Village poultry in Ethiopia

Socio-technical analysis and learning with farmers

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Village poultry in Ethiopia

Socio-technical analysis and learning with farmers

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Abstract

In developing countries village poultry keeping is regarded an important livelihood opportunity for the poor. To improve poultry systems, it is necessary to keep in mind a large number of local complexities. This study aimed to integrate participatory-, survey- and model-based approaches to socio-technical analysis and mutual farmer-researcher learning about constraints to and opportunities for village poultry development in Ethiopia. The study applied a combined technography and systems approach as an input in analyzing possibilities for poultry development in terms of context-mechanism-outcome. To this end it used as data collection methods individual and open-group interviews, a cross-sectional stratified random survey, farm-recording, a market survey, and village-poultry modelling. Feed-back workshops were organised to share between farmers and researchers the data collected through farm-recording and to learn about outcomes of simulation scenarios for identifying improvement options of village poultry systems.

Village poultry significantly contributed to the livelihoods of poor households: economically as starter capital, as a means to recover from disasters, as an accessible protein source and for income and exchange purposes, and socio-culturally for mystical functions, hospitality and exchange of gifts to strengthen social relationships. Poor households used sharing arrangements to have access to poultry. Distance to markets influenced flock sizes and poultry marketing organization. Religious festival days were associated with increased poultry consumption and sales, and fasting periods with decreased consumption.

Farm-recording was as a first entry point to learn about how farmers participate in research. It transpired that researchers needed to understand the religious and customary norms of the community and adjust the data collection tools and procedures to fit these norms. As a second entry point, farm recording information was presented back to farmers to validate the data and to discuss with farmers the reasons of variation between households. A third entry point for sharing between researchers and farmers was modelling and simulation. Information from literature was used for development of a village-poultry model. The study documented experiences of how the modelling process was used to engage farmers and researchers in joint learning about village poultry keeping.

The present study has indicated that through the combination of multiple approaches and methods researchers can arrive at better understanding of constraints affecting farmers' reality. This implies more relevant problem definition and therefore a potentially more effective technology development process. The study confirms that village poultry research and development are not only about finding technical solutions but also involve addressing household livelihoods, and institutional and policy issues from a social science perspective.

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Chapter 1

Introduction

1 General introduction

The production systems of the rural poor are often complex, and based on linking together different livelihood opportunities. Low-intensity poultry keeping is an important livelihood opportunity. To improve poultry systems it is necessary to keep in mind a large number of local complexities. Modelling approaches are useful for examining systemic interactions and improvement scenarios. A model can also be an attractive tool to integrate different processes in village-poultry systems. In the broader field of farming systems research (Collinson, 2000; FAO, 2001), however, modelling has often been used as a way of designing optimal solutions without reference to real life externalities as faced by farmers. Participatory research is sometimes proposed as an antidote to the defects of an imposed modelling approach. In the research project described in this thesis I will treat participatory approaches and modelling not as alternatives but as mutually supportive activities. The thesis seeks to develop a modelling approach linked to scenario assessment by farmers themselves. In other words, it explores ways in which farmers can contribute actively to the development and application of village poultry system models.

A more general objective was to learn about farmer management processes and how potential improvements could be identified. The approach used for this is sometimes termed the technographic approach: i.e. seeking to describe not only the technical processes and equipment but also the human agency and social relations that go to make up a technology (Richards, 2003). In our case, technography serves the specific purpose of seeking to understand which technical and social variables need to be addressed in order effectively to integrate modelling and farmer participation. Understanding what farmers can learn from data collection and model scenarios was a research question that became inherently related to the approach. As the technography progressed, with participation of farmers, we also realized the relevance (for the researcher) of understanding what motivates farmers to participate in basic data gathering.

In this way it is suggested that a modelling approach can become an important tool for participatory development of technologies capable of addressing the needs of some of the poorest groups in rural society. The thesis is developed in relation to the case of village poultry production in Tigray, Ethiopia.

1.1 Relevance of village poultry

In developing countries, many rural households keep poultry in their farmyard. Poultry keeping practiced by rural households using family labour is referred to as village poultry keeping. This practice is also called rural poultry or rural family poultry. In most developing countries, village poultry makes up the largest proportion of the national poultry population (Guèye, 2000; Sonaiya *et al.*, 1999). Poultry provide food and cash income (Sonaiya, 1990; Gunaratne *et al.*, 1993). Approximately 20% of protein consumed in developing countries originates from poultry (Askov and Dolberg, 2002). In Africa, over 70% of poultry products comes from village poultry (Kitalyi, 1998: Sonaiya, 2000). If village poultry are significant for their nutritional or economic value, they also play a significant role in human society through their contribution to the cultural and social life of rural people. The gift of a chicken is often – in many parts of Africa – a way of welcoming high status visitors or honouring affines and kin. Birds are also frequently sacrificed, and in some cultures the entrails of dead birds are consulted as oracles. For this reason the anthropologist Michael Whyte notes "poultry are not simply birds, they are a human creation, a social and cultural practice" (Whyte, 2002).

Rising incomes and urbanization in many parts of the developing world are responsible for a growing demand for animal products. Worldwide, the rate of growth in the production of poultry is the highest, when compared with ruminants and pigs (Brankaert *et al.*, 2000). Poultry meat and egg production accounted for more than 28% of the total animal protein produced world wide in 1997. This proportional contribution of poultry is estimated to reach 40% by the year 2020; the major increase will be in the developing world (Delgado *et al.*, 1999). The per capita consumption of meat more than doubled in the developing world in the last two decades of the 20th century - specifically from 14 kg in 1980 to 29 kg in 2002 (Steinfeld *et al.*, 2006), with an even more spectacular increase in the consumption of poultry. Assuming that a typical average slaughter weight of a chicken for the market is about 1.2 kg (200 days old) and 2.2 kg (40 days old) in the developing and developed world, respectively, then the quantity of poultry meat per person is about 2 kg and 8 kg per year, respectively (Owen *et al.*, 2005). The large discrepancy between these ratios, and especially between the mass of poultry meat per head of population, demonstrates the vast gap in availability of protein from poultry for consumers in North and South. It is thought that this difference between consumption of poultry products in the developing and the developed worlds

will have increased further by 2020 (Kristensen *et al.*, 1999). These estimates and predictions serve to indicate great scope for increased production and consumption of poultry products in the global South (Brankaert *et al.,* 2000). It is sometimes stated that if the suppliers of poultry are smallholder farmers instead of large-scale commercial companies, poultry would contribute to poverty reduction under conditions of expanding demand (Dolberg, 2001; Garces, 2002).

There is wide agreement that the greater part of extreme poverty in the global South is a rural phenomenon. The role of poultry as a potential tool to escape extreme poverty has frequently been claimed (Dolberg, 2001; Kristjanson *et al.*, 2004; Peacock, 2005; Holman *et al.*, 2005; Dossa *et al.*, 2003). Impact on poverty is likely to be achieved through approaches that directly focus on the poorest groups of livestock keepers (Ashley *et al.*, 1999). Poultry have been seen as particularly significant for women's self-reliance (Devendra and Chantalakhana, 2002; Bravo-Baumann, 2000).

Village poultry keeping has attracted attention as a vehicle for rural development. For many decades development agencies, international agencies, governments and non-government organisations have been interested in helping to develop village poultry production. The pace and scope of such support have expanded over the last 20 years and some major initiatives have been undertaken (Mack *et al.*, 2005). These development-oriented interventions range from attempts to replicate commercial poultry innovations at a small-scale household level through to development of innovation and support networks at international level. An overview and characterization of some development-oriented interventions is attempted below.

1.1.1 The Bangladesh model and replicates

The Bangladesh case is considered a good example of how poultry can have an impact on poverty reduction (Nielsen, 1998). The Bangladesh Poultry Development Model has been very effective in reaching and involving poor women in economic development. Dolberg (2003) and Fattah (2000) describe its evolution. During the 1980s the Department of Livestock Services (DLS) and the Bangladesh Rural Advancement Committee (BRAC) developed a model for semi-scavenging poultry production, involving women's groups. The idea was to replicate aspects of large-scale commercial poultry production in terms of

services and marketing, but to bring these down to the village level, where women groups would act as the production units.

The main feature of the model is carefully to sequence supply of inputs and services and ensure appropriate linkages between various actors. The main components are NGOs with access to groups of very poor women, provision (by NGOs) of micro-credit, and training to help groups establish small, semi-scavenging, egg laying units, with special training for poultry workers, feed distributors and egg traders.

Dolberg (2003) contrasted the Bangladesh experience to that of India where, in some states, the commercial sector has a strong presence. He stressed that project 'models' need to be adapted to conditions prevailing in different countries. The smallholder concept developed in Bangladesh is currently undergoing adaptation to conditions in Eastern and Southern Africa (Ahmed, 2000; Jensen, 2001; Gondwe *et al.*, 2001). The adaptation process is rather complicated, as all stakeholders have to be involved and need to be convinced that the poorest segment of the village population is capable of contributing to and managing an income-generating activity based on loans.

1.1.2 Network for Poultry Production and Health in developing countries

The Network for Poultry Production and Health (NPPH) is based on the poverty alleviation concept developed in Bangladesh, with an integrated poultry chain as income-generating activity. The concept has been institutionalised through the Danida/IFAD-supported Smallholder Livestock Development Project (Jensen, 2000).

The vision of NPPH is to build up, through a multi-disciplinary approach, institutional support capacity in Denmark and establish one million smallholder units per year in developing countries for a donor cost of US$100 or less per participating family. NPPH employs a three-pronged strategy to attain its planned institutional capacity. It facilitates human resource development in Denmark and in developing countries; it coordinates research and development activities related to dissemination of the concept; and provides support to planning of pilot projects and for project implementation. The DANIDA supported network has developed a strategy which is both technical and holistic in taking into consideration social, cultural, marketing, credit and general management aspects (Riise *et al.*, 2005).

1.1.3 The ACIAR initiative for Newcastle Disease control

From 1983 the Australian Centre for International Agricultural Research (ACIAR) started to support the development of a Newcastle Disease (NCD) vaccine and delivery programme focused on village chickens. Progress has been made in South-East Asia and Africa with initiatives spearheaded by ACIAR through the promotion of an oral/eye-drop vaccine based on a naturally attenuated NCD strain with the characteristics of heat resistance and an ability to spread horizontally within a flock. The promotion of this vaccine has been significant in reducing NCD in village poultry (Alders *et al.*, 2001; Spradbrow, 1994; Harun *et al.*, 2001). It is assumed that disease control will have a beneficial impact on the economic and social aspects of village chicken production.

1.1.4 International Network for Family Poultry Development (INFPD)

This network, started as the African Network for Rural Poultry Development (ANRPD) in 1989, and was changed to INFPD in 1997 (Mack *et al.*, 2005). INFPD is mainly a network for information exchange; one of its objectives is to encourage higher standards of husbandry for sustainable increase in the productivity of family poultry units. A key aspect is communication of appropriate information. This involves collecting data and detailed information about family poultry-production systems and disseminating the distilled advice through a trilingual (English, French and Spanish) newsletter. It focuses on small-scale poultry-production systems, and assumes a key obstacle to improvement is lack of good information. Since few producers will be able to read the newsletter in English, French, or Spanish, it must be presumed that the information is aimed at technical specialists in the first instance.

1.1.5 International donor efforts

Smallholder poultry production has been a frequent sub-component of a number of donor-funded projects, for example loan projects of the International Fund for Agricultural Development (IFAD), usually targeting poorer rural women (Nabeta, 1997). The most common type of support provided has been credit for small-scale poultry enterprises.

When women are given a choice of loan projects, they often choose poultry production. They are familiar with the activity and set-up costs are relatively low. Frequently IFAD projects have also included other support activities, such as the strengthening of animal health services, the training of

beneficiaries in health and husbandry practices, and on- and off-farm adaptive research on topics related to poultry production. The traditional scavenging system tends to be more successful among the IFAD target group than new semi-intensive systems (IFAD, 2004).

In 2001, the Food and Agriculture Organization (FAO) of the United Nations launched an initiative to facilitate and support the formulation and implementation of policies and institutional changes with positive impact on livestock-dependent poor livelihoods. The basic rationale is derived from the realization that technology-oriented projects in the livestock and related sectors have failed to deliver significant improvements to the poor, and that an enabling institutional and policy environment is indispensable to enhance the impact and sustainability of pro-poor interventions (IFAD, 2004).

The FAO initiative aims at efficient, fair and equitable access to input and output markets, improved access to livestock services, and development of grass-roots organizations that increase the negotiating power of marginalized groups. It is managed by the Pro-Poor Livestock Policy Facility (PPLPF) based at FAO headquarters in Rome, funded by DFID (Department for International Development, UK government), and will be complemented by 'regional hubs' in South Asia, South-East Asia, the Horn of Africa, West Africa and the Andean region.

1.1.6 NGOs and other agencies

Non-governmental agencies (NGOs) play a crucial role in development and are often well placed to target poor livestock keepers without the constraints suffered by larger national or international governmental institutions. Jensen and Dolberg (2002) have argued that if NGO groups using poultry production as a tool for targeting poverty alleviation are to be successful, they must make use of reliable ways to document the achieved results and work to the standards of an institutional science-oriented environment in which sharing of information is encouraged. To date, there is hardly any such information in the scientific literature.

1.2 The relevance of participatory approaches

Experiences from development initiatives show that technology-oriented projects in livestock and related sectors have often failed to deliver significant

improvements in the livelihoods of the poor. To enhance impact and sustainability of pro-poor interventions steps that increase the involvement of marginalized groups are needed, such as efficient, fair and equitable access to input and output markets, improved access to livestock services, and development of grass-roots organizations (Mack *et al.*, 2005).

Research efforts to improve village-poultry production tend still to focus on technical aspects of poultry keeping in the belief that it is these that constitute the principal constraints (Rushton and Ngongi, 2002). The emphasis of poultry research is often on modern (intensive) production systems. For example, research efforts in Ethiopia have focused on evaluation of introduced improved breeds in research station contexts, from where results are disseminated in the hope that the findings can be adopted by farmers (Tadelle *et al.*, 2002). These on-station researches have hardly had any impact on smallholder farmers. This is because schemes are implemented without thorough understanding and consideration of variability in the existing local poultry production system in village settings, and resources and goals of small-scale farmers working in often isolated village settings.

It has been widely accepted in recent decades that research aimed at improving agricultural and natural resources management is likely to be most effective when local people have a voice and are involved in their own development (DeWalt, 1994; Pretty, 1995). The purposes of these approaches have been to achieve impact at household level, particularly in resource-poor and risk-prone areas and diverse agro-ecological and socio-cultural contexts, by developing appropriate technologies and recognizing and cultivating good local practices through integration of information on farmers' perceptions, priorities and household goals (Ashby *et al.*, 1995; Sperling *et al.*, 1993; Thiele *et al.*, 2001).

Although there has been increasing recognition that livestock related research needs to give greater emphasis to farmer knowledge and participation (Sidahmed, 1995; Conway, 1999), the application of participatory approaches in livestock research and development projects is still limited compared to crop-related research (Conroy, 2005). The use of participatory approaches is seen as a way to help ensure that new technologies are appropriate to livestock keepers' needs and circumstances, thus increasing the likelihood of adoption (Reintjes *et al.*, 1992: Conroy *et al.*, 1999).

For village poultry research, this means in practice that researchers have to explore ways to actively engage with poultry keepers, the ultimate beneficiaries and decision makers, to understand and develop village poultry. While more formal and structured types of surveys and needs-assessment exercises can yield useful information, relatively unstructured discussions tend to have a greater capacity to reveal local perceptions and generate a holistic picture (Conroy, 2005). It is expected that the combined use of participatory and formal approaches will allow researchers and farmers jointly to learn about farmer conditions in order that the two groups can help each other to explore farm improvement options. Therefore, this study aims to integrate participatory and formal survey-based approaches to identify social-economic and technical constraints to, and opportunities for, village poultry development in Ethiopia.

1.3 Poultry systems in Ethiopia

Ethiopia is representative of countries where village poultry plays a dominant role in total poultry production. The sector represents an important part of the national economy in general and the rural economy in particular. The population of poultry is estimated to be 56.5 million (BoANR, 1998), making it the second largest African country to Nigeria in terms of total flock size.

According to Alemu (1995), Ethiopian poultry production systems comprise both traditional and modern production systems. Ninety-nine percent of the poultry population consists of local breed types under individual farm household management. The latest figures available indicate that village poultry contributes 98.5% and 99.2% of the national egg and poultry meat production (Tadelle *et al.,* 2002). Birds are owned by individual households and are maintained under a scavenging system, with few or no inputs for housing, feeding and health care.

Modern poultry production started in Ethiopia about 30 years ago, mainly in colleges and research stations. The activities of these institutions focused on the introduction of exotic breeds and their distribution to farmers, along with appropriate management, feeding, housing and health care packages. There are a few private modern production farms around Addis Ababa city. Some state-run poultry multiplication centres have been established, with the aim of providing improved breeds to farmers through the extension service.

Over the last decade, the demand for livestock has almost tripled, with much of this new demand coming from urban areas of Ethiopia. This can be seen in price rises. For example, the price of beef in Mekelle, capital of Tigray region, rose by three times between 1998 and 2006 (from 10-12 birr/kg to 30-32 birr/kg). The price of a live bird (e.g. a cockerel) rose by a similar amount, from 7-12 birr 1998 to 25-30 birr in 2006 (BOANR, 2006). These price rises can be attributed to the growing population and rising incomes in the urban areas.

Although village poultry make up by far the largest element in the national poultry production system, relatively little research (Dessie, 1996; Tadelle *et al*., 2002) has been carried out to characterize, understand and develop village poultry systems in Ethiopia. The present thesis seeks to contribute to this crucial knowledge deficiency.

2 The study area

2.1 Location and population

Ethiopia is located between latitudes 5° N and 15° N, and longitudes 35° E and 45° E. Its neighbouring countries are Eritrea in the North, Djibouti and Somalia in the East, Kenya and Somalia in the South, and Sudan in the West (Fig. 1.1a). With a total land area of 1.1 million km^2 Ethiopia is the fourth largest country in sub-Saharan Africa in geographical extent. The country is divided into nine ethnically-based administrative regions and two chartered cities. These are Afar, Amhara, Benishangul Gumuz, Gambela, Harar, Oromiya, Southern Nations, Nationalities and Peoples Region, Tigray, Addis Ababa, and Dire Dawa, respectively. With about 90% of the inhabitants living in rural areas, the population of Ethiopia increased from 22 million in 1961 to an estimated 69 million in 2007, with an average annual growth rate of 3% (CSA, 2003).

The present study was undertaken in Tigray region, Northern Ethiopia, situated between latitudes 12°15′ N and 14°57′ N and longitudes 36°27′ E and39°59′ E. Tigray is bordered by Eritrea to the north, , Sudan to the west, the Ethiopian region of Afar to the east and the Ethiopian region of Amhara to the south (Fig. 1.1b).

