccine profiles chosen is presented in Table 5.3. In our survey, each choice set had three alternatives; two NCD vaccine programme profiles and an opt-out option. In the survey, the base scenario, profile 1 was chosen in about 60% of the cases, profile 2 was chosen in about 39% of the cases and farmers opted-out in only 1% of cases. Of the various scenarios considered in the simulation, a significant change in the proportion of vaccine profile chosen was observed in a scenario where the attribute level for the vaccine's capacity to reduce severity of the diseases after an outbreak was fixed to 60% across all the choice sets for both profile 1 and profile 2. When it was set to 60% for profile 1, the simulation result indicated that the proportion with which profile 1 was chosen of all the choice sets would have increased by 17.3%. Similarly, the change in proportion profile 2 was chosen from all the choice set would have increased by 20.85% when reduction in severity was set to 60% for profile 2. Another important simulation result was observed in a scenario where the vaccine service was set to be delivered by a veterinary technician. The proportion of cases in which profile 1 was chosen from all the choice set would have increased by 8.11% when the vaccine service was set to be delivered by veterinary technician for profile 1. When the same scenario was set for profile 2, the proportion chosen for profile 2 would have increased by 7%. The simulation results, generally, revealed that vaccine's capacity to reduce severity of NCD and the delivery mechanism are the two attributes of vaccine. These two attributes of NCD are, therefore, important aspects of NCD vaccine programme that would influence adoption of the technology. The reduction in the proportion of opting out observed under all scenarios indicates that farmers consider attribute levels in the choice exercise and choose vaccine profile with bundle of best attribute level, rather than opting out.

Table 5.3 Simulated changes in choice proportion of the NCD vaccine profiles

Scenarios	Simulated changes in choice proportion		
	Vaccine profile 1 (Base =59.68%)	Vaccine profile 2 (Base =39.27%)	Opt-out (Base 1.04%)
Efficacy			
Profile1=70% efficacious	2.27	-2.18	-0.08
Profile2=70% efficacious	-1.78	1.88	-0.09
Delivery mechanism:			
Profile 1= by Veterinary technician	8.11%	-7.79	-0.32
Profile 2= by Veterinary technician	-6.82	7.02	-0.20
Route of administration			
Profile1=with water	3.95	3.73	-0.22
Profile2=with water	-5.23	5.45	-0.22
Profile1=with feed	-1.13	1.09	0.04
Profile2=with feed	1.85	-1.94	0.09
Reduction in severity after outbreak			
Profile 1=60 percent of chicken would survive	17.27	-16.55	-0.71
Profile 2=60 percent of chicken would survive	-20.30	20.85	-0.55

5.5 Conclusion

Newcastle disease (NCD) is considered the most important poultry disease worldwide and outbreaks of this disease can result in mortalities up to 100% in village poultry, affecting the livelihoods of poor farmers across developing countries. Innovations in the development of NCD vaccine technologies suitable for village poultry and implementation experiences in developing countries are encouraging. Designing a socially acceptable and economically sustainable NCD vaccine programme to control NCD in village poultry requires understanding farmers' preference for attributes of possible vaccine programmes and the weight they would attach to attributes. The present research used a discrete choice experiment survey to investigate farmers' preference for attributes of NCD vaccine programme in Ethiopia. This survey was administered to a total of 450 farmers. Random parameter logit was employed to analyse data collected using the discrete choice experiment survey. The analysis of farmers' preference for NCD vaccine attribute provides insights which may inform policy and future research on the design of NCD control efforts in village poultry and contribute towards efforts to improve poor farmers' access to food.

Results from the RPL model showed that farmers preferred NCD vaccine programme that has better capacity to reduce the severity of NCD, in terms of mortality rate, during disease outbreaks. In the present production environment farmers are experiencing considerable chicken mortality and the weight attached to this vaccine attribute looks reasonable. However, reducing chicken mortality cannot be attributed only to NCD control, but chicken management, other poultry disease and nutrition also plays a role. Consequently, addressing farmers' demand for a vaccine that has good capacity to reduce mortality through implementation of NCD vaccine may fail to achieve the intended results. This would negatively influence farmers' perception about the vaccine and the likelihood for future vaccine technologies adoption and make extension systems more demanding. Therefore, it is important to carefully address all other chicken management issues together with vaccination to reduce chicken mortality which is primary a concern for farmers.

Vaccine delivery mechanism was important to farmers and a vaccine service that would be delivered by an animal health development agent was given larger value. This is likely due to farmers' confidence in animal health development agents compared with trained farmers. When getting animal health development agent in every village is practically challenging, using community vaccinators is a more realistic option. However, appropriate and adequate training is crucial to capacitate trained community vaccinators and build farmers' confidence by giving equitable service. Yet, wider adoption of this vaccine techonolgy depends on farmers' preference. It is, therefore, important to carefully consider farmers' perception about possible vaccine delivery mechanisms. The result also showed that farmers preferred and valued a vaccine service that could be given with water even more than the efficacy of the vaccine. In the estimated model, respondents were found to display heterogeneous preferences for the attributes included in the study, particularly for the delivery mechanism and route of administration of the vaccine, suggesting the need to consider these features of the vaccine when extending poultry health interventions.

In order to further investigate how choices would change if the attribute levels of the NCD vaccine choices changed, simulations were used. Results from these simulations also revealed that changes in attribute levels of a vaccine's capacity to reduce severity of a disease is at the best level (70% in our case) and delivery of vaccine by animal heath extension for a vaccine enhances the acceptability of vaccine programme by farmers. The results from estimates of RPL and the simulation results suggest the significance of understanding farmers' preference for features of possible NCD vaccine programme in order to increase the acceptance of NCD control programme in village poultry. This will help in designing widely adoptable NCD vaccine services in the country and hence enable farmers to exploit the potential from village poultry sector that is being hindered by infectious poultry diseases and other factors.

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References

Adamowicz, W., Boxall, P., Williams, M., Louviere, J., 1998. Stated preference approaches for measuring passive use values: choice experiments and contingent valuation. American journal of agricultural economics 80, 64-75.

Alders, R., 2003. Success story on the control of Newcastle disease in village chickens using thermotolerant vaccines. Asia Pacific Association of Agricultural Research Institutions (APAARI), FAO-RAP, Bangkok.

Alders, R., Bagnol, B., Young, M., 2010. Technically sound and sustainable Newcastle disease control in village chickens: lessons learnt over fifteen years. World's Poultry Science Journal 66, 433-440.

Alders , R., Spradbrow, P., 2001. Controlling Newcastle disease in village chickens: a field manual. ACIAR Monograph 82.

Alders, R.G., 2014. Making Newcastle disease vaccines available at village level. Veterinary Record 174, 502-503.

Anebo, Z.G., Teklemichael, K., Bacha, B., Habte, T., Hunde, A., 2013. Evaluation of the newcastle disease antibody level after vaccination regimes in chickens in Debrezeit Agricultural Research Center, Ethiopia. Journal of Veterinary Medicine and Animal Health1, 37-42.

Bagnol, B., 2001. The social impact of Newcastle disease control. In 'SADC planning workshop on Newcastle disease control in village chickens, Maputo, 6–9 March 2000', ed. by R.G. Alders and P.B. Spradbrow. ACIAR Proceedings No. 103, 69–75.

Bateman, I.J., Carson, R.T., Day, B., Hanemann, M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Özdemiroğlu, E., Pearce, D.W., Sugden, R., Swanson, J., 2002. Economic valuation with stated preference techniques: a manual. Edward Elgar Publishing Ltd Cheltenham, UK.