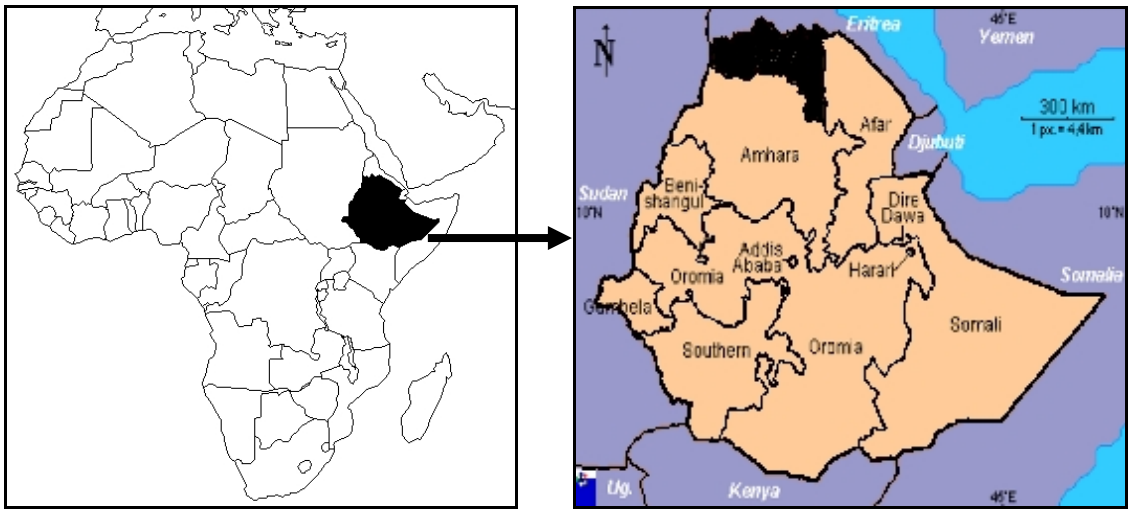

Fig. 1.1a The location of Ethiopia (CSA, 2005)

Fig. 1.1b The administrative states of Ethiopia (CSA, 2005)

2.2 Socio-economic context of Tigray

With an estimated area of 50 079 square kilometers. Tigray has a total population of 4.3 million, of which 85% lives in the rural areas (CSA, 2005). The region is divided into 35 *Woreda*s (districts) (Fig. 1.2). Local market towns and cities are extremely important to the economic activities of rural households in the different *Woredas*. Rural households in many *Woredas* in Tigray rarely have more than a few direct links with more distant urban centres or the capital city (Dercon and Hoddinott, 2006). These towns and cities are the primary locations for the sale of agricultural products. Differences in distance to these towns and cities affect demand and prices. The *Woredas* also vary in quality of roads and population densities.

Enderta, Hintalo and Alaje, *Woredas* located in southern zone of Tigray were chosen as study areas. These districts constitute the major suppliers of eggs and chickens to the regional capital, Mekelle. In Mekelle, there are hardly any commercial poultry farmers and village poultry farmers are the major suppliers. There are variations between these districts in their access to information, market and infrastructure facilities.

Table 1.1 presents populations, number of persons per km^2 and distance to the regional capital of Enderta, Hintalo and Alaje. On this basis, Enderta, Hintalo and Alaje can be respectively categorized as having high, medium, and low access to the main regional market in Mekelle with an urban population of about 200 000.

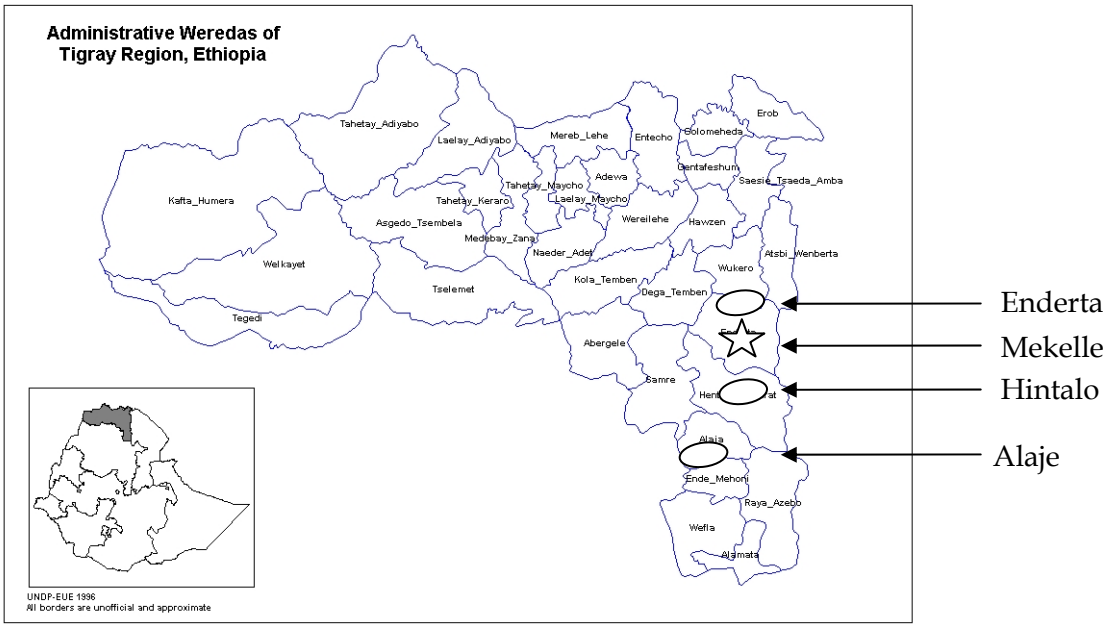

Fig. 1.2 Adminstrative *Woredas* of Tigray (CSA, 2005)

The major religion in Tigray is Orthodox Christianity. In Tigray, about 90-92% of the population belongs to the Ethiopian Orthodox (Coptic) church. About 8-10%, and 1% of the population in Tigray are Muslim, and Evangelical Christians, respectively (Jenkins, 2006). Religion influences livestock consumption and marketing through festivities and fasting periods (Gryseels, 1988).

Tigray is also one of the poorest regions in Ethiopia. Female-headed households tend to belong to the poorest groups, and constitute nearly 30 percent of this region's population. The high prevalence of female-headed households is related to loss of male combatants in the civil war, a traditionally high age gap between wives and husbands, leading to a higher number of widows compared to widowers, a higher likelihood of widowed men remarrying compared to widowed women, and traditional migration patterns, resulting in *de facto* female-headed households even where legal marriage still exists (Meehan, 2004). Being a member of a female-headed household in

Table 1.1 Total population, population density and distance to regional capital of Alaje, Hintalo and Enderta (CSA, 2005)

Woreda	Population	Area (km^2)	People /km^2	Distance to regional. capital (km)
Alaje	113 020	756	150	80 -100
Hintalo	150 504	1764	85	40 - 60
Enderta	144 784	1340	108	10 - 15

highland Ethiopia means having a 35 percent chance of being destitute, compared with only an 8 percent chance if one belongs to a male-headed household (Howard, 2006). Female-headed households account for 80 percent of all malnutrition cases in the project area, covering disadvantaged rural zones of Tigray (Meehan, 2004). Female-headed households are among the poorest households in the region due to constraints on production, including smaller landholdings, less household labour, and greater difficulty in farming their own land, particularly in regard to accessing oxen and labour for ploughing.

The poverty line in Ethiopia is fixed at one dollar day per person. On this basis, about 45% of the rural population lives in poverty compared to about 37% of the urban population (Woldehanna, 2004). But in Tigray, 75% of the population lives under the poverty line, a figure much higher than the national average (BOPED, 2004). Poor nutrition is related to extreme poverty. A long established tradition in Tigray, poultry keeping contributes to nutritional status and serves as a source of cash income through which other foodstuffs can be bought. Poultry keeping is thus a useful asset in the struggle against poverty in a region noted for its food insecurity.

In Tigray, agriculture contributes around 57% of the regional GDP of which 36% is from crop production and about 17% is from livestock (BOPED, 2004). Rain-fed crop production together with livestock production is the main activity for 85% of the population. The average land holding in the region is less than a hectare (Pender *et al.*, 2002b; Pender and Gebremedhin, 2004). The total land under cultivation in the region is about 10 000 square kilometers of which 87.5% is cultivated by smallholder farmers, with the rest managed by private investors (BOPED, 2004). Tigray has a considerable livestock population: 3.1 million cattle, 2.5 million sheep and goats, 0.4 million equines and 5 million poultry in 2004 (Gebremedhin *et al.*, 2004: Solomon, 2005). Livestock plays an important role in the rural economy. Animals are sources of draught power for traction and transportation, cash income from sale of livestock and livestock products, food such as milk for household consumption, manure to maintain soil fertility. They also serve as capital assets for households.

3 Rationale and objectives

A technography is defined by Richards (2003) as "an attempt to map the actors, processes and client groups in such a way that the analyst can see

beyond the technology itself and the problems technological applications are supposed to solve, and to understand what parties and interests are being mobilised in arriving at solutions". This understanding will contribute to knowing "how to make social connection with material outcomes". The aim of this study is to understand, via a technographic analysis using a mixture of modelling and participatory techniques, the interaction between village poultry production (which could be seen as the "technology") and actors (producers and market agents).

The overall objective of a technographic study is "to facilitate better technological intervention" (Richards, 2003). Richards says there are three basic phases in any technography. The Sketch-map phase focuses on the issue "what are the main components of the socio-technical system or process?" and highlights where the information collected is strong or weak and which areas need further detailed investigation. In this research, the sketch map was made with important input from the farmers through farmers' group discussions and interviews. The Analytical phase is problem-focused investigation and aims to explain issues to follow up in order to illuminate problems or controversies". The analysis in this study was not a phase that was neatly separated from the sketch map phase, but emerged from the sketch map process, being further consolidated with the information from the model. The Consultative or Participatory phase is an "opportunity for a more structured consultation with interest groups" to discuss and revise the sketch-map and problem analysis. In this study, the consultation overlapped with the drawing of the sketch map and was then further consolidated by adding the information from the model. In short, the three phases identified by Richards (2003) are present in the current study, but they are treated more as integrated elements than as distinct phases of investigation.

The lack of understanding of the socio-economic context of technology development is a major factor in the failure of research to have an impact on poor farmers' livelihoods (Biggs, 1995). If this danger is to be avoided, in the case of village poultry, this implies the need to understand how farmers' goals, perceptions and resources affect poultry keeping. Village poultry production is managed at household level and development of poultry production therefore requires understanding of technical-biological aspects and social context, as well as their interaction (Whyte, 2002).

Richards (2003) emphasises that technography is methodologically plural. Methodological plurality is required to deal adequately with the complexity of the situation researched, involving technical and socio-economic features and interactions, and to contribute to a similarly complex conception of innovation process or system. To this effect, research has to adequately use and combine social and technical research methodologies in order to find ways to integrate socio-economic and technical dimensions in analysis of village poultry keeping. A survey is one of the most commonly used approaches to study socio-economic characteristics of households. Survey research is the method of collecting data from relatively large numbers of respondents considered to be representative of some population, using an instrument comprising closed or open-ended items or questions (Barrett, 2004). Open-ended items are frequently used as complements to structured items, as they can bring to light unanticipated interpretations and variations in the meaning of responses (Kuiken and David, 2001). Interviews with individual farmers and other key informants and farmer focus group discussions are the most prominent examples of qualitative information gathering. Integrating survey and qualitative research methods is required to obtain a wide range of data and contribute clarity and depth to the research issue under study. In this research, the objective was to further the methodology of a research process in which modelling would be instrumentally integrated in a potential innovation process, and as such allow farmers and researchers to move beyond an extractive type of research, and attain more effective development oriented research outcomes. The assumption was that better integration of farmers' knowledge and priorities, together with a model to assist structured assessment of poultry systems and their constraints would yield more effective (development-relevant) research outcomes.

The methodological foundation underlying the technographic approach is critical realism. Critical realism argues that there are entities with causal efficacy beyond and irrespective of the conceptual systems of investigators (Manicas 2006, Pawson and Tilley, 1997). Critical realism as a research methodology is oriented towards analysis in terms of context-mechanism-outcome (CMO) configurations (Pawson and Tilley 1997). The thesis seeks to understand how a model approach works as mechanism to bring about transformation in village poultry (i.e. the outcome) under the complex circumstances encountered and dealt with by farmers (i.e. context). The CMO as an analytical paradigm provides a framework within which causation can be examined across social and biological strata. This $MxC=O$ equation forms the

conceptual backbone of Realistic Evaluation (Pawson and Tilley, 1997), *i.e.* attempts to understand the ways in which social or development programmes bring about transformations. A realist approach to poultry management operates under the assumption that consequences (changes in poultry management) are to be explained not just by contextual states (in this case farmer knowledge) but by "mechanisms" of decision making and management that need to be uncovered. In this thesis, the CMO framing is applied to what is largely a systems-oriented view. Poultry is considered a component or sub-system of the farming system, managed by the farmer-household members. The development-oriented research process of this thesis aims at developing this poultry component of the farming system, seen as a process in which the modelling serves as a mechanism in a participatory context. It is argued that use of the model, i.e. the mechanism, under farmer-engaged conditions can effectively improve outcomes, *i.e.* performance of village poultry systems, under the proper contextual conditions.

In the agricultural domain, models are used to understand the functioning of production systems, and to explore promising technologies or management options (Hilhost and Manders, 1995; Ramsden *et al.*, 1999; Herrero *et al.*, 1999; Walker and Zhu, 2000). In recent decades, modelling efforts have also included behaviour and impact of technical interventions on farming households (Dimes *et al.*, 2003) and attention has shifted from modelling for purposes of instrumental projection to modelling for improved understanding and adapted management (Van Paassen, 2004). There has been a growing interest to explore the opportunities offered by modelling to sustain interactive research activity serving the needs of small-scale farmers in developing countries, in for example the area of analysis of local production systems and as a support tool in farmer decision making (Dimes *et al.*, 2003). This implies that researchers should engage with farmers in the modelling process for joint learning to pave a more reliable path towards improved farm management. However, a challenge remains concerning how to enhance communication between scientists and farmers and foster joint learning using a modelling process. This study explores the possibility of using a model with farmers in an interactive setting. The approach involved farmers in data gathering through farm recording (as an input to modelling and simulation activities). This modelling activity was then used as a basis for learning with farmers. This had two aspects. Researchers interacted with farmers, but farmers also considered the exchange of ideas and information among themselves as very relevant for understanding their own practices. Modelling and simulation employed

information from literature together with household data obtained through farm recording and market information from the study areas. The aim of the model was to assess the impact of different management strategies on the dynamics in village-poultry systems. Then simulation was used to engage with farmers to encourage mutual learning about village poultry keeping. Farmers "entered" the model, and assessed the implications of outcomes, by taking part in essential activities such as data recording. In effect, they learnt about the possibilities of a modelling approach through participating in the modelling activity, and then being offered opportunities to assess the consequences of simulated outcomes for their own poultry keeping activities.

Objectives

The present study aims to integrate participatory, survey and model-based approaches to socio-technical analysis and mutual farmer-researcher learning about constraints to and opportunities for village poultry development in Ethiopia.

Specific research objectives are:

1. To examine the role of poultry in the livelihoods of poor households' in Tigray, Ethiopia, and how these households' access poultry and associated improved technologies
2. To explore the poultry marketing system in relation to market access, gender and socio-cultural events
3. To learn about the constraints and opportunities of farmers participation in research
4. To explore management options for village poultry using a model approach for joint learning with farmers.

4 Thesis outline

Chapter 1 has addressed the motivation for and issues in this research. The sub-sequent chapters of the thesis are organized as follows.

Chapter 2 examines the role of poultry in the livelihoods of poor households in Tigray, Ethiopia. It also looks at how households acquire poultry and their use of associated improved technologies. In this chapter, multiple methods varying from open interviews with individuals and groups to household records and surveys were employed in order to address the socio-

economic dimensions together with the technical aspects. The chapter also reflects on the value of combining different methods in the research process.

Chapter 3 explores the village-poultry consumption and marketing. It uses different sources of information, such as interviews with producers and intermediaries, market surveys, and farm records. This chapter analyses types of markets and market actors, fluctuations of demand and supply and related price dynamics, in relation to gender, religious festivities and market access.

Chapter 4 reflects on the participation of the farmers in this research project. In particular, it focuses on the experiences of the researcher with farmers in data gathering through a farm-recording exercise that provided information on socio-technical aspects for modelling of village-poultry systems. The experiences are discussed in the light of participatory -research methods.

Chapter 5 presents a dynamic stochastic model to assess the impact of different management strategies in village-poultry systems. Socio-economic and technical data from farm household and market information (chapter 2 and 3) together with literature formed the basis for development of the model and its validation. The chapter demonstrates the use of the model using field data from the project area.

Chapter 6 documents experiences of how the modelling process was used to engage farmers and researchers in joint learning about village poultry keeping. The first part of the chapter documents how information generated from farm recording was used as input data for developing the model, and then utilized for learning with farmers. During the data collection process, farm recording information was reported back to farmers, not only to validate the data but also to provide an entry point to discuss with farmers the reasons for variations between households. This stimulated farmers to think about the management and performance of their flocks. Secondly, the paper presents processes and outcomes using the simulation model for interacting and learning with farmers. Management options were investigated for individual farmers.

Finally **chapter 7** reflects on the context-mechanism-outcome research process. It distills lessons on the added value and limitations of combining participatory, survey and model-based approaches, according to the experiences gained in this research. It also discusses the constraints to and

opportunities for village poultry development, drawing on the findings of the study. The chapter concludes by drawing out some conclusions on research process and opportunities for village poultry keeping.

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Chapter 2

How resource poor households value and access poultry; village poultry keeping in Tigray, Ethiopia

Aklilu, H.A., Udo, H.M.J., Almekinders, C.J.M., and Van der Zijpp, A.J. accepted. How resource poor households value and access poultry; village poultry keeping in Tigray, Ethiopia. Agricultural Systems

Abstract

This study examines the role of poultry in the livelihoods of rural households and the ownership of poultry and related technology in three locations with different market access in Tigray, Ethiopia. The study employed multiple methods such as individual and group open interviews, a cross-sectional stratified random survey of 180 households, and farm recording of 131 households. Rural poultry significantly contributed to the livelihoods of poor households: economically as starter capital, as a means to recover from disasters, as an accessible protein source and for disposable income and exchange purposes, and socio-culturally for mystical functions, hospitality and exchange of gifts to strengthen social relationships. Relatively wealthy households with good market access had significantly more poultry than those in remote areas and the relatively poor. Male-headed households kept larger flocks than female-headed households. The poorest households acquired poultry through poultry sharing. This did not need cash but required building a social network to access poultry. The practice of poultry sharing provided evidence that village poultry played important roles in the livelihoods of poor households. Understanding the interaction of technical aspects with the social context forms the basis for identifying target groups to enhance households' benefits from poultry keeping. The development of village poultry should not be considered as merely solving technical problems but rather as addressing livelihood issues.

Key words: Village poultry; Ethiopia; Market access; Gender; Sharing

1 Introduction

In developing countries, the majority of rural households keep poultry in their farmyard. In Africa, village poultry produce over 70% of poultry products and 20% of animal protein intake (Kitalyi, 1998). In Ethiopia, they contribute almost 99% of the national egg and poultry meat production (Tadelle *et al*., 2003). The per capita poultry consumption in Ethiopia is one of the lowest in the world: 57 eggs and 2.85 kg of chicken meat per annum (Alemu, 1995).

Village poultry has been relatively neglected by the research and development community despite its potential role to improve poor people's income, and nutrition (Guèye, 2000; Sonaiya *et al*., 1999; Udo, 2002). Often, it is claimed that, if the poor can acquire poultry, this can help them to move out of poverty (Dolberg, 2001; Kristjanson *et al*., 2004; Peacock, 2005; Holman *et al*., 2005; Dossa *et al*., 2003). Poultry are particularly associated with the self-reliance of women (Devendra and Chantalakhana, 2002; Bravo-Baumann, 2000; Riise *et al*., 2005). In developing countries, female-headed households represent 20 to 30 percent of all rural households (Saleque, 1999). In Ethiopia, the high percentage of female-headedness (30%) is related to permanent male migration and to being a widow or divorced (Meehan, 2004). In Ethiopia, many poor households lack capital resources to start poultry production. The extent to which households are engaged in poultry keeping is likely to be affected by access to markets (Turner, 2002; Diao and Hazell, 2004). Rural households have different access to markets due not only to differences in transport infrastructure and market information (Holloway and Ehui, 2002), but also to differences in resources (Tegegne *et al*., 2002; Gabre-Madhin and Haggblade, 2004).

Farming systems are managed and used by the households for multiple purposes. Management practices are influenced by the household needs and variable socio-economic and agro-ecological production conditions. Development of the farming system and the various sub-systems of which it is composed therefore requires understanding of technical-biological aspects and the social context and their interactions (Whyte, 2002; Gondwe and Willny, 2007). Biggs (1995) says that the lack of understanding of the socio-economic context of technology development is a major factor in the failure of research to have an impact on the livelihoods of poor farmers. For village poultry development, a component or sub-system of the farming systems, this implies the need for understanding how farmers' goals, perceptions and resources affect poultry keeping.

This study explores socio-economic factors affecting the role of poultry in the livelihoods of rural households in Tigray, Ethiopia. Livelihood is here defined and used as the combination of the household and production system, and includes socio-cultural values of the household. The study thereby focuses on the relation of the poultry system with the farmer household system. In addition, the study relates the poultry system with the marketing system. Tigray, the northern part of Ethiopia, was chosen as research area because it is extremely poor, as reflected in the high percentage (75%) of the population living below the poverty line (BOPED, 2004; Woldehanna, 2004). Rain-fed crop production together with livestock production is the main activity for 85% of the population. To explore how markets influence the poultry keeping by households, three study sites were selected with different level of access to the market.

2 Materials and methods

2.1 The study areas

The study was carried out in Tigray, Northern Ethiopia, situated between latitudes 12°15′ N and 14°57′ N and longitudes 36°27′ E and 39°59′ E. A household in Northern Ethiopia has a farm of less than one ha (Pender and Gebremedhin, 2004), and grows wheat (*Triticum aestivum)*, barley (*Hordeum Vulgare)* and teff (*Eragrostis tef)* as main staple crops. In addition, depending on access to resources, they keep livestock in the form of few sheep, goats, cows, and poultry. Most households keep poultry in the form of chickens. Other poultry species are not common in this part of the country. In all these activities local breeds dominate. Tigray has a livestock population of 3.1 million cattle, 2.5 million sheep and goats, 0.4 million equines and 5 million poultry in 2004 (Gebremedhin *et al.*, 2004).

The sites were selected in a pre-study phase. Based on exploratory visits, interviews and meetings with agricultural officers and extension staff, three sites were randomly selected after the stratification of *Woredas* (districts) by levels of access to the major market in the region: Alaje, Hintalo, and Enderta. They were respectively categorized as having low (80-100 km), medium (30-40 km), and high (5-15 km) access to the market, based on their relative proximity to the regional market in Mekelle, a town with an urban population of about 200 000. In addition, condition of roads, availability of transport services, and market information were considered as a measure of market access. In Enderta

farmers use the several markets in Mekelle throughout the week. The other two *Woredas* have only weekly markets in their villages. Enderta is closer to Mekelle and is connected via a better-asphalted road than Alaje. Because of the distance and the road condition, the availability of transport services from Alaje to Mekelle is low.

2.2 Data collection

The data collection process integrated multiple participatory and survey-based methods. The methods were sequenced in such a way that the outcome of one step was used as an input for the next.

2.2.1 Individual and group interviews

In the first step, key-informant interviews (n=12) and focus-group discussions (n=6) with 4-6 participants were held with members and heads of local councils, women's associations and youth associations in the three locations to collect information on household characteristics. Each discussion took an average of two hours. These discussions indicated that because of differences in access to resources and decision-making patterns, the gender of the household head (male – female) would be a logical factor for stratification. In the three locations, a total of 90 male- and 90 female-headed households were randomly selected for a further study.

In the second step, a total of 21 open individual interviews and 6 group discussions with 4-6 participants were conducted with non-poultry keepers, occasional poultry keepers and permanent poultry keepers in the three locations to find out why they did or did not keep poultry. Individual interviews lasted for one to one and half hours, whereas group discussions lasted more than two hours. Issues addressed included farmers' views on the value of poultry to their livelihoods and the factors determining households' access to poultry and improved technologies. From the discussions, poultry sharing emerged as an important way to access poultry.

The third step aimed at further understanding these sharing arrangements. For this purpose, ten individual and five group interviews were conducted with owners, sharers and with the sharing parties together. The interviewees were asked about the motives for sharing, the relationships between sharing parties (owners and sharers) and their respective responsibilities and benefits. The second and third steps showed what

conditions the respondents considered favourable for households to get involved in poultry keeping.

2.2.2 Cross-sectional survey

In the fourth step, a cross-sectional random questionnaire-based survey of 180 households was then conducted to collect information on farmers' rankings of purposes of poultry keeping, households' participation in poultry sharing and ownership patterns.

2.2.3 Farm recording

Finally, farm recording was used to collect quantitative household-based flock data that served to estimate technical parameters to describe the poultry system and its dynamics. Bi-weekly farm recording in a sub-sample of 131 households willing to continue recording for one year, provided data on flock sizes, breeds (indigenous and improved) and housing facilities. In collaboration with research assistants and farmers more than 3000 farm records were collected between September 2003 and August 2004. The data were collected using farm recording sheets in *Tigrigna* (local language) that were filled by the farmers together with research assistants.

2.3 Data management and analysis

The methods of qualitative and quantitative data analysis were based on Gerald (2001).

2.3.1 Qualitative data

The qualitative data from the individual and group interviews and the farm visit observations were transcribed from field diaries in *Tigrigna* and then translated into English and stored electronically.

2.3.2 Quantitative data

The quantitative data from the surveys and the farm records collected in Tigrigna and translated into English, were entered and managed in Microsoft Excel®. Statistical differences between male- and female-headed households for the relative importance of poultry keeping objectives were determined using t-tests. Chi-square tests were carried out to assess the statistical significance of paired comparisons of the frequency of distributions like ownership patterns of breeds and presence or absence of poultry housing. The General Linear Model (GLM) procedure of ANOVA was used to analyse the variation of numerical

parameters. The model included the effects of market access and gender of household heads.

3 Results

3.1 The role of poultry in farmers' livelihoods

Table 2.1 summarizes the responses of farmers about the roles of poultry in the livelihoods of households in Tigray, Ethiopia. Farmers described the role of poultry in their livelihoods using local expressions or proverbs. Such common expressions illustrated how farmers perceived the functions of poultry as a basis for creating wealth. The functions can be grouped as economic-nutritional and socio-cultural.

3.1.1 Economic and nutritional

Farmers said that '*poultry are* the *first and the last resource a poor household owns*'. They explained that poultry keeping is the first step on the ladder for poor households to climb out of poverty. Poultry is referred to as the '*last resource*' to indicate it is the only capital that households have left when declining into poverty, for example, because of droughts. At the same time it is their initial capital for recovery. Owning poultry but no other livestock, is seen as a sign of absolute poverty. Another expression is ''*Poultry are the seeds you sow to get the fruits, cattle*". This describes the role of poultry as starting capital for poor households. Even after they get cattle, they continue keeping poultry because "*poultry are protectors of sheep and goats*". Selling poultry prevents the sale of their breeding flock of sheep and goats when there is the need to cover immediate, but relatively small expenses. Serving a chicken dish as part payment for labour during, for example, crop harvesting was mentioned by farmers as an important motive for keeping poultry, particularly in remote areas.

An important function of poultry is their bartering value. Layers and cocks are exchanged for farm implements in remote areas where there is no circulation of currency. For example, in Alaje *Woreda*, two layers or cocks are bartered for a *Maresha* (the traditional ox-plough). Once farmers own larger livestock like goats, sheep or cattle, the role of poultry shifts from cash income generation to the more "luxurious" consumption of birds and eggs. For the poor, the consumption of meat and eggs from their own poultry are considered

unaffordable. The poor are described as *"the people that never stop fasting'* because they cannot afford to consume animal products throughout the year.

Farmers also described poultry as a source of self-reliance for women. Poultry and egg sales are decided by women (Aklilu *et al*., 2007) and therefore provide women with an immediate income to meet household expenses (e.g. food items) instead of expecting men to provide the cash. Women describe poultry as the means that '*helps to survive from Saturday to Saturday'*. Saturdays are normally the market days in the study areas. Eggs and poultry are often the only items women sell in the market.

3.1.2 Socio-cultural

Poultry are used for strengthening marriage partnerships. In the local culture, particularly in remote areas, women who can provide men with food like a chicken dish (*doro wot*) are considered to be contributing to a stable marriage. Serving *doro wot* is also a demonstration of respect to guests (e.g. in-laws), thus strengthening social relationships which is especially important for poor households.

There are cultural traditions determining the consumption of poultry that affect nutrition within the household. Customarily, the meatiest and most nutritious parts of the carcass are served to men, for example, the meat on the gizzard, drumsticks and breast bones. It is believed that meaty viscera are especially good for improving the strength of old men and increasing their libido. Lower-quality parts like the neck, wings and skin are served to women and children. A consequence is that men consume more poultry meat.

For the poor, poultry meat is the only special meal they can afford during religious festivities like New Year, Christmas and Easter. Church leaders and attendants are also served with chicken dishes. It has also become common for live birds to be given to very sick people. Cocks are used as alarm clocks of dawn and as offerings to deities. Poultry (mainly local) also have mystical uses. Villagers in the study areas believed bad spirits that target a family member can be diverted with white feathered chickens. Farmers in remote areas attached more importance to such functions (Table 2.1). This explains why many households want to keep at least one chicken in their compound. In general, socio-cultural roles were more important in the area with the poorest market access (Alaje).

Table 2.1 Farmer responses on the roles of poultry in the livelihoods of rural households with low, medium, and high market access in Tigray

Type of role	Description	Alaje (low)	Hintalo (medium)	Enderta (high)
Socio-cultural	Hospitality	+++	+++	+++
	Marriage security	++	+	+
	Gift giving	++	+	+
	Mystical functions	+++	++	++
	Social festivities	+++	+++	+++
	Offerings to deities	+++	+	+
	Alarm clocks for dawn	+++	++	+
Economic-nutritional	Starter capital	++	++	+
	Means of recovery from disasters	++	++	+
	Buffering emergency sales of (large) livestock	++	++	++
	Bartering	+++	++	+
	Disposable household income	+++	+++	+++
	As a protein source	++	+++	+++
	Price for labour sharing	++	+	+
	Short term benefits	+++	+++	+++

+ lowest importance +++ highest importance

3.1.3 Comparative advantages of poultry

Farmers expressed how they valued poultry in comparison with other livestock. According to them, managing cattle, goats or sheep (large stock) was difficult, especially for the poor, because of their high requirements for land, feed and labour, and the risks and consequences of their loss because of drought or diseases were high. Poultry are kept around the homestead and can be managed by small children, the old, weak and even disabled family members, unlike large stock which spend the day away from the homestead and need to be herded by men. Chickens were the only poultry species in the study areas. The farmers said women can manage poultry together with caring for children and other home activities. Based on the farmers, chickens mainly depend on household wastes for feed. They also expressed that the costs of restocking of chickens are not as high as for large stock.

Other advantages farmers emphasized were the short-term benefits they accrue from poultry. A local saying describes this: *"an egg today is worth more than a dairy cow next year''*. Similarly, farmers expressed the fast turnover in poultry as, "*chickens conceive in the morning and deliver in the afternoon"*, referring to the higher reproductive rate of poultry compared to large stock.

3.1.4 Households' priorities in poultry keeping

During the individual and group interviews farmers gave the socio-cultural, economic, and nutritional reasons for their keeping poultry, and in a

formal survey of 180 households they were asked to rank these reasons. Table 2.2 gives the rankings by male- and female-headed households. Location (reflecting market access) did not affect the rankings ($p>0.05$). The rankings suggest that farmers attached more importance to generating cash income from eggs. The higher ranking of the sale of eggs than of birds may reflect a role in meeting immediate financial needs.

In male- and female-headed households, egg and bird consumption by family members and sacrifice for strengthening social relationships were respectively rated as third and fourth most important purposes of poultry keeping. Female-headed households attached significantly ($p<0.05$) more value to egg sales and less to egg consumption than male-headed households.

Table 2.2 Farmers' rankings of relative importance of poultry-keeping purposes in female- and male-headed households in Tigray (mean ± standard deviation)

Parameter	Female	Male
No of households	90	90
Egg sale	$1.4^{a} \pm 0.8$	$1.7^{b} \pm 1.2$
Bird sale	2.0 ± 0.7	2.2 ± 0.8
Egg consumption	$2.5^{a} \pm 1.0$	$2.7^{b} \pm 1.1$
Meat consumption	3.5 ± 0.8	3.6 ± 1.2
Guest reception	4.4 ± 1.1	4.5 ± 1.3
Live bird gifts	5.6 ± 0.9	5.7 ± 0.8

Means with different superscripts within rows are significantly different at $p<0.05$
(1= highest and 6= lowest)

3.2 Factors affecting poultry ownership

3.2.1 Gender

In the group interviews, both male and female farmers associated gender of household head with poultry keeping. The interviews revealed that male- and female-headed households differ in their household resources and priorities. These differences were considered to affect the households' interest, scale of operation, management strategies and knowledge of poultry. Most of the farmers felt that female-headed households would be more interested and involved in poultry production than male-headed households. Farmers suggested that male-headed households have relatively more sources of livelihood and would keep poultry intermittently or keep poultry mainly for home consumption purposes. They could also afford to meet home consumption requirements through occasional purchases. Farmers felt that female-headed households are more involved in poultry keeping as means of

earning income since they have fewer other opportunities than the male-headed ones.

A comparison was made of livestock ownership between male and female-headed households in the study areas. A non-parametric test (X^2) showed that in every location, as compared to male-headed households (n=90), a significantly ($p<0.05$) higher proportion of female-headed households (n=90) had poultry but no other animals. Thus, female-headed households were more often managing only poultry. It can also be observed from Table 2.3 that in each location male-headed households kept significantly more birds than female-headed households ($p<0.05$).

3.2.2 Market access

Farming household members mentioned in interviews that proximity to a village or a regional town affects their involvement in poultry production. They said many farmers in remote areas are not involved in poultry keeping because local demand is low. The farmers described the urbanites as self centred, non-fasting and rich people, whereas rural people are strictly religious and poor, and consume poultry only rarely. In the remote areas it was said that everybody would like to sell poultry but that there are few or no buyers.

The three categories of market access had significantly different ($p<0.05$) average flock size per household (Table 2.3). Households in Enderta, representing the best market access, kept a larger flock size (10.4) than Hintalo and Alaje with flock sizes of 8.4 and 6.9 respectively ($p<0.05$). The interaction effect of gender and market access was significant ($p<0.05$). So, the data are presented per gender per market access area. The significant interaction did not indicate a clear pattern in the difference between female- and male-headed households between the three areas.

Table 2.3 Flock size of female- and male-headed households in three locations with low, medium and high market access in Tigray (mean ± standard deviation)

	Alaje (low)			Hintalo (medium)			Enderta (high)		
	Female	Male	Average	Female	Male	Average	Female	Male	Average
n	26	25	51	25	26	51	17	12	29
Flock size	6.4±2.6[a]	8.0±3.7[b]	6.9±3.9*	8.0±4.9[a]	9.2±4.0[b]	8.4±4.6*	9.1±3.8[a]	11.7±5.4[b]	10.4±4.7*

Superscripts and asterisks show significant differences at $p<0.05$ between gender groups within locations and between locations, respectively

3.2.3 Wealth status

Wealth status was taken as one of the constituent factors that explain differences in poultry keeping amongst sampled households. In order to analyse the influence of wealth status, researchers first tried to understand the distribution of sample households across wealth categories. In the local wealth classification system, each year the *Baito* (local village council) together with elders of the village classify farming households into wealth categories. Researchers learnt that this classification can vary from *Woreda* to *Woreda*, i.e. households with similar resources may fall into different categories in different *Woredas*. Based on group discussions, the main criteria for classifying wealth were identified: family size, number of livestock and area of land owned per household, crop yields, and involvement in non-farm activities. The distribution of households in the study sample is presented in Table 2.4 which shows that better-off households were more often involved in poultry keeping and had more improved chicken breeds and chicken housing. Improved breeds (RIR) are sold to farmers from poultry multiplication stations through the agricultural extension system. Access to improved breeds was defined as the ownership at least once in the year by a participant household. A relatively higher proportion of the male-headed and the better-off households had night time poultry housing facilities.

Table 2.4 Use of local and improved breeds and poultry housing in better-off and poor male- and female-headed households (n=131)

Household head	Wealth class	No of households	Flock size	Type of breeds owned (% of hh)		households with poultry housing (%)
				Only local	Local and improved	
Female	Better-off	17	7.8	76**	24**	47**
	Poor	51	7.2	90*	10*	33*
Male	Better-off	38	8.9	45*	55**	55**
	Poor	25	8.1	88**	12*	40*

Asterisks between rows in a household category are significantly different ($p<0.05$)

3.2.4 Neighbourhood and homestead factors

Farmers considered that distance to neighbouring houses and involvement in backyard gardening affect a household's decision on the flock size they can keep. Households in a dense neighbourhood were expected to have less space and keep fewer poultry to prevent conflicts among neighbours. Farmers used a local expression *´a good neighbour keeps cats but a bad neighbour keeps chicken`* to describe how neighbourhood space limits free-range poultry keeping. Respondents also hypothesized that households that have backyard

vegetable gardens are not involved in poultry keeping. Their explanation was that poultry destroy vegetables and preventing this by fencing the birds or the garden is expensive. Thus, often it is claimed that such households choose between free-range poultry and backyard vegetables.

To verify these statements, a study was carried out to assess how neighbourhood distance and presence or absence of backyard vegetables related to poultry keeping by a household. The distance between the sample household and the nearest household was defined as neighbourhood proximity. During group discussions, it was estimated that, on average, free-ranging poultry roam within a radius of about 300 meters from the household. A sample household that had a neighbour nearer than 300m, was classified in the '*close*' category. The remainder were in the '*far*' category. Households were also grouped based on whether or not they were growing vegetables. Table 2.5 presents how neighbourhood proximity and presence of backyard vegetables related to average flock size per household over the study period. In none of the locations did neighbourhood proximity affect the average number of birds per household. There were also no significant differences in numbers of birds between households with and without backyard vegetables.

Table 2.5 Flock size per household under different neighbourhood and homestead conditions (n=91) in three locations with low, medium and high market access in Tigray

Location	Parameters	Neighbourhood proximity		Ownership of backyard vegetables	
		Close	Far	No	Yes
Alaje (low)	n (%)	18 (44)	22 (56)	28 (69)	12 (31)
	mean ± st.dev.	6.6 ± 5.2	6.1 ± 4.4	6.6 ± 5.2	6.3 ± 4.7
Hintalo (medium)	n (%)	20 (68)	10 (32)	23 (78)	7 (22)
	mean ± st.dev.	7.2 ± 6.1	6.0 ± 5.2	7.0 ± 5.6	7.5 ± 6.6
Enderta (high)	n (%)	14 (80)	11 (20)	17 (75)	6 (25)
	mean ± st.dev.	9.8 ± 6.2	10.9 ± 7.1	10.0 ± 6.4	10.6 ± 8.6

Numbers in parentheses represent percentage of households that fall in neighbourhood or backyard gardening categories

3.3 Access to poultry via sharing arrangements

Farmers in Ethiopia consider that poultry keeping is a strategy for poor households to accumulate capital. Many poor households in the country like to acquire foundation poultry stock but they lack capital for their purchase. During open individual and group interviews, women revealed that poor

households use sharing arrangements to acquire the benefits of keeping poultry in Northern Ethiopia.

3.3.1 The sharing parties

Poultry sharing is usually arranged between households that have close family or marriage relationships and are in the same village. Often this is an inter-household relation between women like sisters or nieces. Often, the better off are the owners and usually the poor are the sharers. The sharers usually initiate the arrangement. Sometimes poor owners look for sharers because they lack feed. For better-off owners, other reasons are more important for going into sharing. Owners normally require sharers to have some experience in poultry keeping and at least a shelter to decrease the risk of predation loss and theft. In the survey, households were asked if they shared poultry during the last two years. A significantly larger proportion ($p<0.05$) of female-headed (23%) than male-headed households (16%) were involved in such arrangements. More often, the female-headed households were sharers. The male-headed households were mostly owners. Thus, poultry sharing can be seen as inter-household interaction mainly of women in the male- and female-headed households.