Bennett, R., Balcombe, K., 2012. Farmers' Willingness to Pay for a Tuberculosis Cattle Vaccine. Journal of Agricultural Economics 63, 408-424.

Bensink, Z., Spradbrow, P., 1999. Newcastle disease virus strain I2 – a prospective thermostable vaccine for use in developing countries. Veterinary Microbiology 68, 131-139.

Carson, R., Louviere, J., Anderson, D., Arabie, P., Bunch, D., Hensher, D., Johnson, R., Kuhfeld, W., Steinberg, D., Swait, J., Timmermans, H., Wiley, J., 1994. Experimental analysis of choice. Market Lett 5, 351-367.

Copland, J.W., Alders, R.G., 2005a. The Australian village poultry development programme in Asia and Africa. World's Poultry Science Journal 61, 31-38.

Copland, J.W., Alders, R.G., 2005b. The Australian village poultry development programme in Asia and Africa. World's Poultry Science Journal 61, 32-37.

Degefa, T, Dadi, L, Yami, A, GMariam, K, and Nassir, M., 2004. Technical and economic evaluation of different methods of Newcastle disease vaccine administration. Journal of Veterinary Medicine, A 51, 365–369

Dessie, T., Ogle, B., 2001. Village poultry production systems in the central highlands of Ethiopia. Tropical animal health and production 33, 521-537.

FAO, 2014. Decision tools for family poultry development, FAO Animal Production and Health Guidelines 16., Rome, Italy.

Garrod, G., Ruto, E., Willis, K., Powe, N., 2014. Investigating Preferences for the Local Delivery of Agri-environment Benefits. Journal of Agricultural Economics 65, 177-190.

Henning, J., Morton, J., Pym, R., Hla, T., Meers, J., 2009. Evaluation of strategies to improve village chicken production-controlled field trials to assess effects of Newcastle disease vaccination and altered chick rearing in Myanmar. Preventive veterinary medicine 90, 17-30.

Hensher, D.A., Greene, W.H., 2003. The mixed logit model: the state of practice. Transportation 30, 133-176.

Hensher, D.A., Rose, J.M., Greene, W.H., 2005. Applied choice analysis: a primer. Cambridge University Press.

Ideris, A., Ibrahim, A.L., Spradbrow, P.B., 1990. Vaccination of chickens against Newcastle disease with a food pellet vaccine. Avian Pathology 19, 371-384.

Irungu, P., Omiti, J.M., Mugunieri, L.G., 2006. Determinants of farmers' preference for alternative animal health service providers in Kenya: a proportional hazard application. Agricultural Economics 35, 11-17.

Kanninen, B.J., 2002. Optimal Design for Multinomial Choice Experiments. Journal of Marketing Research 39, 214-227.

Kassie, G.T., Abdulai, A., Wollny, C., 2009. Valuing Traits of Indigenous Cows in Central Ethiopia. Journal of Agricultural Economics 60, 386-401.

Kuhfeld, W.F., 2010. Marketing research methods in SAS, Experimental Design, Choice, Conjoint, and Graphical Techniques. Cary, NC, SAS-Institute TS-722. Available at http://support.sas.com/techsup/technote/mr2010.pdf.

Lal, M., Zhu, C., McClurkan, C., Koelle, D.M., Miller, P., Afonso, C., Donadeu, M., Dungu, B., Chen, D., 2014. Development of a low-dose fast-dissolving tablet formulation of Newcastle disease vaccine for low-cost backyard poultry immunisation. Veterinary Record 174, 504.

Lancaster, K.J., 1966. A new approach to consumer theory. The journal of political economy 74, 132-157.

McFadden, D., 1974. Conditional Logit Analysis of Qualitative Choice Behaviour, in: Zarembka, P. (Ed.), Frontiers in Econometrics. New York: Academic Pres.

McFadden, D., Train, K., 2000. Mixed MNL models for discrete response. Journal of applied Econometrics 15, 447-470.
McLeod, A., Rushton, J., 2007. Economics of animal vaccination. Revue scientifique et technique (International Office of Epizootics) 26, 313-326.

Msoffe, P.L., Bunn, D., Muhairwa, A.P., Mtambo, M.M., Mwamhehe, H., Msago, A., Mlozi, M.R., Cardona, C.J., 2010. Implementing poultry vaccination and biosecurity at the village level in Tanzania: a social strategy to promote health in free-range poultry populations. Tropical animal health and production 42, 253-263.

Nega, M., Moges, F., Mazengia, H., Zeleke, G., Tamir, S., 2012. Evaluation of I2 thermostable Newcastle disease vaccine on local chickens in selected districts of western Amhara. Online J. Anim. Feed Res 2, 244-248.

Otieno, D.J., Ruto, E., Hubbard, L., 2011. Cattle Farmers' Preferences for Disease-Free Zones in Kenya: An application of the Choice Experiment Method. Journal of Agricultural Economics 62, 207-224.

Rosen, S., 1974. Hedonic prices and implicit markets: Product differentiation in pure competition. Journal of Political Economy 82, 34–35.

Rushton, J., 1995. Assistance to rural women in protecting their chicken flocks from Newcastle Disease. Final Repoer. FAO Project TCP/RAF/2376, Rome, Italy.

Scarpa, R., Drucker, A.G., Anderson, S., Ferraes-Ehuan, N., Gómez, V., Risopatrón, C.R., Rubio-Leonel, O., 2003. Valuing genetic resources in peasant economies: the case of 'hairless' creole pigs in Yucatan. Ecological Economics 45, 427-443.

Spradbrow, P., Samuel, J., Ibrahim, A.L., 1988. Serological response of chickens to oral vaccination with Newcastle disease virus. Veterinary Microbiology 16, 255-262.

Swallow, B.M., Woudyalew, M., 1994. Evaluating willingness to contribute to a local public good: Application of contingent valuation to tsetse control in Ethiopia. Ecological Economics 11, 153-161.

Train, K., 2003. Discrete Choice Methods with Simulation. Cambridge University Press, Cambridge.

Wambura, P.N., Kapaga, A.M., Hyera, J.M., 2000. Experimental trials with a thermostable Newcastle disease virus (strain I2) in commercial and village chickens in Tanzania. Preventive veterinary medicine 43, 75-83.

Woolcock, R., Harun, M., Alders, R., 2004. The impact of Newcastle disease control in village chickens on the welfare of rural households in Mozambique, Fourth Co-ordination Meeting of the FAO/IAEA Co-ordination Research Programme on the 'Assessment of the effectiveness of vaccination strategies against Newcastle Disease and Gumboro Disease using immunoassaybased technologies for increasing backyard poultry production in Africa., Vienna, Austria, pp. 24-28.

Zander, K.K., Drucker, A.G., 2008. Conserving what's important: Using choice model scenarios to value local cattle breeds in East Africa. Ecological Economics 68, 34-45.

Zeleke, A., Sori, T., Gelaye, E., Ayelet, G., 2005. Newcastle Disease in Village Chickens in the Southern and Rift Valley Districts in Ethiopia. International Journal of Poultry Science 4, 507-510

Chapter 6

General conclusions

6.1 Introduction

The studies presented in this thesis investigated the economic value of poultry genetic resources and health services for village poultry in crop-livestock mixed farming systems in rural Ethiopia. The rationale for this valuation study is to inform policies to enhance rural livelihoods through village poultry development. Understanding farmers' preferences, and the worth of poultry genetic resources, is vital to establish an effective poultry genetic improvement and conservation programme. Evaluation of farmers' willingness to pay for village poultry health services, particularly vaccination, helps inform policy to control village poultry diseases through an effective and successful village poultry extension programme that is readily acceptable to, and adaptable by, smallholder farmers. Importantly, the socioeconomic importance of village poultry to smallholder farmers in semi-subsistent production system was assessed with consideration of different socio-cultural and agro-ecological zones.