3.3.2 Motives for sharing

Owners and sharers were asked why they share. The owners said that they provide foundation stock to the sharer who gets a portion of poultry products as a management fee. Sharers borrow or rent laying hens, manage them and share the egg or chicken production with the owner. The reasons for sharing most-often given by owners were feed shortage, disease outbreaks and shortage of labour (Table 2.6). They also transfer poultry to other households in order to prevent the destruction of backyard vegetables and to avoid the spoilage of backyard cattle feed by scratching. Another reason was wanting to help a poorer close relative. A motive can also be to protect property; e.g. if a laying hen belongs to a student, he or she can prevent its sudden sale or consumption by other family members by having a sharing arrangement with another household. The student can use the shared (financial) benefits to cover school expenses. Owners also rent out their poultry in case of temporary migration.

Most sharers said they have some experience and interest in poultry keeping. Making use of a previously built shelter also is a reason for them to share. Besides, sharing allows them to utilize their unused labour.

Table 2.6 Owners' and sharers' reasons for poultry sharing in Tigray

Sharing party	Reasons of sharing	Farmers reasons for sharing poultry		
		% of households	Importance reason[1]	Remarks
Owner	Feed shortage	84	+++	Mainly for poor owners
	Labour	80	+++	Mainly for better off owners
	Disease outbreak	60	++	
	Maintain ownership	30	+	Prevent sudden sale or consumption of birds
	Prevent loss of backyard vegetable and feed stock	72	++	
	Help a relative	45	+	
Sharer	Lack of access to credit	90	+++	
	Risk in use of credit	65	++	Owners claim no compensation during losses

1: + important, +++ highly important

3.3.3 Responsibilities and benefits of sharing

Owners and sharers use no written agreement for poultry sharing. It is based on trust. The owner provides productive birds, while the sharer is responsible for providing proper shelter, feed and protection from thieves and predation. Owners are not expected to claim compensation for losses, especially if they are the result of disease. If owners claim compensation, they are condemned by community members. Conflicts are rare but if they arise, local ''*shimagle*'' (traditional reconciliatory community members) solve them. The division of benefits between sharers and owners ranges from 1:1 to 1:4. The common practice is that sharers and owners share benefits equally. Sharers said if owners rented out improved chickens, they sometimes claim two-thirds of benefits. The products can be shared in cash or in kind. If products are eggs, they are sold by the sharers and the cash is normally shared weekly or bi-weekly. During periods of festivities, the eggs are shared in kind. Birds are shared when they are mature. Hens are the most common birds rented out by owners. But in some cases, young newly hatched chicks are also transferred from the owner to a sharer who is expected to have better possibilities for brooding. At times, owners rent out cockerels of improved breeds to another household and the resulting chicks, usually crosses of improved and local breeds, are shared. The sharing agreement terminates after the sharer has sufficient foundation stock from the share to continue production independently. The initial stock is returned to the owner.

4 Discussion

Village poultry in extremely poor areas, as in Tigray, play important economic, nutritional and socio-cultural roles in the livelihoods of the rural households. During group discussions, households emphasized the many social-cultural, economic and nutritional functions of poultry keeping. However, our cross-sectional survey showed that rural households valued most highly the possibility of cash income from poultry keeping. Village poultry act as a 'starter' that enables people to raise themselves and their families from degrading poverty to a better livelihood (Guèye, 2000). Not all rural households had equal opportunities for keeping poultry which differed according to market access, gender of household head and household wealth status. The flock sizes were smaller than the figures reported from other countries in Africa (Muphosa *et al.,* 2004; Muchadeyi *et al.,* 2004; Gondwe and Willny, 2007). This might illustrate the extent of poverty in the rural areas of Tigray and the poor market access in this region. Households situated closer to the regional capital had better market access and, consequently, larger flock size than those in the more remote locations. Inadequate transport facilities are usually the main constraints for marketing (Abbott and Makeham, 1990). As Ethiopia's road network is improving, household poultry keeping may increase and contribute to better livelihoods through more cash income. The formation of marketing groups could be beneficial for negotiating higher prices and for linking more directly with traders and consumers, especially for households in the remote areas. Better market access is expected to motivate farmers to increase their scale of poultry production and to purchase more inputs.

Female-headed households had fewer poultry than women in male-headed households. Women in female-headed households are poorer than women in male-headed-households and had less access to poultry technologies. This could be due to poor households' lack of access to credit (Tegegne, *et al*., 2002). The financial resources of the poor households were so scarce that they were unable to purchase a hen to start their own flock. However, they had a social system to start poultry keeping based on sharing. Female-headed households were relatively more involved in poultry sharing than male-headed households. Most male-headed households were able to acquire foundation stock by purchasing. The existence of sharing arrangements with larger animals, such as cattle (Ifar, 1996) and small ruminants (Bosma *et al*., 1996) has been reported in developing countries. They result in a more optimal use of the labour, capital and feed resources at village level (Ifar, 1996). In the study areas,

the sharing of sheep and goats has existed for a long time. The sharing parties revealed that poultry sharing started relatively recently in Ethiopia. This suggests an increase in resource scarcity among rural households and the importance of community coping strategies. The sharing system is based on trust and not a formal agreement. The sharing showed that for households with scarce cash capital, a partnership with other households enabled access to poultry which they could not otherwise acquire. Such livestock-in-kind partnerships can result in increased power for owners and higher dependency for sharers (Schilhorn van Veen, 2001). Programmes like Heifer International (HPI, 1998) use animal-in-trust schemes to promote livestock for smallholders. They can use this existing sharing system as entry point for supporting poor households through providing them with live animals on credit where first offspring are to be redistributed to poor households.

In order to address socio-cultural and technical aspects, this study employed multiple methods varying from open interviews with individuals and groups to household records and surveys. The results of the qualitative methods used at the beginning of the research informed the design of the survey and site selection by identifying locally relevant factors like market access, gender and wealth status. The use of qualitative methods underscored the importance of issues which we would not have appreciated using only a survey. For example, the open-ended approach made us aware of the poultry sharing practice and how it is organized. Prior to our study there was hardly any information on poultry sharing and the practise would not have been included in a questionnaire.

There was some overlap as well as discrepancies between the outcomes of the open-ended methods and the surveys. For example, the importance of market access for poultry keeping was identified by both methodologies, whereas the effect of homestead factors was not. Farmers suggested that homestead factors like neighbourhood proximity and presence of backyard gardening would decrease poultry keeping. But farm records did not show a relationship between these factors and flock size per household.

It can be concluded that market access, gender, wealth status and sharing arrangements are relevant to village poultry keeping. If rural development projects through poultry are to be successful at community level, they should consider these driving forces for poultry keeping. Our findings suggest that project designs have to consider not only technical dimensions but that they

also have to be sensitive to the socio-cultural and economic environments of potential beneficiaries. Thus, village poultry research and development is not only about animal scientists finding technical solutions but also it involves addressing livelihood issues which require social science oriented studies.

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Chapter 3

Village poultry consumption and marketing in relation to gender, religious festivities and market access

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Abstract

This study aimed to examine village poultry consumption and marketing in Ethiopia in relation to gender, socio-cultural events and market access. Main objects of the research were producers, poultry markets, producer-sellers, and intermediary sellers in three locations representing different levels of market access in Tigray. About 3000 farm records were collected over a period of 12 months from 131 producers to obtain quantitative data on sales and consumption. Ninety-three semi-structured interviews with 58 producer-sellers and 35 intermediaries and 12 group discussions with these market actors were conducted to explore organization, price dynamics and socio-cultural aspects of poultry marketing. In total, 928 producer-sellers and 225 intermediaries were monitored monthly to examine participation of gender in poultry marketing. Better market access was associated with a shorter market chain and higher prices for the producers. Female-headed households had smaller poultry sale and consumption per household but sale and consumption per family member were 25% and 66% higher, respectively, than in male-headed households. While women dominated in the producer-sellers group, intermediaries were mainly men. Religious festivals periodically shifted local demand and prices of poultry. To improve the benefit of poultry keeping, poverty stricken poor households may profit from better market access through better market information, infrastructure, market group formation and careful planning to match the dynamics in demand.

Key words: Ethiopia; Gender; Market access; Religious festivities; Village poultry

1 Introduction

In developing countries, such as Ethiopia, village poultry represent a significant component of the rural household livelihood as a source of income and nutrition, and as gifts to strengthen social relationships (Guèye, 1998; Sonaiya *et al*., 1999; Whyte, 2002). Research to improve village poultry production tends to focus on technical aspects of poultry keeping in the belief that these constitute the principal constraints. It is, however, increasingly recognized that marketing opportunities are crucial to capitalize on improved technologies by generating cash income. Often, farmers are not attracted by new technology even when it appears to be better than their current practices owing to market limitations (Diao and Hazell, 2004). Smallholder households are not only producers but also consumers. Understanding of the household consumption and marketing patterns and the relation between these two are therefore relevant basic information for development of household poultry production. Household consumption is related to food security and nutrition. On the other hand, marketing of poultry products is one of the few opportunities for poor rural households to generate cash income. Understanding of marketing structure and functioning is a prerequisite for developing market opportunities for rural households and can be used to inform policy makers and development workers in considering the commercial and institutional environment in which village poultry keepers have to operate (Hellin *et al*., 2005). Access to markets is considered an important factor in marketing opportunities. Market access affects price of the product and transaction costs and is influenced by infrastructure and information. Generally, for poorer households and with increased distance to the market, market access is low (Holloway and Ehui, 2002).

Many studies have shown that village poultry production is the domain of women (Bravo-Baumann, 2000; Devendra and Chantalakhana, 2002). In sub-Saharan Africa, 85 percent of all households keep poultry, with women owning 70 percent of the poultry (Guèye, 1998; Branckaert and Guèye, 1999). Village poultry are used as a tool in promoting gender equality and women's development (Guèye, 2000). The role of gender not only in production but also in consumption and marketing is important to effectively increase benefits from poultry keeping for poor female-headed households (Rushton and Ngongi, 2002).

Socio-cultural factors are likely to influence poultry consumption and marketing, and flock management as shown by the situations with other livestock (Solomon *et al*., 2003; Budiastra *et al*., 2006). In Ethiopia religious events affect the consumption of animal products. The country has the most numerous and longest fasting periods in the Christian world. For common people, there are 110-150 fasting days per year and for priests, monks, other people connected with the church, and for old people, the total can reach up to 220 days (Knutson and Selinus, 1970). Fasting involves abstention from eating meat, eggs, milk and butter.

The objective of this study was to understand variation in household consumption and marketing, and the possible relation between them in three areas with different market access in Tigray, Ethiopia. Tigray is a region with a long tradition of poultry keeping. It is also one of the poorest regions in Ethiopia and protein deficiencies cause high mortality and retarded growth in children (BOANR, 1999). The study considered type of markets and market actors, fluctuations in demand and supply and related price dynamics in relation to gender and socio-cultural events.

2 Materials and Methods

2.1 The study areas

The study took place in Tigray region, Northern Ethiopia, between latitudes 12° 15'N and 14° 57' N and longitudes 36° 27' E and 39° 59' E. Three *Woredas* (districts) were selected, using a stratified sampling based on levels of access to a major market in the region. In this study, the combination of distance to the market, condition of roads, availability of transport services, and market information was considered as a measure for the market access. Enderta is located within a walking distance (5-35 minutes) to Mekelle. Thus, farmers in this *Woreda* use the several markets in Mekelle throughout the week. The other two *Woredas* are several hours' of walking distance from the regional market and have only weekly markets in their villages. Enderta is closer to Mekelle and is connected via a better-asphalted road than Alaje. Because of the distance and the road condition, the availability of transport services from Alaje and to Mekelle is low. The three studied *Woredas*, Enderta, Hintalo and Alaje were categorized as having high, medium and low access to markets, respectively (Fig. 3.1). Villages in each *Woreda* were randomly selected, from which sample participant households were drawn.

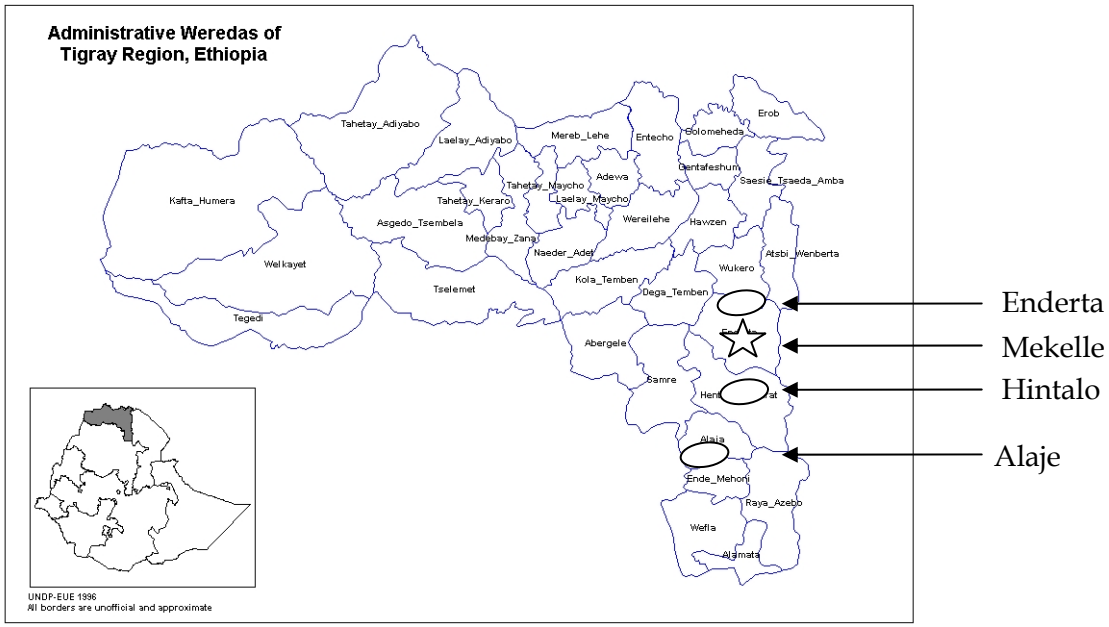

Fig. 3.1 Map of Tigray, the study area, situated in the North of Ethiopia (CSA, 2005)

In these study sites, 30% of the households were female-headed; the others were male-headed. The high percentage of female-heads of households is due to widowhood, divorce, and permanent male migration (Meehan 2004; BoANR, 1999). For the study, 68 female-headed and 63 male-headed households were selected.

Orthodox Christianity is the major religion in the study areas. In this religion, five major festivities are celebrated every year: St. John's day, also Ethiopian New Year (September 11), Ethiopian Christmas (January 5), Ethiopian Epiphany (January 19), Ethiopian Easter (varying dates in April), and St. Mary's day (August 23). Each of these religious festival days is preceded by a fasting period of a few days to several months. During the fasting period, household members abstain from consuming all kinds of animal products.

2.2 Farm recording

About 3000 farm records were collected from 131 households between September 2003 and August 2004 to explore how religious events affect poultry dynamics. This provided quantitative data on sales and consumption of birds and eggs. The farm records were kept in Tigrigna (local language) by farmers using written formats, stones, and memory in collaboration with research assistants. The farm records were translated from Tigrigna into English during the data collection process.

2.3 Marketing study

A marketing survey was conducted to identify the gender of producer-sellers and intermediaries. This served a first characterization of the participants involved in the poultry chain. Producers-sellers are defined as producers who sell their produce directly to consumers or to intermediaries in the market. Intermediaries are traders who form the link between producers and other traders or consumers. A total of 58 and 35 interviews, respectively, using semi-structured questionnaires and 12 group discussions were carried out with 3-6 of these marketing actors to explore the poultry marketing system in the three *Woredas*. This provided information on organization, price dynamics and social aspects of poultry marketing. Data were collected monthly in the markets by six research assistants. This yielded a total number of 928 observations from producer-sellers and 225 from intermediaries.

2.4 Data analysis

Scale variables from farm recording and market surveys were entered and managed in Microsoft Excel® and analyzed with SPSS (2002). *F*-test was applied to test differences between means of relevant parameters using the GLM procedure of SPSS 11.5. For frequency variables, chi-square was applied to test dependency of row and column factors. Trend lines were used to visualize seasonal dynamics of marketing and consumption variables. Qualitative data from interviews and discussions were transcribed from field diaries in Tigrigna, translated into English and stored electronically. Sorting and organizing related information served to generate the qualitative description.

3 Results

3.1 Household sales and consumptions

3.1.1 Monthly fluctuations in poultry household consumptions and sales

There were fluctuations across the months of the year in sales as well as in consumption of both birds and eggs (Fig. 3.2 and 3.3). The highest bird sales and consumption overlapped with the major social and religious festivals of the year. These are Ethiopian new year (September), Ethiopian Christmas (January),

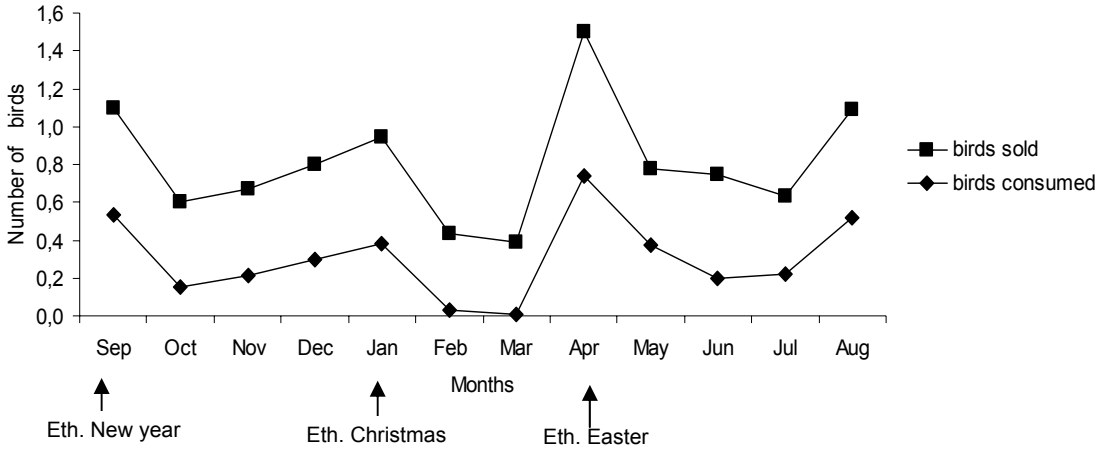

Fig. 3.2 Average numbers of birds sold and consumed per household per month in the year 2003-2004 in the study areas

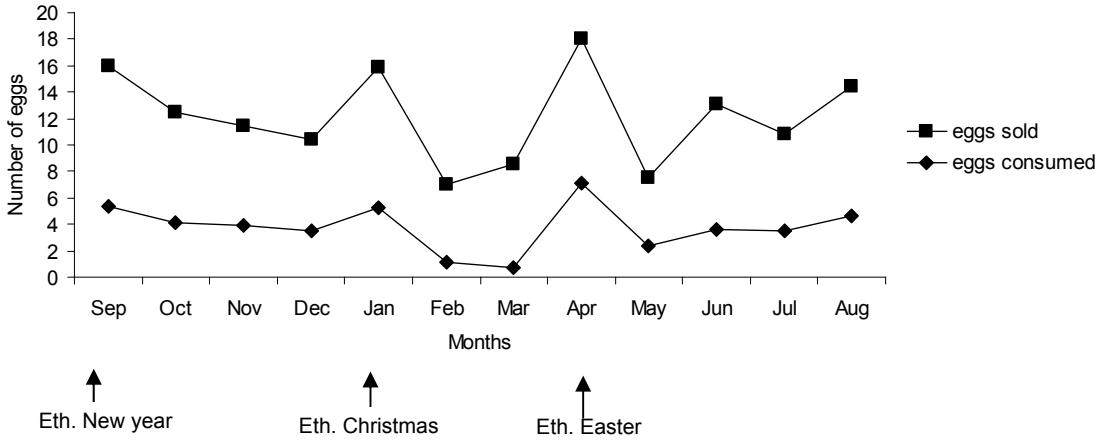

Fig. 3.3 Average numbers of eggs consumed and sold per household per month in the year 2003-2004 in the study areas

Ethiopian Epiphany (January), Ethiopian Easter (April), and St. Mary's day (August).