This thesis presented findings of these studies in three main sections. The first section dealt with village poultry in rural livelihood. This part of the study attempted to assess the socio-economic role of village poultry to farmers of different wealth statuses and different socio-cultural systems. The second part of the study dealt with the valuation of poultry genetic resources in semi-subsistence village poultry production systems. The third part of this thesis covered the evaluation of preferences, and willingness to pay, for village poultry health services, particularly village poultry vaccination services. This part of the study employed two different valuation approaches to evaluate farmers' WTP for poultry vaccination programmes and to identify preferred attributes of possible vaccination programmes for Newcastle disease. The general conclusions and a discussion of the overall research findings are presented in the following section. The conclusions and policy implications given in the following section are based on findings reported in each of the chapters of the thesis. The findings are mainly obtained from primary data collected through field surveys, and analysed using different statistical tools.

6.2 Conclusions

In Ethiopia, the average land area owned per rural person has fallen from 0.5 hectare in the 1960s to only 0.2 hectare during late 1990s (World Bank, 2005). The total population of the country in 2013 was approximately 94 million (United Nations, 2013). This implies a critical shortage of land available to farmers to keep larger livestock, like cattle, in mixed crop-livestock production systems. Poultry is generally believed to be a livestock species that landless people could keep and that can potentially help to improve resource poor peoples' livelihood and access to animal protein. This study (particularly Chapter 2) was, therefore, conducted to assess the potential roles of village poultry, in light of an ever-increasing population with subsequent effects on decreasing landholding size and rising demand for animal protein. Findings from the study presented in Chapter 2, based on primary data collected through the field survey, indicate that village poultry plays important social and economic roles, but that the realization and utilization of the benefits from village poultry varies between regions. Variation in the roles of chickens is mainly attributed to socio-cultural difference and access to markets. Land shortage is comparatively more pronounced in Jarso, one of food deficit districts that are under the food safety net programme, and hence it may seem rational to suggest a key role for poultry-based livelihood enhancement interventions. However, chicken consumption in this area has little cultural significance compared, for example, to Horro. Nevertheless, chicken is locally produced and is consumed within the farming community (to a limited extent) and in nearby urban areas with limited market access (see also Negassa et al., 2011). Consequently, the demand for eggs and chicken in the country is largely dependent on local markets and changes throughout the year, and is greatest during the festive periods. Farmers' access to markets in the cities, which also only rise during festive periods, is also limited due to poor infrastructure and transportation facilities (Aklilu et al., 2007; Negassa et al., 2011). Consequently, in Jarso, where there was limited market access due to both socio-cultural factors and poor market linkages, there was tendency to undermine village poultry as a farm enterprise and as a means to improve rural livelihoods. Another factor that might be important in the limited role of poultry in the livelihoods of farmers in Jarso is the cultivation of *kaht* as a cash crop that can be used as an alternative method to meet cash needs. Indeed, *kaht* may be seen as a more reliable commodity compared to the risks associated with production of chickens that arise due to pathogens, predators, and poor market access.

In contrast, in Horro, where there is better market access, farmers realize and utilize poultry as a tradable commodity and for consumption to a greater extent compared to Jarso. Hence, it is important to facilitate farmers' access to market to enhance rural livelihood based on village poultry development, particularly in areas where land shortage is critical and access to animal protein is very limited. Equally important is awareness creation regarding culinary and eating traditions associated with the cooking of chicken (which make chicken consumption expensive) and changing the notion of chicken as 'luxurious food' to daily food for the masses, as has happened elsewhere in the world. This would potentially raise consumption of chicken and, thereby, local demand for chicken.

A more striking result from the analysis of the socioeconomic importance of poultry was the important role of poultry as a gift to relatives, particularly among poorer farm households. This suggests that village poultry may play a significant role in strengthening resource poor farmers' social-bonds. Another socio-cultural importance of chicken is their consumption during (religious) festive periods in areas where the socio-cultural role of poultry is significant. As reported previously, this study also found that income from sale of chickens and eggs is largely controlled by women, supporting the often stated role of village poultry to empower women. Therefore, interventions in village poultry development would likely improve poor farmers' and women's livelihoods. In this study, however, the findings in Chapter 2 suggest that poultry extension services may be biased towards better-off farm households, with poor farmers having limited access to these services. This implies the need for more appropriate targeting of interventions to benefit the most disadvantaged, particularly in those areas where poultry could bring significant impact to the lives of beneficiaries.

Despite the socio-economic roles of village poultry, there is yet further untapped potential; various interrelated factors identified in this project hinder performance of the village poultry sector. The results presented here indicate that infectious disease had a major impact, leading to underutilization of the potential benefit from village poultry. The number of poultry reported to be lost in a year due to disease was approximately equivalent to flock size owned at the time of sampling – indicating substantial wastage. Predators also cause significant losses and, together, the total chicken lost to disease and predation per year was greater than the average observed flock size. Therefore, making the best of the potential livelihood improvement from village poultry depends on reducing the impact of infectious diseases and improvement of chicken management.

In Ethiopia, research and development related to poultry has been in place for more than fifty years. Poultry development interventions with the aim to improve poultry productivity have mainly focused on the introduction of exotic breeds into the country. This strategy threatens the genetic resource base of indigenous chicken in the country (Halima et al., 2007), particularly because of the indiscriminate and uncontrolled distribution of exotic chickens. However, this strategy has failed to become a sustainable approach to village poultry development due to various socioeconomic factors and unsuitability of the exotic chickens to the prevailing production systems (Teklewold et al., 2006). Indeed, numerous genetic improvement programmes in the tropics have failed to reach their intended targets mainly because the interventions were imposed upon the farmers in a top-down approach, with the breeding goals of the farmers being poorly understood and largely ignored (Mirkena, 2010). Chapter 3 of this research applied a class of stated preference valuation approach (i.e. discrete choice experiment) to elicit farmers' preferences for traits of chickens. This part of the study was conducted in order to inform effective poultry breeding and conservation programmes and the sustainable use of poultry genetic resources. The results indicate that the important traits of chicken to farmers include mothering ability, disease resistance and meat and eggs taste. Among the preferred traits of chicken, mothering ability is the most preferred and valued by farmers. This finding is contrary to past and ongoing efforts to improve village poultry productivity that focus on introduction of specialized exotic chickens (which typically grow quickly and produce more eggs at the expense of broodiness and mothering ability). In the prevailing production systems which are traditional, mothering ability is crucial to farmers as incubation of eggs depends on broodiness of hen and chicks are believed to develop scavenging behaviour from their mother. However, as a result of artificial selection in commercial egg laying chickens, broodiness has been reduced in exotic/specialized chicken lines. These findings, therefore, question the appropriateness of the Ethiopian national government's effort to improve productivity in village poultry by targeting specialized egg layer improved chicken through breeding programmes, at least, in the prevailing production systems.

The results also show that disease resistance is a highly preferred trait of chicken (Chapter 3). In a low-input/low-output production system, the use of health inputs and supplementary feed is very limited or uncommon (Alemu et al., 2008; Bush, 2006). Local chickens have evolved over time under this production system and are, therefore, at least somewhat adapted to the local production environments. Hence, there is the potentially important role for local genetic resources in addressing farmers' needs and preferences within village poultry development programmes.

Traits of cultural significance and egg and meat taste were also preferred and valued, even more than egg productivity (Chapter 3). This is in line with the fact that smallholder farmers in Ethiopia, and across developing countries in general, keep poultry for multiple purposes (Aklilu et al., 2008). Hence, these findings also suggest that poultry breeding programmes aiming to provide breed technologies readily acceptable to farmers need to prioritize traits of adaptive and socio-cultural importance instead of (or in addition to) focusing on egg productivity only. Generally, an important implication of this part of the research is that the unique qualities of the indigenous poultry breeds need to be carefully identified and valued before resorting to those that proved to be successful in different production systems and in different contexts.

Infectious poultry diseases are a major bottleneck to village poultry development in Ethiopia. Poultry health services are very rarely part of agricultural extension support to enhance village poultry productivity. There has been neither a comprehensive policy to control village poultry diseases nor adequate information available to policy makers. In the current studies, smallholder farmers' willingness to pay for a village poultry vaccination programme in crop-livestock mixed farming system of Ethiopia was evaluated (Chapter 4) to help inform policymakers in designing sustainable diseases control programmes for village poultry. The contingent valuation method (CVM) was employed to elicit farmers' willingness to pay for village poultry vaccination programmes. For the CVM survey, two hypothetical vaccination programmes were designed; both included vaccines against Newcastle disease and Infectious Bursal disease (IBD). Both parametric and non-parametric methods were employed in the analysis of these data. The results indicated the existence of potential interest in vaccination services by farmers, and a considerable proportion of interviewed farmers were willing to pay for the proposed poultry vaccine programmes. This suggests that there is the potential and prospect to reduce impacts of vaccine-preventable infectious poultry diseases and enhance rural livelihood through village poultry development. Therefore, it is important to reconsider the poultry extension services and ensure farmers' access to vaccination services for key contagious diseases as smallholder farmers are willing to pay for the service. This also suggests a potential to establish sustainable vaccination programmes where farmers are willing to devote their scarce resources.

The parametric analysis using exponential probit model indicated that farmers' willingness to pay for village poultry vaccination service is influenced by several characteristics of the respondents (Chapter 4). Farmers who had some form of education, and younger farmers, were more likely to be willing to pay for poultry vaccination compared to uneducated farmers and older farmers'. Farmers with some form of education and the younger farmers could recognize the production risk under which they keep poultry and the possible benefit they would gain if diseases risk could be controlled. It is, therefore, important to enhance awareness among farmers on the impact of infectious diseases and possible benefit of disease control as most farmers have little or no education of any form. There was also significant difference in farmers' WTP between the regions studied here. In a region where poultry disease was identified as major constraint, Horro, (see Chapter 2 and 4) farmers' were more likely willing to pay compared with another region (Jarso) where diseases was not identified as primary constraint by farmers. It is important here to take into account the difference in cultural significance of chickens in these two regions, which impact local markets for poultry, particularly as the market for poultry in Ethiopia is mainly local. There were also differences in the position of poultry in the livelihood of farmers in the two regions. Therefore, there is greater likelihood for adoption of, and WTP for, the service where disease is a major concern and where there is incentive (i.e. market access). The results also show that farmers' perceptions about effectiveness of the vaccine also influence farmers' WTP for the service. As failure of a given technology may be long remembered by farmers and influence future attitudes and WTP, it is important that the effectiveness of the vaccine is carefully communicated and monitored. Accordingly, it is important to carefully consider various socioeconomic factors in targeting a poultry health intervention programmes.

The findings from the contingent valuation method were further substantiated using the discrete choice experiment approach to understand farmers' preference for possible Newcastle disease (NCD) vaccine programmes. This part of the study mainly focused on NCD vaccine and identifying the traits of NCD vaccine programmes that farmers preferred and would value, and that would influence acceptance of possible NCD vaccine programmes (Chapter 5). The results show that NCD vaccine programmes that reduce chicken mortality during disease outbreaks was the most preferred attribute of NCD vaccination programmes. Farmers preferred and valued reduction in mortality of chicken the most due to the fact that they lose substantial proportion of their chicken due to infectious disease (see Chapter 2). However, NCD is not the only disease responsible for chicken mortality in village chicken. In a recent study, Bettridge et al. (2014) found that a number of infectious pathogens and their interactions impact village chicken health and production in Ethiopia. Farmers' management practices also have an impact on mortality of chickens. Therefore, while ensuring the vaccine's capacity to reduce mortality in times of outbreak is vital for a vaccine to be widely accepted, it is also vital to consider management and other factors to reduce chicken mortality. It is equally important to carefully communicate information to farmers regarding use and potential effects of the vaccine in reducing chicken mortality, as undeliverable promises may erode farmers' confidence in future poultry health technologies.

The results also showed that farmers prefer a vaccine service that could be delivered by an animal health development agent, rather than by trained farmers (Chapter 5). It is likely that not all villages would have an animal health development agent, particularly in remote areas. Therefore, it is important to either improve farmers' access to such animal health service or to consider developing community vaccinators by providing adequate training to ensure equitable service would be given and enhance the likelihood to meet farmers' need and preference. It was also revealed that farmers preferred route of vaccine administration was via water.

Simulations were conducted to further investigate how choices would change if the attribute levels of the NCD vaccine profile/programme changed (see Chapter 5). Results from the simulations on the influence of changes in attribute levels revealed that reduction in the severity of NCD disease and delivery of vaccine by animal heath extension affects farmers' preferences more than other traits. The key implication is that for NCD vaccine to be readily accepted by farmers, it is important to consider farmers' preferences for delivery mechanisms and routes of vaccine administration, in addition to vaccine's capacity to reduce severity of NCD.

6.3 Limitations and future research

This research provides important insights into smallholder farmers' behaviour regarding preferences and willingness to pay for village poultry vaccination services and poultry genetic resources. However, some limitations remain in the thesis, in spite of the fact that efforts were made to minimize potential problems. Based on the limitations and major conclusions of the thesis, some suggestions are made for future research.

The choice experiment surveys for this research were conducted in one district, in West Ethiopia, despite the various socio-cultural and poultry production systems that prevail in the country. Consequently, it was not possible to investigate variation in farmers' preference for traits of chicken in different parts of the country in this thesis. One would normally expect differences in preference for traits of chicken between farmers, which could be due to difference in production objectives. Farmers in the peripheries of the capital city, for instance, may target the effective demand for eggs in the city and prefer traits of chicken that reflect the egg production potential of chicken, and mothering ability of chicken may not be their preferred trait. Therefore, understanding preferred traits of chickens under different socio-cultural and production objectives is an important future research target. This study also used cross sectional survey data; therefore, it was not possible to assess changes in farmers' preferences over time. Hence, panel data would be helpful to see how farmers' preferences are changing and to assess how the production system is moving towards a market oriented system.

A follow-up survey to the CVM study was not conducted in this research. In the CVM study, conducting a follow-up CVM survey would have given important insight into the temporal stability of the stated WTP in the original survey for further policy implications, and should be considered in future research. Therefore, the estimated WTP for vaccine service in this study should be carefully interpreted, though the findings give important insight into farmers' behaviour with regard to the use of poultry vaccine technology. An important future research area related to farmers' preference and WTP for vaccine technology is to investigate the technical and economic feasibility of using the technology in the prevailing production environment. Pilot work on delivery of vaccination services, and *ex-ante* and *ex-post* impact evaluations of the use of poultry vaccine technologies in village poultry production environment would help to justify using the technologies and inform policymakers and development practitioners.