The periods of low bird sales and consumption coincided with the pre-Easter fasting period which lasts about two months: from February through March. The other low sales and consumption period was during pre-Christmas fasting period. Similarly, egg sales and consumption followed the same pattern as that of bird sales and consumption (Fig. 3.3).

In addition to the fasting periods, most strict orthodox Christian households, especially in the rural areas, abstain from eating animal products on most Wednesdays and Fridays except for a few months after Easter. In many cases, sick people, children and pregnant women are exempted from fasting.

3.1.2 Accumulated sales and consumption

Table 3.1 presents bird and egg sale and consumption in female-headed and male-headed households in the period between September 2003 and August 2004. In female-headed households bird and egg sales and consumption per household were lower than in male- headed households, but the figures per family member were higher in female-headed households. This can be explained by the smaller family size of female-headed households as compared to male-headed households. Significant differences between the locations were observed in bird and eggs sales per household and per family member ($p<0.05$) with the largest sales of birds and eggs in Enderta, the location closest to Mekelle.

Table 3.1 Number of birds and eggs sold and consumed over 12 months in male- and female-headed households in locations representing low, medium and high market access in Tigray in 2003-2004

	Alaje		Hintalo		Enderta		p
Parameter	Female	Male	Female	Male	Female	Male	
Households	26	25	25	26	17	12	
Household size	3.6	5.0	4.2	5.4	4.1	6.7	
Flock size per hh	6.4	7.9	8.0	9.2	9.1	11.7	*
Consumption							
Birds per household	3.5±3.3	4.0±3.7	3.4±3.1^a	3.0±2.5^b	4.1±3.8^a	3.9±3.6^b	
Birds per hh. member	0.8±0.4^a	0.6±0.8^b	0.7±0.8^a	0.6±0.6^b	1.2±1.5^a	0.7±0.9^b	*
Eggs per household	34.1±31.2	35.5±29.6	42.1±35.1	46.5±33.4	51.8±47.4	64.7±52.2	
Eggs per hh. member	9.5± 8.7	7.1±5.9	10.0± 8.4	8.6± 6.2	12.6±11.6	9.7±7.8	
Sales							
Birds per household	3.9± 4.3^a	4.4±4.1^b	6.3± 6.8^a	6.8±5.5^b	6.6±8.9^a	8.2±7.7^b	*
Birds per hh. member	0.7± 0.4^a	0.6±1.2^b	1.7±1.6^a	1.2±3.7^b	2.1±1.3^a	1.5±1.5^b	*
Eggs per household	75.3± 4.8	78.3±45.2	92.8± 56.6^a	103±58.8^b	114±59.8^a	143±68.3^b	*
Eggs per hh. member	20.9± 9.7	15.7± 9.0	22.1± 13.5	19.0± 10.9	27.9± 14.6	21.3± 10.2	*

Different superscripts denote significant differences between columns and asterisks indicate significant differences between locations ($p<0.05$)

3.2 Poultry marketing system

3.2.1 Marketing structure

In the study area, the marketing system involves a series of producer-sellers and intermediaries. Fig. 3.4 presents the marketing structure in the three locations with three levels of market access. Live birds and eggs are either directly sold to consumers or sold to intermediaries for retail in the larger towns and cities. Although each location has its own local market (neighbours and village markets) where transactions take place, marketed produce finally flows to urban consumers, particularly in the regional capital Mekelle. In all locations, producers were also consumers. Home consumption can be

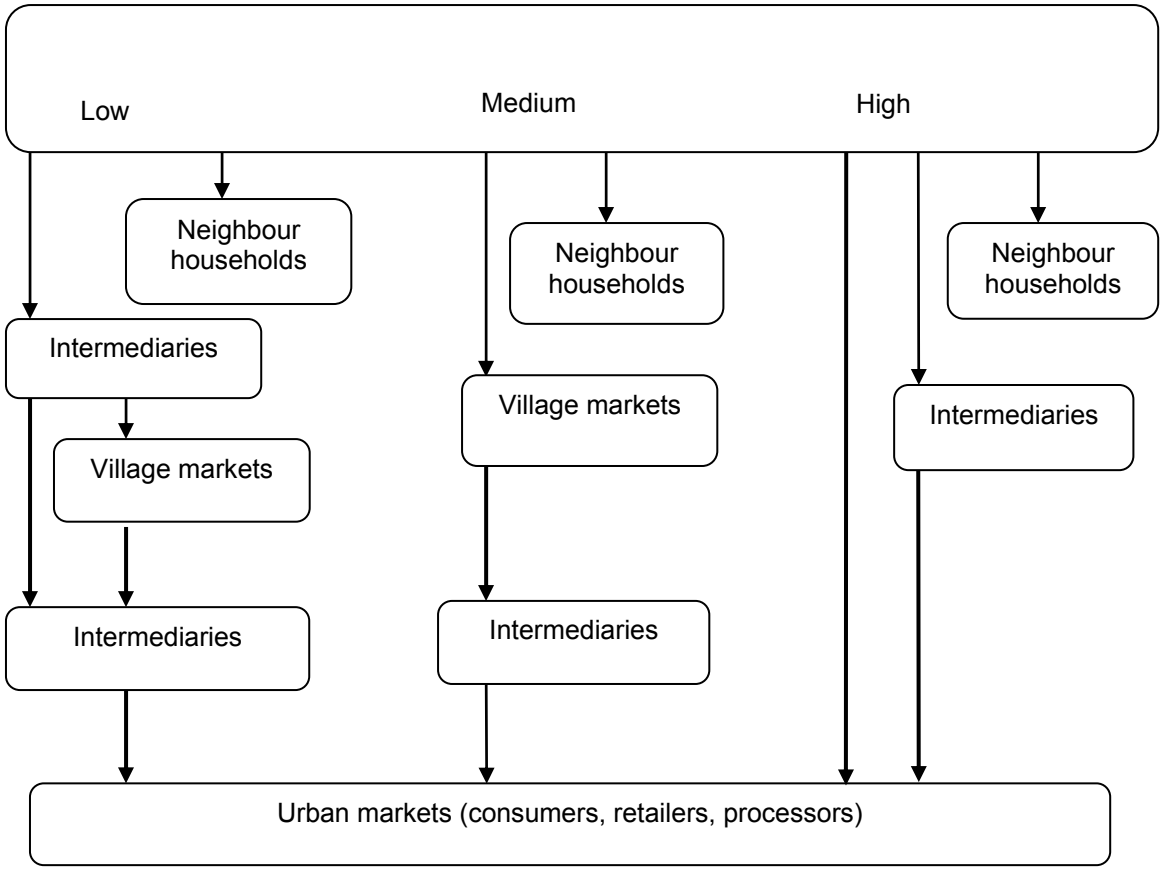

Fig. 3.4 Poultry marketing channels in locations representing low, medium and high market access in Tigray

understood as one of the market outlets. Thus, producing households have a double role in the market chain and have to balance competing demands from household consumption and the buyers in the market place.

The length of the marketing chain varied between locations. Alaje, at a walking distance of 1-2 days from Mekelle, has the longest chain involving secondary and tertiary intermediaries before products are delivered to the city consumers. In this area, village markets are weekly on a fixed day. The majority of transactions within the villages mainly is from farmer to farmer and may not involve cash. For example, among neighbours, chickens are sometimes bartered for larger animals such as sheep and goats. The poultry sharing arrangement (Aklilu *et al*., submitted) can be considered as another form of informal marketing in these areas. Although the main purpose of selling is to obtain income, fellow farmers who need a hen or cock for production may purchase from or share with a neighbour.

Some farmers give their chickens to children to sell at the village market or to the roadside traders, who in turn sell to other traders who are often found

at important crossroads and well-known spots on main truck roads. There is a high level of secondary (and even tertiary) marketing in these locations. At the other extreme, Enderta, the area representing high market access, has the shortest chain where most producers directly deliver their birds and eggs either to urban consumers or to road-side poultry buyers at relatively good prices. Thus, direct selling, from producers to consumers, is highest in the locations close to Mekelle. During the weekly major market day, producers can directly find a large number of buying consumers. On other days of the week, producers also sell their poultry to stationed traders in the urban markets. Often, there are designated locations where movable chicken stalls are erected. In addition to the nearby villages, suppliers to such markets can be traders who buy from secondary markets, place chickens on taxi racks and take them to towns from remote village locations like Alaje. Buyers at urban markets are hotels, restaurants and affluent city dwellers. Ordinary urban dwellers also buy poultry occasionally, mainly during festivities.

3.2.2 Gender participation in poultry marketing

Table 3.2 presents the participation of children, women and men in poultry marketing in three locations in Tigray in 2003-2004. In general, data show that all gender categories of producing households are involved in direct selling. In all locations, women make up the majority (40-58%) of the producers who sell at local markets. Men's participation in marketing increases with better market access. The larger markets in towns are male-dominated. During group discussions, participants disclosed that women are more likely to control the spending of the money from sales when they sell their poultry themselves than when men do the selling. They said that women who get cash from poultry sales certainly spend it on family needs. The participation of gender categories

Table 3.2 Participation of children, women and men in poultry marketing in three locations representing low, medium and high market access in Tigray in 2003-2004

	Alaje	Hintalo	Enderta
Composition of producer sellers			
Number of observations (n)	312	292	324
Children (%)	24	26	22
Women (%)	58	44	40
Men (%)	18	30	38
Composition of intermediaries			
Number of observations (n)	72	63	90
Children (%)	21	23	24
Women (%)	22	17	12
Men (%)	57	60	64

in secondary poultry marketing shows a different picture. Men make up the major portion of secondarysellers in all locations. The proportion of women and children in secondary selling was relatively lower than in primary selling. The proportion of men involved in poultry marketing tended to increase with increasing market access.

3.3 Market prices of poultry products

3.3.1 Price variation across months

Prices of poultry varied between months of the year at all the locations. Fig. 3.5 presents the trends of average prices of cockerels over 12 months in the year 2003-2004. Cockerels are the main birds sold. In conformity with the trends in sales and consumption, price of birds increased in the high-sale periods like Easter (April) and Christmas (December -January). Periods of low prices also coincided with times of low sales, e.g. the pre-Easter fasting period (February). Throughout the observation period, prices remained highest in the areas with better access and lowest in the remote areas.

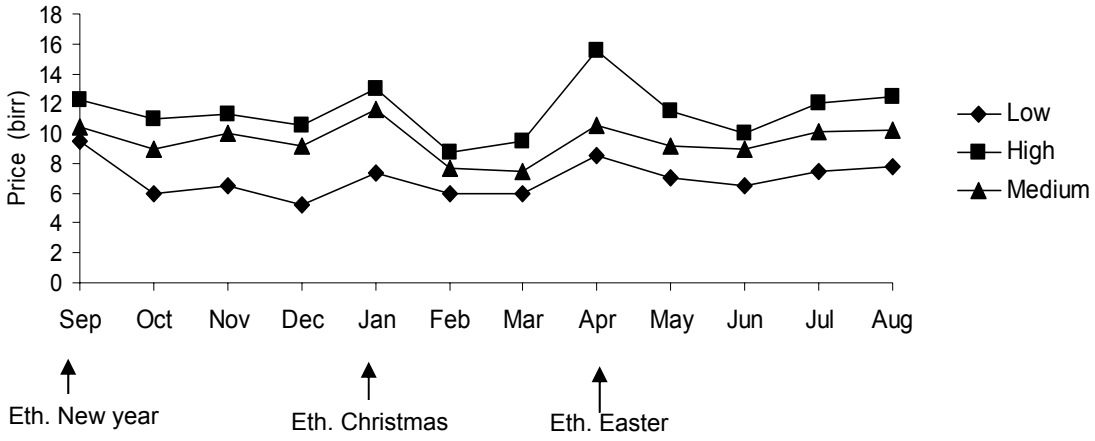

Fig. 3.5 Prices of cockerels (birr/bird) in low, medium and high market access areas over the period September 2003–August 2004

3.3.2 Prices of birds and eggs in different markets

Table 3.3 indicates how prices of birds and eggs varied between the three locations. For all parameters, prices significantly increased with increasing market access ($p<0.05$). The price of fertile eggs is higher than that of table eggs. Live birds and eggs for consumption are sold in markets, but fertile eggs are sold at the farm gate and not in markets. Sale of fertile eggs is usually pre-arranged between the buyer and seller (producer) for timely collection and

Table 3.3 Average prices (in birr) of local birds in three locations representing low, medium and high market access in Tigray during 2003-2004 (1USD = 8.67 birr)

Parameter	Means ± standard deviations of price per bird or per egg		
	Low	Medium	High
Cockerel	6.8^{a} ± 2.3 (168)	10.6^{b}± 1.8 (226)	14.3^{c}± 3.2 (267)
Pullet	7.3^{a}± 2.4 (251)	10.2^{b}± 2.4 (303)	11.3^{c}± 1.8(225)
Hen	9.4^{a}± 2.4 (407)	11.8^{b}± 1.8 (213)	13.0^{c}± 3.8 (374)
Cock	9.5^{a}± 3.3 (243)	12.2^{b}± 2.8 (188)	15.7^{c}± 3.1 (257)
Table eggs	0.3^{a}± 0.1 (416)	0.3^{a}± 0.5 (518)	0.4^{b}± 0.1 (234)
Hatching eggs	0.3^{a} ± 0.1(27)	0.3^{b}± 0.07 (52)	0.4^{c}± 0.2 (40)

Means with different superscripts are significantly different between columns at $p<0.05$
Numbers in parentheses denote the numbers of observations

proper pre-incubation storage. Intermediaries are not involved in hatching-egg marketing.

3.3.3 Long term trends in prices

Producers and intermediaries were asked individually and in groups to share their experience on changes in prices of birds and eggs over the previous ten years. Respondents stated that prices of birds and eggs had doubled or even tripled over those ten years (table 3.4). For example, the price of cocks has increased from 5 birr ten years before to 10-15 birr, even in remote locations like Alaje. Respondents explained that driving factors include the increase in number of consumers such as government employees and the development of restaurants and hotels in small villages. The introduction of chicken onto menus in local restaurants is a new phenomenon. A general increase in numbers of urban dwellers in the study areas also increased demand. Dramatic increase in price of sheep, goats and cattle and the need for 'animal sacrifice' during social festivities has additionally contributed to the increased demand for poultry. The sellers also indicated a shift from small ruminants to poultry for consumption. There is no need for storing poultry meat, unlike beef and sheep and goat meat. Live chicken has become the most common gift item when visiting sick people.

3.3.4 Buyers' preferences

The market actors mentioned socio-cultural factors that influence the prices of individual birds in markets (table 3.4). Consumers prefer brown birds, and pay higher prices for them. Black colour is believed to bring bad fortune. White birds are considered as agents of transmission of (human) disease between households. Type of comb is also considered: double combed birds are preferred. Exotic birds such as White Leghorn apart from being white, are not selected for consumption because they are single combed. Buyers also look at

Table 3.4 Respondent percentages of market actors on retrospective price changes and consumer preferences of poultry in Tigray

	Producer-sellers	Intermediaries
Number of respondents (n)	58	35
Level of increase in poultry prices over 10 years (%)		
Only slightly	16	9
Onefold increase	78	86
Twofold increase	12	5
Reason for increase in prices (%) [a]		
Increased urban consumers	62	77
Increased poultry traders	33	49
Increased use of live chicken as a gift	28	68
Inclusion of chicken and eggs in food menu of local restaurants	38	63
Higher price of sheep and goats	72	80
Higher use of poultry for school fees	95	80
Decrease in use of beef	84	77
Consumer preference during purchasing chickens for consumption (%) [a]		
Feather colour	98	94
Sex	72	77
Age	66	69
Comb structure	84	86
Breed	97	74
Feathered necks	98	54
Source of birds (confined or free range system)	76	91
Egg colour	45	94
Egg size	90	75
Fertility	88	86
Egg shape	28	25

[a] Percentages do not add up to 100% as respondents mentioned two or more reasons or factors related to price trends or consumer preference

the age of birds when they buy them for different purposes. For consumption, growers are generally preferred for their lean meat, whereas adult birds are demanded for breeding purposes. Experienced buyers, especially traders, estimate the age by looking at the roughness of the legs of the birds. Birds with rough legs are considered old and fetch lower prices. Birds with feathered necks are preferred over those with naked necks. Free-ranging and local birds are taken to have tastier meat than confined and exotic breeds. As for eggs, consumers prefer brown, bigger, infertile, and regular-shaped eggs.

4 Discussion

4.1 Household consumption and marketing

Most research efforts on village poultry tend to focus on production aspects (Rushton and Ngongi, 2002). This study has explored what rural

households decide to do with their poultry after they produce them. In the literature on subsistence and semi-subsistence agriculture in developing countries, household consumption is considered the primary production goal and it is assumed that surpluses are marketed (Aboe *et al*., 2006). However, the decisions of households regarding the use of poultry products (table 3.1) indicate that consumption is not the priority objective in poultry keeping households and only partly meets the protein needs of the household. The general level of consumption of poultry by family members was very low. On average, a family member consumed 0.6-1.2 birds and 6.8-17.1 eggs in a year. Considering that carcass weight of cocks, hens, cockerels and pullets respectively is 0.9, 0.6, 0.5, and 0.4 kg, respectively (Kondombo, 2005), a family member consumes only about 0.5 kg of poultry meat per year, which is very low even for the African situation. Estimates from other countries such as Egypt and South Africa are 8.7 and 26.3 kg (FAS, 2001). The number of birds and eggs sold was higher than the number of those consumed. When a household has only a single bird, it is more likely they decide to sell it than to consume it (table 3.4). The cash from sales is presumably used to buy household needs including food (Kyvsgaard *et al*., 1999; Kondombo, 2005).

4.2 Gender

Our study illustrates the importance of poultry for female-headed households. The poultry consumption and sale per family member were larger for female-headed households than for male-headed households by 25% and 66%, respectively. This is not an indication of well-being. The larger poultry consumption per family member in female-headed households is probably the result of lack of other sources of animal protein. Family poultry meat and eggs are estimated to contribute 20-30% of the total animal protein supply in low-income and food-deficit countries (Alam, 1997; Branckaert and Guèye, 1999). For female-headed households, the contribution must be much higher to meet protein requirements because they usually lack meat and milk from other livestock (Guèye, 2000). Ehui *et al*. (2000) found that in Ethiopia wealthy households are more likely to buy live sheep for festivals than the poor. Wealth and gender are linked since female-headed households form a larger part of the category of poor households than of rich households.

4.3 Market structure and prices

Despite the benefits of village poultry keeping to poor households, they

face large market constraints. Access to markets, in this study highly determined by distance to the market, influences poultry marketing, which agrees with other reports (Holloway, and Ehui, 2002). The three locations representing three levels of market access showed different marketing structure and prices of poultry products. With increasing market access, the marketing chain between producers and consumers was shorter which was associated with higher prices for both live birds and eggs. It is clear that increased involvement of intermediaries leads to reduced prices for the producer. We observed a price reduction of 68% for birds and 25% for eggs in the low market access location compared to the high market-access one. Lack of information for producers and relatively high profits for the intermediaries are representing transaction costs that actually provide opportunities. These costs may be reduced through improving access to information and better infrastructure and organisation of the poultry producers. However, costs of transport and credit and marketing risks should be carefully assessed.

Religious festival days are associated with increased poultry consumption and sales and fasting periods with decreased consumption. These patterns cause strong fluctuations in prices of poultry products. Prices increase in the onset of festivities and decrease in fasting periods. It is difficult to change this demand pattern as it is a matter of religion. The only option is to cope with the existing situation. If poultry production could be carefully planned and managed to match the fluctuating market demand, economic benefits might be higher. Ideally, households increase and reduce their flock according to prices. The fact that predictability of the price fluctuations is high, since they are based on socio-cultural events (Thomsen, 2005) is an advantage. However, in Ethiopia, the planning of production in relation to periods with demands may be difficult because of the many fasting periods and festivals. Farmers can select key festivals, for example, New Year (in September) and Easter (in April), which are the most important festivals of high demand, and prepare to supply their flock in these periods. This requires relatively long storage of eggs before marketing. Farmers in the study area use local pottery materials which are cool and dry to store eggs without spoilage until they sell them. The planning is more challenging for the poor than for the wealthy as the poor have smaller flocks. More urgent needs make it more difficult for them to wait until peak demand periods.