Smallholder farmers in developing countries rarely practice record keeping. The socioeconomic data used in Chapter 2 of this thesis were collected using a survey instrument in which the information gathered relied on the farmers' memory. In such circumstances understating/overstating at least some socioeconomic data would not be unexpected, though it is not uncommon to rely on respondents' memory of the past in most related studies in developing countries. In this study, households were categorized into income quartiles to analyse the role of poultry to households across income quartiles. Yet, we suggest this income data is carefully interpreted and used in characterising households as poor or non-poor. Another area of research in this regard may be working with farmers in record keeping and a more accurate evaluation of the role of poultry to household in different wealth status and the impact of infectious diseases and control interventions where there is opportunity for trial intervention. The analysis could also be moved forward towards flock modelling.

References

Aklilu, H., Almekinders, C., Udo, H., Van der Zijpp, A., 2007. Village poultry consumption and marketing in relation to gender, religious festivals and market access. Tropical animal health and production 39, 165-177.

Aklilu, H., Udo, H., Almekinders, C., Van der Zijpp, A., 2008. How resource poor households value and access poultry: Village poultry keeping in Tigray, Ethiopia. Agricultural Systems 96, 175-183.

Alemu, D., Degefe, T., Ferede, S., Nzietcheung, S., Roy.D., 2008. Overview and background paper on Ethiopia's poultry sector: Relevance for HPAI research in Ethiopia. DFID Pro-poor HPAI Risk Reduction Strategies Project Africa/Indonesia Region Report No. 1. Washington, DC: International Food Policy Research Institute.

Bush, J., 2006. The Threat of Avian Flu Predicted Impacts on Rural Livelihoods in Southern Nation, Nationalities and Peoples Region (SNNPR), Ethiopia. The Food Economy Group, May 2006.

Bettridge, J., Lynch, S., Brena, M., Melese, K., Dessie, T., Terfa, Z., Desta, T., Rushton, S., Hanotte, O., Kaiser, P., Wigleya, P., Christley, R.M., 2014. Infection-interactions in Ethiopian village chickens. Preventive veterinary medicine 117, 358-366.

Halima, H., Neser, F.W.C., Marle-Koster, E., Kock, A., 2007. Village-based indigenous chicken production system in north-west Ethiopia. Tropical animal health and production 39, 189-197.

Mirkena, T., 2010. Identifying breeding objectives of smallholders/pastoralists and optimizing community-based breeding programs, Department of Sustainable Agricultural Systems. University of Natural Resources and Life Sciences (BOKU), Vienna.

Negassa, A., Rashid, S., Gebremedhin, B., 2011. Livestock Production and Marketing. International Food Policy Research Institute – Ethiopia Strategy Support Program II,Working Paper 26.
Teklewold, H., Dadi, L., Yami, A., Dana, N., 2006. Determinants of adoption of poultry technology: a double-hurdle approach. Livestock Research for Rural Development 18(3) available at http://www.lrrd.cipav.org.co/lrrd18/3/tekl18040.htm

United Nations, 2013. World population policies 2013, New York. Accessed 01-07-2014, at http://www.un.org/en/development/desa/population/publications/pdf/policy/WPP2013/wpp2013.pdf#zoom=100.

World Bank, 2005. Ethiopia - Well-being and poverty in Ethiopia : the role of agriculture and agency. Washington, DC: World Bank. Accessed 06 June, 2014 at http://documents.worldbank.org/curated/en/2005/07/6297093/ethiopia-well-being-poverty-ethiopia-role-agriculture-agency.

Appendices

Appendix 1

Questionnaire for cross sectional study- Socioeconomic and CVM survey

Introductory sheet

1. **Start by greeting the respondent in their language!**
2. **Explain the following briefly to the respondent!**

This is a questionnaire is part of a research study into the economic and health problems of village poultry in rural Ethiopia, Jarso and Horro. The study is conducted by International Livestock Research Institute and the University of Liverpool. Before you decide whether to participate, we would like to explain to you why the research is being done and what it will involve. Please feel free to ask us if you would like more information or if there is anything that you do not understand.

The data to be generated will be on socioeconomic importance of poultry, poultry health services, management, disease problems and preference for traits of indigenous poultry. By doing this, we hope we can develop ways to reduce the problems with disease that will work in your village.

This questionnaire will take about 120 minutes but respondents have the right to stop the interview at any time. Yet, the data will only be used if the questionnaire is completed. Data generated with this questionnaire will not be transferred to a third person and will be used only for the purpose of the study.

We would like to stress that you do not have to accept this invitation and should take part only if you want to. If you decide later you would like your data to be removed, you can tell your DA who will contact us.
Thank you in advance for your willingness to discuss with us!

Village name:
....
Date /dd/mm/yyyy/:..
Time started:...
Name of the
enumerator:..

NOTE: QUESTIONS CAN HAVE MORE THAN ONE ANSWER!

Part-A

I. Households' access to and participation in poultry extension services and knowledge of poultry diseases.

Now we would like to know about poultry extension services and health related issues.

1. How would you say the problem of poultry disease in your area?
    1. Good
    2. Poor
    3. Worst
2. Is there animal health clinic in your village? A/ yes B/ No
3. How far is animal health clinic from your home? _____km or _______walking minutes
4. Does the animal health clinic give health service for poultry? A. Yes B. No
5. Do you know that poultry can be treated in animal health clinic like other livestock?
    1. Yes 2. No
6. Do you have access to advisory/technical/ support from extension workers on poultry production? A. Yes B. No
7. If yes, how often they visit you per month?___________________________
8. If the government starts some auxiliary services to help with poultry production, are you likely to access these?
    1. Yes
    2. No
9. What type of auxiliary services would be important to you?
    1. Training on bird management
    2. Subsidising feed
    3. Providing vaccination services
    4. Providing disease resistant birds
    5. Others specify__________________

II. WTP Elicitation questionnaire- CVM for poultry disease control-vaccine

Currently, the existing poultry health service for village poultry in the country at large and in your area, in particular, is only curative service. With the assistance of veterinary technicians and development agents, we are working to design a vaccination programme for village poultry. We would like to ask you some questions about this programme. Your answers will help us understand the demand for poultry vaccination and design the right kind of programme. Please consider the programme we describe carefully before you answer. If you have any questions about the programme please ask us. We will be happy to answer any of your questions. If you like to discuss with other members of your family before answering us – this is fine. Please take your time!

Scenario 1: In this case, the vaccine service will be offered by veterinary technicians (animal health development agent) at your own home. They will come to your house three times a year and will vaccinate your entire flock of birds. Three times is required for optimum control of disease. This vaccine will protect your birds against '*fingille*[9]' and Gumboro diseases. The vaccine will be administered orally, by mixing in drinking water or feed and/or eye drop method. The

[9] Fingille is local name for Newcastle disease

delivery of the program will be coordinated by livestock agency of the district and relevant offices.

This service entails a cost to the household which you will have to pay in order to take advantage of the vaccination programme. It costs your household____ ETB to get the service each year. Please remember this is in addition to other living costs that your household spends in a year.

If questioned, be prepared with answers for following:

1. Did you understand the details of this vaccination program? A. Yes B. No

If respondent answers NO to question 1, go back and explain - till you receive the answer YES.

2. Do you have any question for further clarification? A. Yes B. No

If respondent answers YES to question 3, go back and explain - till you receive the answer NO

3. On a scale from 0 to 4, what do you think of the program?
    A. 0= very bad
    B. 1= bad
    C. 2=moderate
    D. 3=Good
    E. 4=very good?
4. (Depending on score in 3) What aspect of the program do you like/dislike? ______________________________
5. Do you think the vaccination program we have just described to you will help control poultry disease outbreaks in your village?
    1. Yes
    2. No
    3. I'm not sure
6. Would you pay the annual fee and take advantage of the vaccination program?
    1. Yes
    2. No
    3. I do not know/ I don't want to answer /No answer (please tick one)
7. If no, or I do not know, can you tell us your reason, please?
    1. I do not have the money
    2. I don't think, I should have to pay for vaccine
    3. It is expensive (*if respondent mentions a lower amount make note of it here*!!!)
    4. I do not believe the service will be in place
    5. Other____
8. If no answer, why?

1. I need more time and information.
2. I prefer some other mechanism/ like curative service/.
3. Indifferent to choose yes or no
4. I don't want to spend more time

9. Why you vote yes, if yes?

____

Scenario 2: We are also considering a different version of the above programme. In this case, you will be given exactly the same vaccination service in every respect, except that the vaccination will be administered by yourself. You will have to go to the village centre on the assigned day and here you will be trained by the technician in the use of the vaccines. You will be given the vaccine, which you will have to give to your birds orally, by mixing this in their feed and drinking water and/or eye drop method. You will be asked to come to the village centre to collect the vaccine three times in the year.

This service entails a cost to the household which you will have to pay in order to take advantage of the vaccination programme. It costs your household ____ETB to get the service each year. Please remember this is in addition to other living costs that your household spends in a year.

1. Did you understand the details of this vaccination program? A. Yes B. No

If respondent answers NO to question 1, go back and explain - till you receive the answer YES.

2. Do you have any question for further clarification? A. Yes B. No

If respondent answers YES to question 3, go back and explain - till you receive the answer NO

3. On a scale from 0 to 4, what do you think of the program?
   F. 0= very bad
   G. 1= bad
   H. 2=moderate
   I. 3=Good
   J. 4=very good?
4. (Depending on score in 3) What aspect of the program do you like/dislike? ______________________________
5. Do you think the vaccination program we have just described to you will help control poultry disease outbreaks in your village?
   1. Yes
   2. No
   3. I'm not sure
6. Will you pay the annual fee and take advantage of the vaccination program?
   1. Yes

2. No
3. I do not know/ I don't want to answer /No answer (please tick one)

7. If no, or I do not know, can you tell us your reason, please?
    1. I do not have the money
    2. I don't think, I should have to pay for vaccine
    3. It is expensive (*if respondent mentions a lower amount make note of it here*!!!)
    4. I do not believe the service will be in place
    5. Other____

8. If no answer, why?
    1. I need more time and information.
    2. I prefer some other mechanism/ like curative service/.
    3. Indifferent to chose yes or no
    4. I don't want to spend more time

9. Why you vote yes, if yes?

    ____

Part-B

I. Family structure

We will now start by asking some questions about your family structure, how many members, what age and who does what etc. Let us start with you/head of the household.

1. Family size, activity, and related issues

No	HH head/ relation to HH head(A)	Marital status of HH head (B)	Sex (C)	Age in years	Education (D)	Main Work (E)	Secondary work (E)
1	HH head						
2							
3							
4							
5							
6							
7							
8							
9							
10							

(A) 1= Parent; 2 = Spouse; 3= Son/daughter; 4 = Sibling; 5 = Others
(B) 1= Single, 2= married, 3= Divorced, 4= Widowed
(C) 1-female, 2-male
(D) 0= None, 1= primary school, 2= secondary school , 3= high school, 4= vocational training; 5= college; 6 = degree and above
(E) 1- farmer/family farm work, 2- family non/off farm activity, 3-student, 4- casual wage worker (farm/off-farm) 5- salaried worker , 6-unemployed, looking for a job, 7- unwilling work/ retired/not able to work, , 8-Other (specify)

II. Resource ownership and allocation

Now we would like to ask you some questions about resources related to housing, land allocation, crop production and income, livestock production and use, and other sources of livelihoods.

2. Dwelling/Housing

	Roofing (A)	No. of rooms	Exterior walls (B)	Flooring (C)	Electric supply(D)	Energy source(E)	Drinking water sources(F)
Main							
Kitchen							
Toilet							
Other							

(A) 1-grass roofed 2-Plastic; 3 - Iron sheet roofed; 4 – Combination, 5- Not roofed
(B) 1-Mud plastered, 2-Mud plastered and reinforces with cement 3-covered with straw
(C) 1-Mud/leveled earth, 2--Covered by plastics 3 Cement and stone, , 4-Others
(D) 1-yes, 2-no
(E) 1-Fire-wood, 2-dung, 3-charcoal,4-fuel/like kerosene/, 5- electricity
(F) 1- natural spring-unprotected, 2-natural spring-protected, 3- potable-supplied at water point, 4-potable-supplied at home, 5 other______________________________

3. Land size, allocation and crop income during the last cropping season:

3.1 Total land size in hactar/olma/sanga/qarxi_________________

3.2 Land allocation, costs and crop income in the last cropping season

Crop / Land /input/output/	Crop-1	Crop-2	Crop-3	Crop-4	Crop-5	Fallow land And/or *kalo*
Land allocated in s*anga/olma/qarxi/Hectare*[*]						
Quantity of seed used/Quintal or KG/						
Value of seed used/Birr/						
Quantity of fertilizer used/Quintal/-DAP						
Value of fertilizer used/Birr/-DAP						
Quantity of fertilizer used/Quintal/-UREA						
Value of fertilizer used/Birr/-UREA						
Quantity of Pesticide used/litre/						
Value of Pesticide used/Birr/						
Capital cost/interest paid//Birr/						
Size of land rented-in						
Value of land rent-in / in Birr/						
Oxen rent /value in Birr/						
labour cost-employed in the year -crop						
labour cost-employed in the year -Value						
Labor cost for land preparation /Birr/						
Labor cost for weeding /Birr/						
Labor cost for harvesting /Birr/						
Total cost/Birr/						
Harvest in *KG/quintal/*						
Sold harvest in *KG/quintal*						
Value of sold harvest/Birr/						
Consumed from harvest/Quintal or KG/						
Value of consumed crop/Birr/						
Crop at store/Quintal or kg/						
Value of crop at store/Birr/						
Land rent/for land rented out/-value/Birr/						
Sell of *kallo/*hay/in Birr/						
Total revenue						

4. Livestock and other asset ownership, expenditure, sale and income from livestock products

Livestock type	No. currently owned	Current market value of currently owned	No. /quantity/ sold in the last 12 months	price sold for/valve of rent /	No. purchased in the last 12 months	Purchase price
Cows						
• Income from sale of milk						
• Income from sale of yogurt						
• Income from sale of butter						
Oxen						
• Income from rent						
• Hides/skin						
Bull						
Heifer						
Calves						
Goats(young)						
Goats(adult)						
Sheep (young)						
Sheep (adult)						
Donkey(young)						
Donkey(adult)						
Horses						
Mules						
Others						
Home appliance		Year of purchase	Purchase price			
Radio						
Television						
Tape recorder						
Bicycle						
Others						

5. Livestock expenditure: have you had any of the following expenditures related to livestock during the last cropping season?