It is mostly women who are responsible for poultry production and selling, and spending the income. Men come in when the benefit becomes larger

and market access increases. The results of the group discussions show that when women are the sellers it is more likely that cash will be spent on family welfare; this may be less in the case of men. Intermediaries are principally men. The higher participation of men as intermediaries can be associated with access to financial resources, ability to take risks and access to market information. Women are less likely to have these than men (Turner and Williams, 2002). Understanding gender differences related to these aspects in Tigray would contribute to identifying opportunities for women to increase participation and bargaining power in order to benefit more from the marketing. Examples from other countries show that such opportunities may exist. For example, in West Africa women are acknowledged entrepreneurs in the vegetable and fruit markets (Harsch, 2001). In Bangladesh and Kenya, the availability of inexpensive mobile phones enabled producers in remote areas to seek markets, negotiate sales, and get better prices from traders or consumers (Upton, 2005).

4.4 Opportunities

The marketing channel might be shortened by forming farmers' groups that could organize direct sales of poultry to consumers (Budisatria, *et al*., 2006). Membership of a marketing group increases equity and bargaining power of farmers for getting better prices for their products through improved access to market information (D'Haese *et al*., 2003). This could also create more space for women from producing to participating in poultry marketing. However, initiatives to organize farmers to acquire better access to markets need a proper understanding of costs and benefits and of transaction costs such as those related to group organization, transportation, credit and marketing risks. So far few studies have been carried out that have convincingly shown the economic viability of farmer-organized marketing. An understanding of why the participation of men as producer-sellers and intermediaries increases with increased market access in the situation in this study would contribute to understanding the opportunities to improve market access and benefits for the most marginalized households. Tools such as market mapping could be used to help actors like members of market groups to understand their own marketing system and to access to market information (Hellin *et al*., 2005). Formation of marketing groups could be beneficial for consumers as well through lowering prices as a result of buying directly from producers (Niamir-Fuller, 1994). Forming a marketing group can be time-consuming and requires facilitation and organizational skills. This can be brought in by outside agencies such as

NGOs and through capacity-building of interested farmers. Female-headed households, for whom poultry keeping constitutes the major source of livelihood, are probably willing to spend time on organizing poultry marketing. For the better-off farmers, poultry keeping is only a secondary activity and they are less likely to invest time in such activities, though they may be interesting partners for poorer female-headed households in mobilizing resources and bulking up produce. The poultry sharing arrangements (Aklilu *et al*., submitted) may present an interesting entry point to pursue such ideas.

The study has shown that, at the household level, family consumption and marketing of eggs and birds are competing demands on poultry production. In addition, the pattern of peaks in market demand and prices coincides with the peaks in home consumption of the producers. The difficulty to match the different production interests in bird and egg production needs to be taken into account when addressing improved poultry production for rural households. Access to markets, strongly associated with distance to markets and resourcefulness of households, represents a constraint in capturing higher benefits from poultry marketing. Organizing farmers to increase bargaining power and shortening the marketing chain offers interesting opportunities, but needs better understanding of the different transaction costs involved. Since the most resource-poor households include many female-headed households, this is an area of research and development that merits ample attention. Finally, the findings support the call for more integrated analysis and technology design, taking in consideration the multiple actors in the production and marketing chain.

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Chapter 4

Farmers' motivations to participate in research: experiences from research on village poultry keeping in Ethiopia

Aklilu, H.A., Almekinders, C.J.M., Kibwika, P. Submitted. Farmers' motivations to participate in research: experiences from research on village poultry keeping in Ethiopia. Journal of Agriculture and Human Values

Abstract

Research aimed at improving agricultural and natural resources management is assumed to be most effective when local people have a voice and are involved as part of their own development. In practice, this means that farmers actively engage with researchers and development agents in problem identification, planning, implementation and evaluation of research and development activities. Active engagement of farmers in the different project phases poses a challenge. On-farm research has recently been emphasized as a means to enhance farmer participation and increase the relevance of research to the small-holder farmers. In on-farm research, farm data recording is an often used tool for monitoring farm performance and measuring effects of technologies on agricultural production. Data recording on farm performance is essentially an extractive process. Understanding farmer perceptions about farm recording is an important prerequisite for motivating farmers to participate in research and has not been given adequate attention by researchers. This paper discusses factors that influence farmer participation using the experiences of farm recording in village poultry in Ethiopia as a case-study. The study looked at why some farmers dropped out of a research process that lasted over a period of 12 months. The findings show that participation in the research was a constraint, especially for the poorest farmers in the case-study villages. Agricultural scientists should pay attention to farmers' perceptions of the research process, in order to ensure valid on-farm data for scientific purposes as well as joint learning with farmers for technology development relevant to the situation of the poorest.

Key words: Participatory research; Farm recording; Drop-outs; Village poultry; Ethiopia

1 Introduction

Research aimed at improving agricultural and natural resource management is likely to be most effective when local people have a voice in it and consider it beneficial to their own development (DeWalt, 1994 and Pretty, 1995). Participatory approaches are considered particularly suitable for developing improved technologies in resource-poor and risk-prone areas and diverse agro-ecological and socio-cultural contexts through integration of farmers' perceptions, priorities and household goals in participatory research (Ashby *et al.*, 1995; Sperling *et al.*, 1993; Thiele *et al.*, 2001). In addition, it is also recognized that participatory research enhances farmer empowerment to deal with local development challenges (Biggs, 1989). These reasons lie behind the popularisation of participatory approaches in agricultural research and development initiatives since the late 1980s (Chambers *et al.*, 1989; Jiggins and De Zeeuw, 1992).

In practice, participatory approaches mean that farmers actively engage with researchers and development agents in problem identification, planning, implementation and evaluation of research and development activities. But it is often a challenge to bring about the active engagement of farmers in the different phases of the project cycle (Martin and Sherrington, 1997; Dorward *et al.*, 1997). This is partly because of the need to demonstrate immediate benefits to farmers, in order to motivate them to participate in research.

Collaborative generation and use of farm (household) information by researchers and farmers is seen as an effective way of capturing data and empowering farmers through research. Farm recording is one of the tools most often used by researchers. It allows for assessing and monitoring farm performance and measuring of effects of technologies in agricultural production (De Groot, 1996; Abdel-Aziz, 1996). This can then be made of value to farmers by seeking ways to feed back the insights which are understandable and useful for the farmers. This can strengthen their decision making to improve their farming practices and serve as an entry point for joint definition of a research agenda. Therefore, farm recording is a potential entry point for researchers to interact and learn with farmers (Flamant, 1997). However, such interaction and learning is preceded by an earlier phase in which the data are collected; collaboration with farmers in this earlier phase has been deemed 'extractive' (Pretty, 1995) because presumably it is of little direct value to the farmers. This paper reflects on this part of the research process and the participation of the

farmers in it. In particular, it focuses on the experiences of the researchers with farmer participation in the farm recording, and shows that the various parts of the process can become meaningful for farmers.

2 Context of the research

The overall objective of the research was to explore ways in which farmers and researchers can jointly learn about constraints to and opportunities for village poultry improvement in Tigray, North Ethiopia. The research involved several phases. The first phase aimed at understanding the socio-economic contribution of village poultry through individual and group discussions and workshops with poultry keepers. This stage also involved a cross-sectional survey to generate data on the nature of village poultry systems. The second phase was to understand production systems and marketing arrangements for village poultry, through a combination of group discussions with producers and intermediaries, and via marketing surveys. The third phase aimed to explore how farmers and researchers can learn about poultry dynamics. This entailed generation of household data as a starting point for joint leaning about dynamics in poultry keeping. The household data included farm recording by farmers (or family members) in collaboration with extension agents (or research assistants). The farm recordings were validated and interpreted by farmers and researchers in a joint learning exercise (phase four). Phase five was modeling village poultry system using the household data. The scenarios generated by the model were fed back to the farmers and used to explore appropriate options for improvement of poultry based on the dynamics of households. This paper reports on the step of farm recording. Farm records were important inputs to subsequent stages.

Poultry keeping households in the areas of study were stratified by gender of household head. District data bases were used to identify men and women headed poultry keeping households. A random sample of 90 men and 90 women-headed households was then taken using the SPSS randomization facilities. With the help of extension agents and community leaders, the sampled households were identified and contacted to explain the aims of the research and to interest them to participate. They were later categorized into two wealth classes on the basis of survey results (Aklilu *et al.*, 2007).

3 Methodology

3.1 Introducing farmers to farm recording

3.1.1 Why farm recording

In the initial stages of the research, discussions were held with farmers on the role and constraints of village poultry production in the local communities. Through these discussions, researchers realized that while farmers could explain the general trends in the dynamics of poultry, they could not quantify the gains and losses at household level. Basic information was lacking and farmers too realised that they needed this type of information to understand their household poultry dynamics and make decisions for improvement of village poultry as a source of livelihood. Farm recording was found to be a relevant tool for capturing such information.

3.1.2 What to record

Once the need was realised, consultations and negotiations were made on the type of records needed. To start with, events that influence poultry trends were listed by groups of farmers in meetings facilitated by the researcher. These issues were related to poultry utilization, losses and production performance. The researcher used these issues to develop a farm recording format which was pre-tested to check its relevance and feasibility in use. The format was adjusted with insights from the pre-test, bearing in mind farmers' technical capability, a need for simplicity and the adequacy of the information for an understanding of local poultry dynamics.

3.1.3 How to keep records

Discussions with farmers also explored how the records might be kept, in view of the literacy levels of the farmers, actual content of the records in question, and proposed recording intervals. Given the diversity of the farmers, it was agreed that different ways would be used for keeping records. Households with literate family members would keep daily written records. Those without literate household members would use memory, or symbols such as stones, to record daily poultry dynamic events. Intervals for reporting records were negotiated. This took into account the periodicity of poultry dynamic events and the ease of remembering. It was finally agreed that a two-weeks interval was appropriate. Therefore, the research assistants came every two weeks to take copies of records kept and reported by the farmers.

3.2 Role of farmers and researchers

The roles and responsibilities in data taking were agreed with farmers. The farmers kept record of events in their poultry keeping in the way they thought most suitable for them, for example, using memory, stones, written records, or requests to a literate neighbour to assist. The research assistants transformed farmers' daily records into a common format that systematically summarized the information. The research assistants also observed and interviewed farmers on how they perceived their own monitoring of poultry and the farm record exercise in general. Two types of assistants were used. In the first three months, third-year students from Mekelle University participated as part of their internship. Each of them worked in three locations. After three months, the students had to return to University and the extension agents in the respective areas took over. A total of six extension workers, two in each location, were involved in the process for an additional 9 months.

The farm recording exercise lasted approximately 12 months, from September 2003 to August 2004. Research assistants gathered the household data bi-weekly. Each research assistant closely monitored about 30 households. On average, the research assistants visited each household twenty times over the entire period. Researcher assistants recorded their observations on the status of farmers' participation in the research as notes integrated within the bi-weekly reporting on each household.

The role of the principle researcher was to monitor and document information on the experiences of farmer participation in the farm recording process, through discussions and reflections with research assistants. In addition, the researcher met with the participating farmers to discuss their experiences and perceptions of the farm recording exercise. This allowed the researcher to assess the quality of information generated through farm recording.

The principle researcher also had a one-on-one meeting with the research assistants every month. Every three months the researcher met with all the research assistants to share their experiences on farmer participation in the research across all sample locations. Based on these experiences, farmers were categorized into three groups with regard to their participation: 'the active ones' who consistently kept farm records throughout the entire period; 'the semi-engagers' who were not consistent in the farm recording; and 'dropouts'

who gave up the exercise along the way. Interest was on further investigating why some farmers dropped out, and why others continued to participate.

3.3 Case study: why farmers choose not to participate

As a follow-up of issues discussed with research assistants, the principal researcher designed a case study to understand further why some farmers dropped out while others continued to participate. Thirty five farmers (20%) were classified as semi-engagers or drop-outs during the research (Table 4.1). Using the information from the survey results (Aklilu *et al*., 2007) learnt that most of the semi-engagers and drop-outs were farmers who were classified as poor (Table 4.1). Whereas in the category of wealthier farmers (n=77), 14 % semi-engaged or discontinued, in the category of poor farmers (n=103) this was 23%. The researcher interviewed and interacted with 30 of the semi-engagers or dropped outs. The researcher also held discussions with the district agricultural officers to learn about experiences with farmer participation in previous research. From these interviews, a number of reasons of farmers for being more or less interested and/or constrained to participate in the research emerged. These data were related with information from the surveys (Aklilu *et al*., 2007) to find out how these reasons reflected in semi-engaging and discontinuation of the participation in the group of poorer and wealthier households.

Table 4.1 Percent of participating, semi-engaged, and drop-outs among poorer and wealthier households (n=180) in village poultry keeping research in Tigray

Wealth class	Number of households	Percent of households *		
		Participating	Semi engaging	Drop outs
Poor	103	77 (79)	9 (9)	14 (15)
Rich	77	86 (66)	9 (7)	5 (4)
Total	180	80 (145)	9 (16)	11 (19)

* numbers in brackets refer to absolute number of households

4 Findings

4.1 Interest in poultry keeping

In this research, poultry keeping for households was of relatively higher value for poorer farmers than for richer farmers in the selected villages. During their bi-weekly visits to households, assistants learned that lesser significance was one of the reasons for drop-outs or semi-engagement among richer farmers. The richer farmers have alternative, more profitable enterprises such

as cattle and home gardens. To them, village poultry is less important than for the poor. Their interest to participate in the research that asks monitoring the poultry was therefore much lower than for the poor farmers. For the poor farmers, poultry is a critical source of livelihood in terms of income and food (protein). Monitoring of their poultry is already part of their daily activity. They normally count their birds daily before they shelter them. They also monitor egg production and utilization daily to decide how many eggs to sell the next market day. In the case of poor female-headed households, eggs were 'audited'. No member of the household consumes or sells eggs without authorisation of the household head. For the poor households, the record taking and the discussion of the data therefore fitted very well their production routines and objectives.

4.2 Interest in direct problem solving research

Farmers mentioned they feel motivated to participate in activities that provide solutions to their problems. This research, however, did not address these critical problems directly. As much as monitoring poultry dynamics would help them understand their enterprise from a business perspective, it did not address critical problems leading to losses, such as predation and disease. Some farmers dropped out of the research for this reason. A female farmer put her concern forward clearly: "*we have always been informing the agricultural office that wild cats are finishing all our chickens but there has not been any response. Now you and we are taking these records so that you know how much we lose to predators. We believe now the government knows this problem and you are going to tell them again and show the figures. Why can't you help us to find solutions?''* Such statements show frustration with agricultural services (both research and extension).

From a different perspective, the more optimistic farmers thought that the research signified government attention to the enterprise. They hoped that it was the beginning of government initiatives to address their poultry problems. These farmers exhibited a lot of interest and commitment in their participation and some of them increased their flock size in expectation that government support would depend on the number of birds kept. Whereas this research was not part of government programme, these anticipations emanated from the perception that all research is done by or on behalf of government. This 'false' expectation to some extent positively influenced farmer participation in the research.

4.3 Relation with other initiatives

4.3.1 Farmers' expectations and linking with on-going initiatives

Farmers do not differentiate development and research projects: their expectations of the two in terms of benefits are largely the same. An ongoing food security programme in the area, carried out by the Ministry of Agriculture and local NGOs, offered packages of agricultural inputs on credit to stimulate household food productivity. The packages included fertilizers and improved seeds, fattening oxen, sheep and goats, modern bee hives, cross-bred dairy cows, and improved chicken breeds. These packages were offered to farmers who were organised in a group. Membership of a group is taken as collateral (guarantee) to pay back the credit. The interest groups were enterprise specific, e.g. poultry farmers, dairy farmers, etc., and this classified farmers for a specific package even though many of them were engaged in multiple enterprises. In the case of poultry-groups, the farmers got credit to acquire improved breeds. With this experience, farmers expected the research project also to refer to interest groups. However, the intention of the research was to sample farmers randomly and individually. Some of the sampled farmers withdrew because they did not regard themselves as part of a poultry farmer interest group, because they did not give priority to poultry and were pre-occupied with other enterprises. Similarly, farmers who were recognised and organised in the poultry-interest groups for the food security program were more enthusiastic and engaged more consistently, as they perceived the research to be an opportunity to learn; the research complemented their on-going poultry involvement.

This experience shows that overlooking ongoing initiatives can seriously hinder, as well as offer opportunities. On the one hand, in this case, it interfered with random sampling. On the other hand, had the researchers been better informed, they could have built on the on-going initiative, possibly in partnership with the organisation that implemented the food program. This might have meant less effort to organise the farmers, as the project already had them organised and held regular meetings where exchange of information could have been facilitated. A serious consideration is also the availability of time on the part of involved farmers. Some of the semi-engagers complained to assistants that keeping on recording the relatively small changes of poultry and eggs was costing them a lot of time. This is one more argument for researchers to seek integration with on-going initiatives. It also implies that research

designs, like sampling for farm records, would need to be adapted by the researchers, with the possibility that the self-selecting adaptations will bias the sample.

4.3.2 Perpetuation of inclusion and exclusion from projects

Farmers perceive research as a means for government to follow-up or evaluate its interventions. Previous government projects distributed improved chicken breeds to some farmers. Those who did not benefit from these schemes thought they were irrelevant as participants in our research. Thus, previous exclusion may lead to farmers excluding themselves in future interventions. It also implies that once being included in an initiative increases the chances of be included in future initiatives. Again, this gives some insight into the way random sampling may end up as non-random. If they remain unaware of such factors, researchers easily but unintentionally contribute to the constitution of a 'privileged' elite group of farmers.

This bias is further consolidated by the focus of the extension system on model farmers for dissemination of technologies. From the side of the research and extension system this is logical: the fragility of the livelihoods of the poor deprives them of the abilities to deal with uncertainty and risk of failure. This is often expressed in the scepticism towards experimentation and new interventions. One farmer who dropped out of the research said: *"we have always been keeping local chickens from time immemorial. Why are you so much concerned now?''*. Another farmer said he would prefer to participate in the next round after he sees the benefits from the first group.

Model farmers tend thus to be relatively wealthier, and better educated than the average, and are usually the first contacts for interventions in the area. Hence the explained perpetuation of exclusion of some farmer categories, which in turn reinforces the perception among the other farmers that research is not meant for them anyway. In the villages where the research team worked with both model farmers - who are officially recognized by the local office of agriculture - and ordinary farmers, the latter felt uncomfortable to participate. Some of the ordinary farmers who dropped out expressed their fear that the extension agents would compare them with the advantaged and already better prepared farmers in terms of performance. The 'unlevelled ground' would then lead to unfair judgement of their capabilities.

4.4 Compensation and status-related incentives

Generally, as farmers see research as follow up of government interventions, they also consider researchers as government employees. Along the same line of reasoning, they often expect and sometimes demand that their participation is rewarded, since they are assisting government employees to do their job. This is reinforced by projects providing incentives to farmers, either to compensate for their time of involvement or as a way of buying their acceptance or willingness to participate in research. One farmer expressed his experience as follows: "*those former researchers we worked with were blessed and generous. They felt our poverty and did their best to help us. They sympathized with us and our time. In this research we hope to see such things. You know that one has to be grateful to others*". Failure to fulfil such expectations leads to some farmers declining to participate. Reversing such attitudes is a challenge.

Other forms of incentives, however, have to do with social status and building networks (social capital) to access other services such as inputs, credit, and recognition by higher authorities, or being invited to take part in workshops outside their areas. Contrary to the immediate short-term benefits, these are more strategic long-term benefits. In the study area, recognition and social networks are considered sources of power. A former development agent in the village noted"*model farmers like to appear on posters. They like to be photographed, audio recorded and video recorded. When some farmers see these things happen, they participate. They say these researchers are serious''*. While there is not a problem per sé with farmers strategically benefiting from participation, it may reinforce further social differentiation. The challenge that remains is how to generate motivation appropriate to the research objective or outcome, and to engage in genuine learning processes through research.

4.5 Research methodology

4.5.1 Randomization and exclusion

Research considers randomization as an objective non-biased way of selecting samples. To farmers, it is a choice of the researcher to involve or not to involve individual farmers. This creates tension between those who are selected to participate in the research and those who are left out. For example, neighbours of the selected farmers saw their exclusion as evidence of deliberate and even repeated bias on the part of extension staff members, who were in this case also the research assistants. Tension stems from envy, as involvement

increases one's social capital through new contacts and networks, especially where government agents are involved. Connection to the wider world is highly valued in remote rural communities. The social capital is sometimes manifested in the social status that the participating farmers are accorded when visited by researchers and other government agents. One farmer described his participating neighbour in the following terms: *"my neighbour always likes to see cars parked in his compound. They often visit him and take him in the car."* Beyond the social capital, contacts made by farmers through involvement in research are believed to yield power and recognition. This establishes an attitude of competition rather than enhancing social interaction for social learning. In a related example, one farmer who did not have poultry at the start of the research bought a chicken after his neighbour was selected to participate and thus claimed his own eligibility to participate.

4.5.2 Suspicion of the purposes to which research results will be put

The research involved comprehensive recording of poultry dynamics at household level over an extended period. This raised suspicion among some farmers about what else such data could be used for. Some farmers were hesitant to share information on income for fear that it would place them in the wealthy category and hence mean they would miss out on government support to the poor. With the view that research is done by or on behalf of government, farmers could not fully trust the researchers that such information would not be used against them by government. In another perspective, some farmers interpreted the exercise as a competition through which government would reward the best performers. Those who held this view tended to change their management practices (e.g. building poultry houses, or undertaking regular cleaning) for the sake of appearing to be good performers rather than through deliberate investment in the enterprise.

4.6 Relation between farmers and researchers

4.6.1 Background of the researchers and their relationship with farmers

Working freely with farmers in participatory research requires a high degree of trust. How quickly a researcher established that trust with farmers was influenced by background and ability. One of the research assistants, a university student, had difficulties being accepted by farmers largely because he came from a different region, was of a different religion and spoke a slightly different language. Some farmers were not enthusiastic to work with him and in some households he was rejected. The research assistants who were working

in their home areas, or areas where they had lived before, obtained and sustained farmer participation more easily. The farmers' trust was more easily gained and farmers did not want to fail someone they know well. One of the research assistants commented: *"my farmers are trustworthy. I like them. They do not let me down. I am born and brought up in this village. They believe my words. They are certain that these records will be useful to them.*

4.6.2 Gender of the researcher

The gender of the researcher and research assistants also had a bearing on farmer participation. Most of the research assistants in our research were male and they had to make multiple visits over a period of one year. They mostly interacted with women and children alone, as often the men were not present during visits. For the researchers, this was not a problem since women were more involved and therefore knew more about the poultry than the men. But the men felt uneasy about male research assistants interacting with their wives and daughters so often in their absence. One of the men told the principle researcher that he would rather withdraw from participating in the research than allow the research assistant to interact with his wife and daughters in his absence. It is not clear whether a similar situation would arise if a female research assistant interacted with male farmers.

4.6.3 Pleasing the researcher

Farmers perceive research to be of value to the researcher and not themselves. They have a tendency, therefore, to give information that they think will please the researcher. In this study, several farmers felt unhappy to participate in the research during seasons when they did not have many chickens because they thought they would not be able to live up to the expectations of the researcher. In one of the meetings, a farmer said this to the research assistant: *"Now this is a rainy season and chickens do not do well in this season. I am not satisfied with the chickens I have at the moment. They are not many and are not laying so much. I do not think this is good time for recording. If you come in November or December during the harvest period, I will have a good number of them. That is a good time for the research.''*. This factor seems to have been more significant with those farmers who had small flocks. Those with larger flocks either felt less embarrassed by a drop in egg production or still felt the egg production was still at a high enough level to be significant to the researcher.

4.7 Farmers' traditions, beliefs and social relations

Despite the fact that the researcher and his assistants were fairly familiar with the cultural and religious issues in the study areas, there were still surprises that influenced the research.

4.7.1 Sensitivity to religious beliefs

The framing of the questions research assistants felt to be 'normal' for the farmers displayed some insensitivity to religious beliefs. In one instance, a research assistant sought to get information on poultry consumption and a farmer who had previously volunteered such information freely suddenly was upset and shouted at a research assistant: "*why are you asking me questions whose answers you should know already. You know that I am an orthodox Christian. I am strong believer like my parents. Who told you that we consume eggs and birds in our Holy pre-Easter-fasting period?"* The research assistant did not know that such a question in that particular month would provoke that type of reaction. The farmer apparently felt the research assistant was testing his religious faith. Subsequent to this incident, it was difficult to motivate the farmer and his household to continue participating in the research.

4.7.2 Confidentiality of information

Some farmers hesitated to disclose information on poultry consumption. This information was treated as confidential because of the perception that home consumption of poultry is wastage and selling was the wise decision. In this respect, one male farmer said: *''these food items (chicken meat and eggs) are too expensive to eat. A wise farmer should sell them to meet other family needs.''* Generally consumption of poultry at household level is associated with being rich while selling is associated with being poor. Most farmers, therefore, did not want to portray themselves as rich, even if they consumed poultry. One of the sample households declined to provide information on consumption to the research assistant but was quite willing to provide information on the selling of chickens or eggs because they do not see this as being something which portrays them as rich. They also did not hesitate to disclose what they lost through predation and disease. Therefore, accuracy of data, in this case about home consumption of poultry and eggs, may be influenced by the cultural sensitivity of disclosure of such information. Also, the attitude towards displaying ones wealth level can vary from situation to situation.

In some cases, some farmers suspected that government would use the collected information about their livelihood resources to determine whether a

particular farmer would be eligible for food relief supply or not. This was in our research the most likely reason why most farmers did not want to portray themselves as rich. On the other hand, among the households considered as poor in the local wealth classification, some did not want to expose their levels of poverty, as they thought it could make others rejoice over their unfortunate status. One of the farmers who refused to disclose his household poultry consumption said: *''I am poor but I do not want to let you know (make it public) how poor I am, as doing that means pleasing those who wish me bad luck.''* Such farmers think that portraying them as extremely poor may cause them to be socially excluded.

4.7.3 Cost of hosting researchers

In the Ethiopian culture, a visitor is offered something in the form of a meal, as a sign of respect and hospitality. This cultural tradition constrained farmers' willingness frequently to receive researchers, who they consider as visitors. Even with constant reminding the farmers that they did not have to offer anything when the research assistants visited, the poorest farmers, in particular, did not feel comfortable. Some households opted out of the research because of worries about having to host researchers so frequently.

4.8 Positive learning experiences

So far, we have described tensions that arose out of participation and reasons to drop out of the research exercise. The research did however not invoke adverse or negative feelings among all farmers. For many farmers, the research was a stimulating experience and allowed learning about poultry through information exchange amongst farmers. Although the research focused on taken-for-granted-aspects of poultry, this somehow stimulated curiosity among farmers. Poultry became the common talk in the villages where the research took place. As the participating farmers discussed their records and observed trends, a wide range of poultry management experiences were brought up. In the process, they exchanged a lot of knowledge around the benefits and constraints of poultry, for example around losses due to predation and diseases, or incubation and hatching. Through interaction with participating farmers in the neighbourhood, these exchanges also extended to non-participating farmers who were curious to know what was going on in the research. These interactions helped to fuel dialogues on potential improvements to maximise benefits from poultry. That this process occurred is a significant

finding, since it indicates the possibility to reduce over-dependence on extension and research for farmer problem solving. In this case, the information exchange among farmers served to tap and disseminate a rich input of knowledge from the researchers on the village poultry keeping. In a continued process of exploration and experimentation, researchers can help farmers to systematise their practices and increase their ability to analyse and understand their enterprises better.

5 Discussion

This study has revealed a number of factors influencing farmer participation in a research exercise that involved farm recording of poultry and egg production in Ethiopia. These factors affect the quality of data and bring up some ethical considerations of doing research with farmers. They therefore need to be considered in the planning and implementing research with farmers, especially in a research set up that involves multiple interactions over an extended period.

This research found that the poor farmers were most interested in participating because poultry is a more important activity than for the farmers who are better-off. This does, however, not reflect in a lower percentage of semi and drop outs because there were several factors that constrained participation of poorer farmers more than that of wealthier ones. First of all, there is the natural risk aversion of those who have few resources to cope with variations in food production and other needs. Perceptions regarding the purpose of the research, for what it was intended, and pressure to live -up to expectations also seemingly worked against the participation of the more marginal. Combining this with earlier experiences of the farmers in projects that work with interest groups and model farmers, and the farmers' lack of understanding of randomized selection for participation slightly biased the participation in our research to those who could afford to participate.

When asked, all farmers answered that they were interested in participating in research activities provided they actually solve their problems. Recognizing the need for diagnostic research and more basic and strategic research means an acceptance that not all research can be of direct benefit in terms of direct practical problem solving. This is a dilemma and constraint for participatory research that researchers should be aware of. Nevertheless, the

experience of this research is that even in a phase where participation remains largely extractive in character, farmers access important learning opportunities. Basic for participation in the research was the realisation of the farmers that they actually did not know, but wanted to know, about gains and losses in their poultry flocks, and the factors influencing this. This realisation was achieved through the effective feedback workshops. Making sure that farmers have optimal chances to benefit in one way or another from extractive research demands time and resources. However, it is also a moral obligation to pursue this objective, since these farmers are among the most marginalised in society, and have invested scarce time in collecting data that contributes to research that, if successful, will be to the benefit of many more.

In addition, the chapter has shown that unless provisions are made to overcome constraints for the poorest farmers to participate – such as ensuring sufficient trust for them not to feel obliged to provide food to a visiting researcher, to talk freely about home consumed poultry and eggs, etc., they more easily drop out of the research process. This courts the danger that the research will become a self-perpetuating collaboration with the wealthier farmers. Although there is no specific evidence that this will yield technology irrelevant to the most marginal farmers, it does carry the risk that researchers identify problems and solutions that are only adapted to the needs of better resourced farmers capable of investing, for example, in improved breeds, vaccines and housing for the chickens.

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Chapter 5

A dynamic stochastic model to explore management options for village poultry systems

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Abstract

There are many technical possibilities promoted by development organizations to improve village poultry production. Rural households, however, are not adopting them widely. This paper presents a model for *ex ante* evaluation of improvement options in village poultry systems. The dynamic stochastic computer model considers mortality, egg production, reproduction, offtake, and their interrelationships. The model was validated with data from Tigray, Ethiopia. Observed and simulated flock size, egg production and bird offtake have shown close trends. To demonstrate the use of the model, daytime housing and NCD vaccination were used as examples for exploring the effects of management options on village poultry. The overall conclusion is that the model assesses dynamics in village poultry in biological and economic terms and as such it can be used to investigate current performances and to explore the impact of management options.

Key words: Simulation, Village poultry, Management options, Ethiopia

1 Introduction

In developing countries, village poultry represents an important component of the rural household livelihoods as a source of income and nutrition, and a means to strengthen social relationships (Guèye, 1998; Whyte, 2002). Village poultry are characterized by low levels of inputs and outputs (Sonaiya *et al.*, 1999). There are many technical possibilities promoted by development organizations to improve village poultry systems, such as vaccination, exotic breeds, and using housing and supplementary feeding (Kitalyi, 1997). Farming households, however, are not adopting them widely. Many of the technologies are too risky, too labour intensive, or too unprofitable (Udo, 1997; Rushton and Ngongi, 2002).

Village poultry systems are complex, improvements, therefore, should be introduced with caution. Changes in one component imply trade-offs in others. However, research on these systems is often fragmentary. Enhancing sustainable development of village poultry requires insight in the dynamics of the production system. Temporal variations in village poultry could be the result of interactions of several factors, such as flock mortality, egg production, reproduction, consumptions, and sales. The dynamics of village systems are influenced by random phenomena. Simulation could be an attractive research tool , therefore, to integrate the different processes and to explore management options (Konandreas and Anderson, 1982; Sorensen, 1990). Sonaiya (2002) advocated development of mathematical models to assess impact of management options on village poultry so as to highlight causal linkages between technical and economic issues.

To integrate probabilistic effects in management systems, dynamic stochastic models could prove relevant (McAinsh and Kristensen, 2004). This paper presents a dynamic stochastic model to assess impact of different management strategies on the dynamics in village poultry systems. VIPOSIM (**VI**llage **PO**ultry **SI**mulation **M**odel) can be used to test the effect of different improvement opportunities on poultry performance. Data from field studies in Ethiopia were used to validate the model.

2 Materials and Methods

2.1 Model design

The model approach involved three phases: conceptualisation, quantification, and analyses. The first two phases describe the model design and the last describes simulations using the model.

In the first phase, a conceptual model was developed from literature, comprising six processes related to production and utilization: flock mortality, flock offtake (bird sale and consumption), egg production, egg loss, egg offtake (egg sale and consumption) and reproduction (incubation and hatching).

In the second step, VIPOSIM was programmed in Microsoft Excel® and integrates quantitative relationships of various elements of the system in a series of mathematical equations. Calculations were performed in time steps: the length of one step is a season of 3 months and the maximum number of steps was 12. One time step represents one reproduction cycle, i.e., the period of time a broody hen needs to produce and hatch eggs, and to rear chicks. Fig. 5.1 presents a flow diagram of sequences of events in the model: initial flock, mortality, bird sales, bird consumptions, average flock present, egg production, egg losses, incubation, hatching, egg sales, egg consumptions and new flock. The mathematical procedures for the above events and other related parameters are stipulated below.

2.1.1 Randomization

Random numbers were used as coefficients of standard deviations of average input values of explanatory variables to determine the different results of a given scenario. The random coefficients from a normal distribution were generated as follows based on Gilchrist (1984):

$$R = (\sum_{12}^{1} Rand()i) - 6 \quad \textbf{(1)}$$

where R was random coefficient and $Rand()\ i$ was the i^{th} random number in a normal distribution. The value of the explanatory variable is calculated as X = $\bar{x}$ +(R*SD). If X<0, it was set to zero. Additionally, for percent values, if X>100%, it will be set to 100%. If for all sd values zero is entered, the model becomes deterministic instead of stochastic. It is also possible to enter zero for a parameter, to exclude the variation in this parameter.

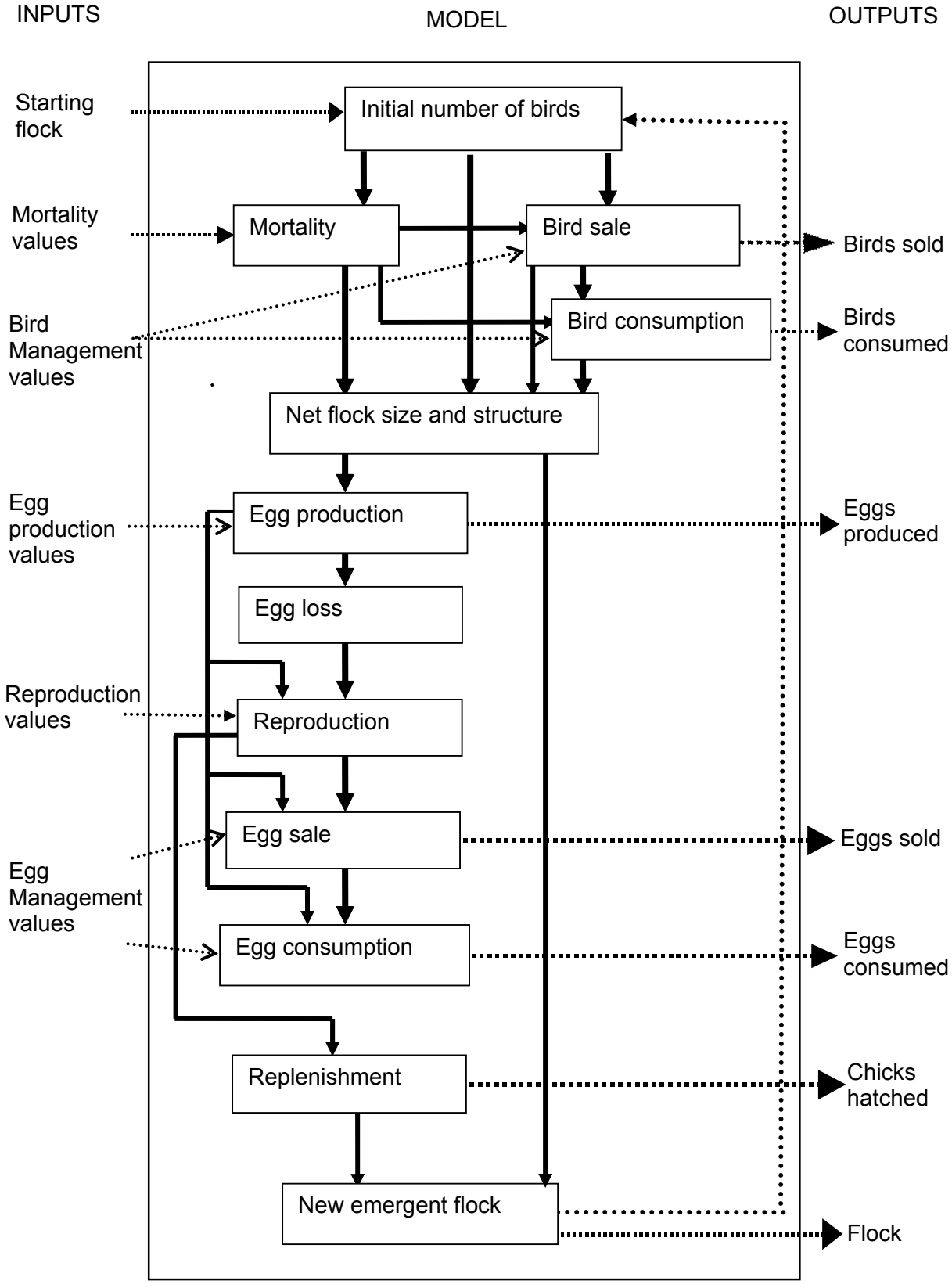

Fig. 5.1 Schematic representation of sequences of events in the model for each time step; broken arrows represent inputs and outputs

The standard procedure to deal with random variation of simulation results, given the same input data, is to replicate the simulation a number of times and take the averages of a parameter. The number of replications required, *N(m)*, is determined using initial replications (Burghout, 2004; Ahmed, 1999):

$$N(m) = \left(\frac{S(m) t_{m-1,1-\alpha/2}}{X(m)\varepsilon} \right)^2 \quad \textbf{(2)}$$

Where *N(m)* is number of replications required, given *m* replications, *X(m)* is estimate of the real mean μ from *m* simulation runs (samples), *S(m)* is estimate of the real standard deviation σ from *m* simulation runs, α is level of significance, ε is allowable percentage error of the estimate X (*m*). $\varepsilon = |X(m) - \mu| / |\mu|$. $t_{m-1,\ 1-\alpha/2}$ is critical value of the two-tailed t-distribution at a level α of significance, given *m-1* degrees of freedom.

Using 10 initial sample runs, at 95% level of significance and 5% allowable error, the number of replication runs was calculated to be 50. The initial sample runs were performed using field data from Tigray, Ethiopia.