Type of expenditure	**Cash value**
Labour for herding	
Feed	
Veterinary services/medicine	
Other expenses	

Other livelihoods type and income from each

Livelihoods type	**Number in hh engaged**		**Income in last 12 months**	
Petty trade	Adults:	Children:	Adult:	Children:
Wage labor	Adults:	Children:	Adult:	Children:
Food for work	Adults:	Children:	Adult:	Children:
Skilled labor employment	Adults:	Children:	Adult:	Children:
Others	Adults:	Children:	Adult:	Children:

6. Other incomes and expenditures:
    1. Saving at bank/home(in cash-Birr)________
    2. Saving rate income in the year(in cash-Birr)____________
    3. Remittance (in Birr) ____________
    4. Transfers out of household (in Birr)__________________
    5. House rent paid (in Birr)______________
    6. House rent that would have been paid(in Birr)_____________

III. Poultry production and marketing practice

We would also like to learn about poultry production and marketing practice of your household.

7. How long have you kept poultry for?___________
8. What/who are sources of hen/chicken to begin poultry production?
    1. Market
    2. Neighbour areas
    3. Office of Agriculture and Rural development
    4. Others_____________
9. What is the main reason for choosing the above source?
    1. Easily accessible
    2. Characteristics of chicken trustable
    3. Known for their good productivity
    4. Chicken health well known
    5. Others_________________________
10. If answer is not from market, why?
    1. Production performance cannot be known/trusted
    2. May be infected by disease
    3. Others____
11. Do you have exotic/improved mother birds?
    1. Yes
    2. No
12. Which breed do you prefer for reproduction?
    1. Exotic
    2. Indigenous
    3. Both

13. Why do you prefer this breed?
    1. Good in brooding and hatchability
    2. Produce more eggs
    3. Resist local conditions, like low inputs/feed
    4. Others___________________________________
14. Do you have separate house for you poultry?
    1. Yes
    2. No
15. What is primary role of chicken production in your household?
    1. For sell to meet day to day financial need of the household.
    2. For consumption: on festive period
    3. For consumption : general-anytime
    4. Others______________
16. What is primary role of egg production in your household?
    1. For sell to meet day to day financial need of the household.
    2. For consumption
    3. Hatching for reproduction
    4. Others_________

17. Poultry and egg ownership, lost and sold

Poultry by Age and sex group and egg	Number currently owned	Current market value	No. lost during last 12 months due to diseases	No. lost during last 12 months due to predator /accidents	Number sold during last 12 months	Number consumed during last 12 months	Value of sold chickens /egg	Who owns it (A)
Hens								
Cocks								
Pullets								
Cockerels								
Young chickens								
Egg								
Total								

(A) 1-children, 2- adult-women, 3-adult-men, 4-youth

18. Role and responsibility of household members on poultry production and marketing: Identify key stages and then look at decision maker.

Activity	Responsibility (A)
Shelter construction	
Cleaning chicken house	
Provision of feed and water	
Purchasing of drugs	
Purchasing of replacement stock	

(A). 1=Adult men, 2= Adult women, 3= children

19. Poultry and egg selling place, target season, and reason by households

Type	Selling place (A)	Reason to choose these market place(B)	Main season at which you sell them(C)	Reason for sale (D)
Chicken/poultry				
Egg				

(A) 1=Neighbors, 2=Local collectors, 3=Near market, 4=Take to far markets 5= to restaurants 6= others

(B) 1=near home, 2= Good price, 3= Fear of diseases in big market, 4= Others

(C) 1= Christmas, 2= Easter, 3= Ramadan, 4= “Meskel”, 5= new year, 6= dry season, 7= summer season, 8= any time need arise or the product available

(D) 1-To purchase food or other stuff, 2- to send children to school, 3-to cover hospital expense, 4- others specify__________

20. Poultry Income: Who decides, who keeps, who sells and what use

Type	Who decides to sell? (A)	Who takes to market? (A)	Who keeps income? (A)	How is income used? (B)
Chicken				
Egg				

(A). 1=Adult men, 2= Adult women, 3= children

(B). 1=Adult men, 2= Adult women, 3= children

Thank you!

Time ended:..

Appendix 2

Questionnaire for Choice experiment survey on Ethiopian smallholder farmers' preferences for different chicken traits and for vaccine services in the poultry sector

I. Participant Introduction and Information Statement

This questionnaire is part of a research study into the productivity and health problems of village poultry in rural Ethiopia. The study is conducted by International Livestock Research Institute, the Ethiopian Institute of Agricultural Research and the University of Liverpool in Great Britain.

Before you decide if you want to participate, we will explain to you why the research is being done and what it will involve for you. Please feel free to ask us if you would like more information or if there is anything that you do not understand.

We hope to find out which are the most important characteristics of chickens to you and also learn about the important characteristics of vaccines. By doing this, we hope we can develop ways to improve chickens in your village and work toward implementing vaccination programmes in the future.

To do this we would like to ask you some questions. During the interview we first want you to compare two imaginary chickens. We will tell you some characteristics of each chickens and we would like you to tell us which chicken you prefer to buy, or that you would not buy either.

Similarly, we will tell you about the characteristics of different vaccination packages and we would like you to tell us which, if any, you would prefer to buy.

We would like to stress that you do not have to accept this invitation and should take part only if you want to. If you change your mind after you have answered the questions and would not like to be included in our study, we can destroy your answers so they are not used. If, after we leave, you are worried for any reason please tell your Development Agent, who will contact us.

II. Interview control information and village data

1. Field interview completed by : ___________________________________
2. Household identifier code:_____________________
3. Village name: ___________________________________
4. GPS location of the household:___________________________
5. Date of interview (DD/MM/YYYY):_____/______/_______
6. Time taken (Hour: minutes): start: ___________ end :_________
7. Questionnaire checked and collected (Date and time): ___/___/___ time ______

III. Household characteristics

8. About the respondent?

Position in the household	Person interviewed (0=No, 1=Yes)	Age (number in years)	Sex (0=Female 1= Male)	Marital status (0=single, 1= married)	Religion $^{\alpha}$	Educational background*
Husband						
Wife						
Others (specify)						

* 0=illiterate, 1= read and write, 2= elementary level, 3 = secondary level, 4= above secondary level.

$^{\alpha}$ 1=protestant, 2=orthodox Christian, 3= 'waqeffata'

9. Family size and composition (in terms of age) including head of the household(the respondent):

Age group	Male	Female
Below 5 years		
≥5 and less than 10 years		
10 - 13 years		
14 - 16 years		
17 – 50 years		
51-65		
Greater than 65 years		

* *Family size* represents number of people who share meals on a daily basis and live together

IV. Responses for the two choice experiments

10. The response for hen choice experiment, please fill in the following table carefully!

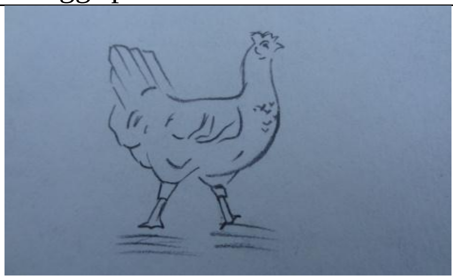
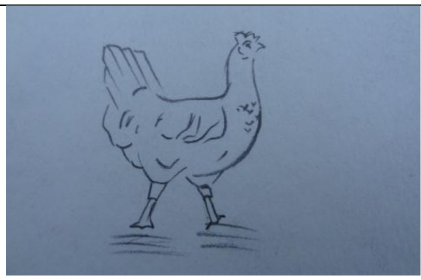
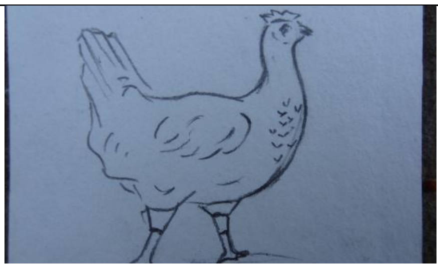
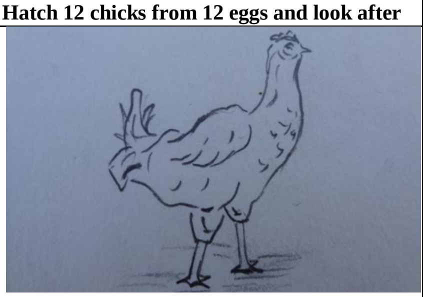
Chicken profile choice			
Block No. and choice set No.	Selected profile		
	1	2	Opt-out
Block No._ _ _ _ choice set No. _ _ _ _			
Block No._ _ _ _ choice set No. _ _ _ _			
Block No._ _ _ _ choice set No. _ _ _ _			
Block No._ _ _ _ choice set No. _ _ _ _			
Block No._ _ _ _ choice set No. _ _ _ _			
Block No._ _ _ _ choice set No. _ _ _ _			

11. The response for vaccine choice experiment, please fill in the following table carefully!

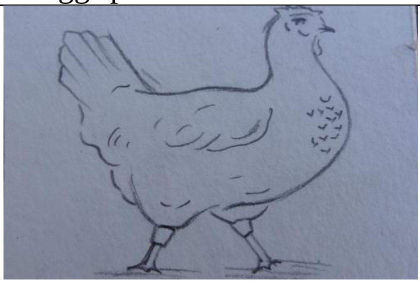
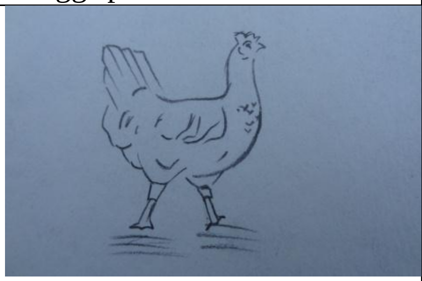
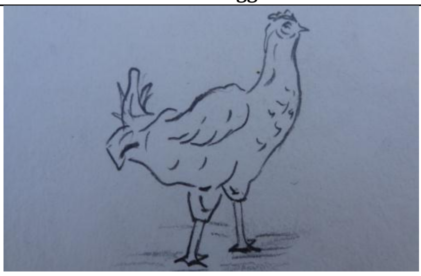
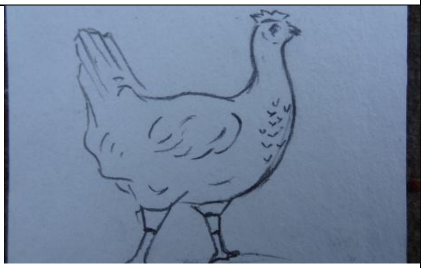
Vaccine services profile choice			
Block No. and choice set No. (Please, fill in order presented to the respondent!)	Selected profile		
	1	2	Opt-out
Block No._ _ _ _ choice set No. _ _ _ _			
Block No._ _ _ _ choice set No. _ _ _ _			
Block No._ _ _ _ choice set No. _ _ _ _			
Block No._ _ _ _ choice set No. _ _ _ _			
Block No._ _ _ _ choice set No. _ _ _ _			
Block No._ _ _ _ choice set No. _ _ _ _			

Appendix 2.1: Sample choice cards used in DCE survey to elicit chicken trait preference

Block 2- choice set 5

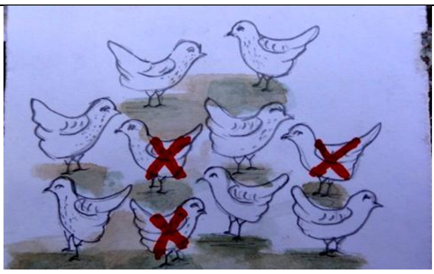
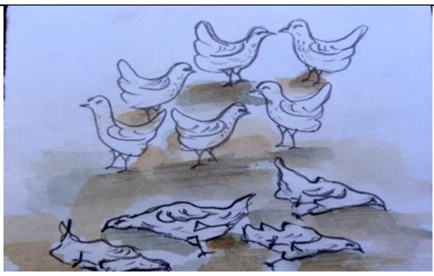
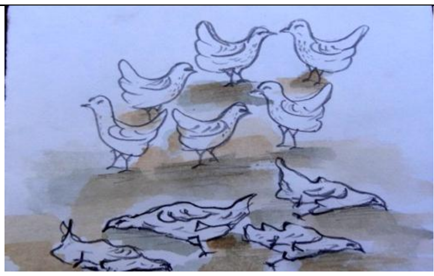
Profile-1	**Profile-2**	**Opt-out**
Predominantly Black	**Predominantly Black**	
 20 eggs per clutch	 12 eggs per clutch	
 Body size-Small	 Body size-Small	
 **Hatch 8 chicks from 12 eggs and look after**	 **Hatch 12 chicks from 12 eggs and look after**	
 Rarely get sick	 Often get sick and may die	
Poor meat and egg taste	**Good meat and egg taste**	
 **Birr40**	 **Birr 55**	

Block 3- choice set 3

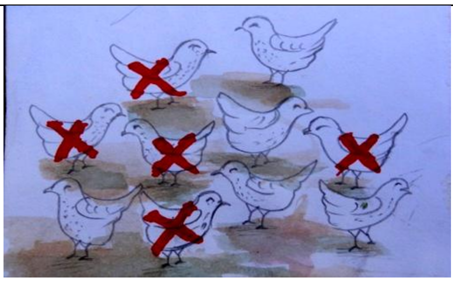
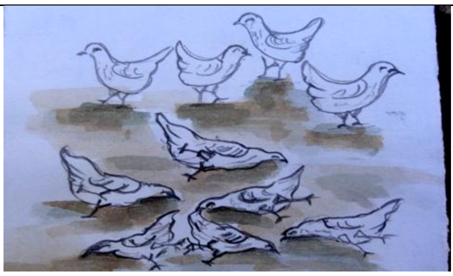
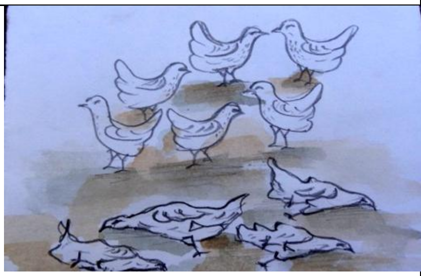
Profile-1	Profile-2	Opt-out
Predominantly Black	**Predominantly White**	
 16 eggs per clutch	 16 eggs per clutch	
 Body size-Big	 Body size-Small	
 **Hatch 12 chicks from 12 eggs and look after**	 **Hatch 8 chicks from 12 eggs and look after**	
 Often get sick and may die	 Rarely get sick	
Poor meat and egg taste	**Good meat and egg taste**	
 **Birr 55**	 **Birr 55**	

Appendix 2.2: Sample choice cards used in DCE survey to elicit preference for attributes of Newcastle diseases vaccine

Block 2- Choice Set 5

Profile-1	Profile-2	Opt-out
 Efficacy- 70%	 Efficacy- 70%	
 Delivery by: vet technician	 Delivery by: trained farmer	
 Route- with water	 Route-Aerosol spray	
 Reduction in severity- 60%	 Reduction in severity- 60%	
 **Birr 100**	 **Birr 100**	

Block 1- choice Set 4

Profile-1	Profile-2	Opt-out
 Efficacy- 50%	 Efficacy- 70%	
 Delivery by: trained farmer	 Delivery by: trained farmer	
 Route- with feed	 Route- with feed	
 Reduction in severity- 40%	 Reduction in severity- 60%	
 **Birr 60**	 **Birr 100**	