2.1.2 Initial flock

The user must enter numbers of initial flock categories: chicks (up to 3 months of age), pullets, cockerels, hens, and cocks. The user may purchase birds of different categories in each season. In the model, the flock categories were denoted as *i*, where *i* runs from 1…5 representing chicks, pullets, cockerels, cocks, and hens. After entry of initial numbers, random number of birds in category *i* in the initial flock (*IFi*) is calculated as:

$$IFi = CMi + (SDi * R) \quad \textbf{(3)}$$

where *CMi* is average number of birds in category *i* entered by the user, *SDi* is standard deviation of the number of birds in category *i* entered by the user and *R* the random coefficient for flock size.

2.1.3 Mortality

Diseases and predation are the main causes of mortality and mortality is a main cause of variation in village poultry systems (Smith, 1992; Spradbrow, 1994; Kitalyi, 1997; Okitoi, 1999). Other causes of mortality are accidents, smothering, drowning and theft (Maijer, 1987). Mortality differs among

categories (Okitoi, 1999) and seasons (Dessie, 1996). Predation losses, for example, are higher in wet seasons than in dry seasons: lack of feed in the wet season weakens birds and makes them more vulnerable for predators than in the dry season, and the relatively denser vegetation in villages during wet seasons harbours predators (Asgedom, 2000). The variations in mortality can be entered by the user for *j*, representing the four seasons autumn, winter, spring and summer, for a period of three years, so 12 year-season categories. One can distinguish between mortality due to diseases, predation or other reasons. The modelling procedures of mortality considered the different flock categories and year seasons categories.

The predation loss of a flock category was determined from initial number of birds, predation mortality rate (varied by *SD* and random number) and season:

$$P_{ij} = Cij * (PRij + (Rj * SDij)) \quad \textbf{(4)}$$

where P_{ij} is number of birds killed by predators in category *i* season *j*, *Cij* is number of birds present of category *i* in the beginning of season *j*, *PRij* is predation rate (%) of category *i* season *j*, *SDij* is standard deviation of *PRij*, *Rj* is random coefficient in the season *j*. The same random coefficient was used across mortality rates per season for each category because positive correlation was observed between parameters of different flock categories. This means as mortality in one flock category increases, the same pattern is observed with that of other categories.

Mortality from diseases and other unknown reasons was computed in the same procedure as predation mortality.

2.1.4 Bird offtake

The number of birds sold or consumed, requires understanding of farmers' policy of sale or consumption of birds of different categories of birds in relation to the required development of the flock. Farmers try to maintain a bird flock at a certain target number, adjusted to household resources (Hoyer, 1992; Roberts, 1997). Above a certain flock size, however, birds are consumed or sold. Consumption and sales can vary with seasons.

Bird sale: Number of birds sold depends on the number of birds left after mortality. No sales are allowed below minimum limits which depend on

flock categories. Maximum limits are also set, beyond which all birds will be sold. In addition, for flock sizes between the minimum and maximum limits, the number of birds sold of category *i* in season *j* (*Sij)* was calculated using the formula:

$$Sij = AFij * (SRij + (Rj * SDij)) \quad \textbf{(5)}$$

AFij is number of birds present after mortality of category *i* in season *j*, *SRij* is sale rate (%) of category *i* in season *j*, *SDij* is standard deviation of sale rate of category *i* in season *j* and *Rj* is random coefficient of sale rate in season *j*.

Bird consumption: Number of birds consumed depends on number of birds after mortality, and sale and the same minimum threshold limits as mentioned for bird sale. Based on farmers' offtake priorities, consumption comes after sale (Sonaiya, 2002). Given threshold limits, number of consumed birds of category *i* in season *j* (C_{ij}) was modelled as:

$$C_{ij} = SAFij * (CRij + (Rj * SDij)) \quad \textbf{(6)}$$

where *SAFij is* number of birds present after sale of category *i* in season *j, CRij* is consumption rate (%) of category *i* in season *j*, *SDij* is standard deviation of consumption rate of the *CRij,* and *Rj* is random coefficient for consumption rate in season *j.*

The total weight of poultry meat consumed in season *j* (*TWBCj)* was determined as a function of number, live weight and carcass percent of each flock category summed over *i* as follows:

$$TWBCj = \sum CCij * LWij * CPij \quad \textbf{(7)}$$

where, *CCij* is number of birds consumed of category *i* in season *j*, *LWij* is live weight of category *i* in season *j*, and *CPij* is carcass percent of category *i* in season *j.*

The difference of the initial number of birds and the birds removed by mortality, sale and consumption was the net flock size and structure.

2.1.5 Egg production

Egg production depends on average number of hens in the net flock in a specific season and number of eggs laid in a clutch. Number of eggs per clutch

is influenced by season because of differences in feed availability (Maijer, 1987; Dessie, 1996; Okitoi, 1999). Total number of eggs produced in season *j* (*EPj)* was computed as:

$$EP_j = 0.5 * (H0j + H1j) * (Pj + (SDj * Rj)) \quad \textbf{(8)}$$

where *H0j* is number of hens in the beginning of season *j*, *H1j* is number of hens at the end of season *j*, *Pj* is number of eggs per hen in season *j*, *SDj* is standard deviation of egg number per hen in season *j*, *Rj* is random coefficient of number of eggs per hen in season *j*.

The model assumes that all hens become broody and have to spend some time incubating and rearing their chicks over a period of three months.

2.1.6 Reproduction

Setting of eggs, incubation capacity of broody hens and hatchability determine the reproduction process. The model assumes that for the eggs produced, farmers' first priority is hatching to maintain the flock (Hoyer, 1992). The maximum number of eggs per hen is set to 12 by default but can be changed by the user. The total number of eggs set for hatching and the hatchability rate determine the number of chicks born in one season. Number of incubated eggs in season *j* (*ESj*) was determined as:

$$ES_j = EPj * (SRj + (SDj * Rj)) \quad \textbf{(9)}$$

where EP_j is number of eggs produced in season *j, SRj* is rate of incubation in season *j*, SD_j is standard deviation of *SRj*, and R_j is random coefficient of SD_j. Whereas the number of hatched eggs in season *j* (*EHj*) was calculated as:

$$EHj = ESj * (HRj + (SDj * Rj)) \quad \textbf{(10)}$$

where *ESj* is number of eggs incubated in season *j*, *HRj* is hatchability rate in season *j*, *SDj* is standard deviation of *HRj* and R_j is random coefficient of *SRj*.

2.1.7 Egg offtake

The egg offtake rate is defined as the number of eggs consumed or sold as a percentage of the total number of eggs produced. The egg offtake rate can fluctuate between seasons (Okitoi, 1999). The total number of eggs sold in season *j* (*SEj*) was calculated as:

$$SEj = EPj * (SERj + (SDj * Rj)) \quad \textbf{(11)}$$

where EPj is number of eggs available (produced) in season j, $SERj$ is egg sale rate in season j, SD_j is standard deviation of EPj and Rj is random coefficient of SDj.

Number of eggs consumed in season j (ECj) is influenced by the number of eggs produced, incubated, lost or broken and sold:

$$ECj = EPj - EBj - ESj - SEj \quad \textbf{(12)}$$

where EPj is number of eggs produced in season j, EBj is number of eggs broken or lost in season j, ESj is number of eggs incubated in season j and SEj is number of eggs sold in season j.

Consumption can also be expressed in terms of egg mass in kg. Egg mass in season j (EMj) was calculated from number of eggs consumed, and egg weight as indicated below:

$$EMj = ECj * (EWj / 1000) \quad \textbf{(13)}$$

where ECj is number of eggs consumed in season j, EWj is weight of eggs in grams in season j.

2.1.8 Average flock present

Flock size varies within a season due to mortality and offtake. Flock present refers to the average number of birds available in each season. The average number of birds is average number of birds of category i in season j ($AvCij$). This was computed as:

$$AvCij = (C0ij + C1ij)/2 \quad \textbf{(14)}$$

where $C0ij$ is number of initial birds of category i in season j, and $C1ij$ is number of birds of category i left at the end of season j.

2.1.9 New flock

The flock size and structure changes after each time step (season). The number of hens in a new season depends on the number of hens at the end of the previous season and the number of pullets becoming hens. The number of

pullets joining the hens depends on age at first egg. Number of hens in the new flock in season *i* (*i*=*j*+1), *NHi,* was calculated as:

$$NHi = AFHj + ((AFPj * (3/(AGE - 3)) \quad (15)$$

where *AFHj* is number of hens at the end of season *j*, *AFPj* is number of pullets at the end of season *j*, and *AGE* is maturity age.

The number of cocks in the new flock is computed the same way as for hens. The number of cockerels joining the cocks depends on age of maturity. This age of maturity is assumed to be equal to the age at first egg for the pullets. All chicks in a new season come from the chicks newly hatched in the previous season. After one season chicks are assumed to become growers and will be equally distributed as cockerels and pullets.

2.1.10 Manure production

The model calculated the amount of dry matter in kg of DM manure produced in season *j* (*Mj*) as function of average birds present of different categories and their respective manure yield and dry matter:

$$Mj = \sum (CMij * AvCij) \quad (16)$$

where *CMij* is manure yield (kg of DM) of category *i* in season *j*, *AvCij* is average number of birds of category *i* in season *j*.

2.1.11 Workload

The workload expressed in total labour hours spent on poultry in season *j* (*LHj)* was determined considering time spent per day per bird and average flock size in a given season:

$$LHj = \sum ((MCDj * AvCij) * 90) \quad (17)$$

where *MCDj* is average number of hours spent per day per bird in season *j*, and *AvCij* is average present number of birds of category *i* in season *j*.

2.1.12 Costs

The model has the ability to define input values of extra costs per day per bird of various inputs. It then calculates total cost of production in season *j*

(*TCj*) as a result of input cost/day/bird, and average flock size in this season:

$$TCj = \sum (BCj * 90 * AvCij) \quad \textbf{(18)}$$

where *BCj* is cost per bird per day in season *j*, *AvCij* is number of birds of category *i* in season *j*. The model separates costs of labour and other costs. The formulae (18) refers to the other costs. Labour cost in season *j* (*LCj*) was calculated based on labour hours and labour cost per hour:

$$LCj = \sum (LHj * CLHRj * AvCij * 90) \quad \textbf{(19)}$$

where *LHj* is number of hours spent per day per bird in season *j*, *CLHRj* is cost of labour per hour in season *j* and *AvCij* is number of birds of category *i* in season *j*.

2.1.13 Benefits

The model considers benefits of cash income and opportunity values. The computations consider various bird categories and seasonal variations in flock size and prices.

Direct benefits included cash values of bird sales and consumptions, and egg sales and consumptions. Direct benefit in season *j* (*DBj)* was calculated as:

$$DBj = \sum (((Sij + Cij) * BPij * Rj)) + ((SEj + ECj) * EPj * Rj)) \quad \textbf{(20)}$$

where *Sij* is number of birds sold in category *i* in season *j*, *Cij* is number of birds consumed of category *i* in season *j*, *BPij* is price of birds of category *i* in season *j*, *Rj* is random coefficient for prices in season *j, SEj* is number of eggs sold in season *j*, *ECj* is number of eggs consumed in season *j,* and *EPj* is price of eggs in season *j*.

The indirect benefits in season *j* (*IBj*) were derived from the cash values of average present flock and manure production:

$$IBj = \sum (AvCij * (AV / 4)) * BPij * Rj) + (Mj * MPj) \quad \textbf{(21)}$$

where *AvCij* is average number of present birds of category *i* in season *j, AV* is the animal presence value, the value of having birds in case of urgent cash or social needs (Bosman *et al*., 1997), *BPij* is price of birds category *i* in season *j*, *Rj* is random coefficient for prices in season *j, Mj* is amount (kg DM) of poultry manure produced in season *j*, and *MPj* is price per kg DM of manure in season *j*

2.1.14 Net return

Net return in season *j* (*NRj)* was calculated as difference of the total benefits and total costs. This is done for every season according to the equation:

$$NRj = (DBj + IBj) - TCj \quad \textbf{(22)}$$

where *DBJ* is direct benefits in season *j*, *IBj* is indirect benefits in season *j*, and *TCj* is total cost in season *j*.

The model also calculates effectiveness of labour in terms of net return per labour hour:

$$LNRj = (TBj - TCj)/(MCD * 90) \quad \textbf{(23)}$$

where *LNRj* is net return per labour hour in season *j, TBj* is total benefits in season *j*, *TCj* is total cost in season *j* and *MCD* is number of labour hours per day.

2.2 Validation; approach

To test the validity of the model, data were used from a monitoring study of village poultry in Tigray, Ethiopia. A bi-weekly farm recording of 131 households was done for 12 months during the year 2003-2004. The farm records, prepared in *Tigrigna* (local language), were filled in by farmers in collaboration with research assistants. The records provided farm data on flock size and structure, mortality, (re)production, and offtake. Table 5.1 gives the mortality and bird offtake data.

The four seasons specified in table 5.1 represent (1) a dry season (autumn), (2) another dry season (winter), (3) a season with short rains (spring), and (4) a wet season with long rains (summer). There were variations in mortality and offtake between seasons and bird categories. Predation losses were relatively higher in winter because the open field without vegetation is

Table 5.1 Means and standard deviations of mortality and bird offtake rates of different flock categories in autumn (season 1), winter (season 2), spring (season 3) and summer (season 4) in Tigray

Parameters (%)	Season	chicks	pullets	cockerels	hens	cocks
Predation losses	1	16.6 ± 24.0	2.1 ± 8.5	1.3 ± 7.2	4.6 ± 14.7	0.6 ± 5.6
	2	26.8 ± 22.5	6.0 ± 16.5	7.5 ± 20.4	5.3 ± 13.1	0.0 ± 0.0
	3	12.3 ± 18.2	3.5 ± 14.8	1.9 ± 11.4	1.4 ± 6.5	0.8 ± 4.8
	4	17.6 ± 19.4	2.9 ± 12.9	0.6 ± 4.6	2.2 ± 9.0	2.4 ± 14.2
Disease losses	1	6.0 ± 14.7	0.43 ± 3.9	0.0 ± 0.0	1.5 ± 8.0	0.0 ± 0.0
	2	10.7 ± 15.9	3.0 ± 12.4	4.8 ± 18.1	0.5 ± 4.4	0.1 ± 4.1
	3	14.6 ± 21.4	1.17 ± 5.9	1.1 ± 5.4	0.5 ± 2.8	1.0 ± 6.5
	4	17.3 ± 22.5	2.4 ± 11.4	1.0 ± 7.5	1.9 ± 8.5	3.1 ± 13.0
Other losses	1	0.8 ± 5.6	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
	2	0.48 ± 4.7	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.32 ± 2.9
	3	0.18 ± 1.4	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
	4	0.39 ± 2.7	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Consumption	1	0.5 ± 3.9	5.52 ± 17.3	13.9 ± 27.5	2.7 ± 8.2	8.6 ± 22.9
	2	0.0 ± 0.0	5.1 ± 15.1	6.1 ± 16.7	10.2 ± 14.9	12.0 ± 23.1
	3	0.3 ± 1.8	7.8 ± 17.3	8.27 ± 19.6	13.1 ± 16.6	21.3 ± 28.4
	4	0.0 ± 0.0	8.7 ± 17.1	10.6 ± 19.4	11.8 ± 16.9	18.7 ± 26.0
Sales	1	0.5 ± 4.1	10.3 ± 21.2	20.7 ± 31.0	5.9 ± 14.6	14.8 ± 27.3
	2	0.0 ± 0.0	21.5 ± 29.0	19.9 ± 29.7	11.9 ± 15.9	21.8 ± 33.8
	3	0.3 ± 2.7	18.6 ± 27.4	28.2 ± 30.7	11.1 ± 15.1	18.7 ± 30.6
	4	0.0 ± 0.0	27.4 ± 29.6	28.8 ± 34.4	7.4 ± 13.7	23.6 ± 29.3

suitable for aerial predators. Young birds were more susceptible to mortality than the older ones in all seasons.

Table 5.2 presents field data for egg production, offtake, loss, and reproduction. Farmers incubated a relatively lower proportion of their eggs in the wet season as hatchability seems be lower in this season. The starting flock in the model validation consists of 2.84 chicks, 1.21 pullets, 0.52 cockerels, 2.44 hens and 0.61 cocks. This represents an average flock of village poultry in Ethiopia, and is consistent with findings throughout rural Africa (Guèye, 1998). There was no purchase of birds. The maximum number of eggs incubated per hen was set at 12 based on the field data. The age at first egg was set at 8 months in the model. No sales were allowed if the number of birds were less than or equal to 1 chick, 1 pullet, 0.5 cockerels, 2 hens and 0.5 cocks. All birds were sold above 10 pullets, 3 cockerels, 5 hens and 2 cocks.

Table 5.2 Means and standard deviations of egg production, offtake, loss, and reproduction rates in autumn (season 1), winter (season 2), spring (season 3) and summer (season 4) in Tigray

parameters	season 1	season 2	season 3	season 4
Eggs produced /hen	14.9 ± 17.2	13.9 ± 11.5	13.3 ± 16.4	14.0 ± 15.8
Eggs consumed (%)	23.9 ± 26.5	28.1 ± 23.8	27.7 ± 19.3	28.6 ± 23.6
Eggs sold (%)	54.7 ± 33.9	56.7 ± 26.8	65.3 ± 24.2	62.2 ± 25.6
Eggs lost/broken (%)	4.4 ± 8.3	3.4 ± 5.8	1.0 ± 6.0	2.7 ± 8.4
Eggs incubated (%)	16.9 ± 33.8	11.8 ± 25.2	6.0 ± 19.7	6.5 ± 20.3
Hatchability (%)	91.6 ± 16.2	81.6 ± 18.4	78.2 ± 29.9	72.2 ± 28.0

2.3 Model application; approach

Changes in input values were used to explore effects of management options on village poultry. Daytime housing and NCD vaccination were considered as examples to demonstrate how the model behaves. Flock size is an aggregate measure to evaluate changes; it combines the different processes of mortality, bird offtake, reproduction, egg production and egg offtake. Input values for daytime housing related to predation, other bird losses, and egg losses were decreased by 100%, other losses by 50%, egg losses by 100% respectively based on field studies in Ethiopia (Aklilu, 2006) and in other countries (Maijer, 1987). Egg production per hen was increased by 50% and age at first egg was reduced by 15% (Okitoi, 1999). Housing of birds requires that they are fed. Field data were also used to assess economic performance of housing. NCD vaccination was considered to decrease mortality by 50% (Maijer, 1987; Okitoi, 1999). The cost of NCD vaccination was 0.35 birr per bird in north Ethiopia (Aklilu, 2006). A monthly marketing survey was conducted for 12 months during 2003-2004 along with the bi-weekly farm recording of 131 households to determine prices of different categories of birds and eggs, and inputs and outputs of village poultry. Table 5.3 gives the prices used for the cost–benefit calculations for the Tigray region.

Table 5.3 Means and standard deviations of prices (in US $cents) of birds and eggs in autumn (season 1), winter (season 2), spring (season 3) and summer (season 4) in Tigray

category	season 1	season 2	season 3	season 4
Cock	164 ± 19	142 ± 8	144 ± 20	170 ± 36
Hen	144 ± 17	132 ± 16	126 ± 25	150 ± 28
Pullet	101 ± 20	97 ± 19	88 ± 11	115 ± 17
Cockerel	109 ± 19	97 ± 7	92 ± 3	143 ± 29
Egg	3.56 ± 0.39	3.36 ± 0.46	3.4 ± 0.36	3.71 ± 0.73

The animal presence value was set at 15% of the market value of the birds (Bosman *et al*., 1997). The value of manure was estimated to be 0.023 $ (0.2 birr) per kg of DM (Amsalu, 2006). The value of labour per hour was estimated at 0.116 $ for the dry seasons and 0.139 $ for the wet season (BOANR, 1999).

3 Results

3.1 Base situation

Fig. 5.2 shows the first 10 of the 50 replication runs of the changes in the number of birds for the simulated period of 12 seasons (3 years). Starting with the same initial flock, the model gives different outcomes showing variance of flock development in the simulated period of three years. The changes in mortality, offtake, egg production, and reproduction interact in such a way that the flock remains relatively stable over the simulated period of three years as indicated by the bold line in Fig. 5.2.

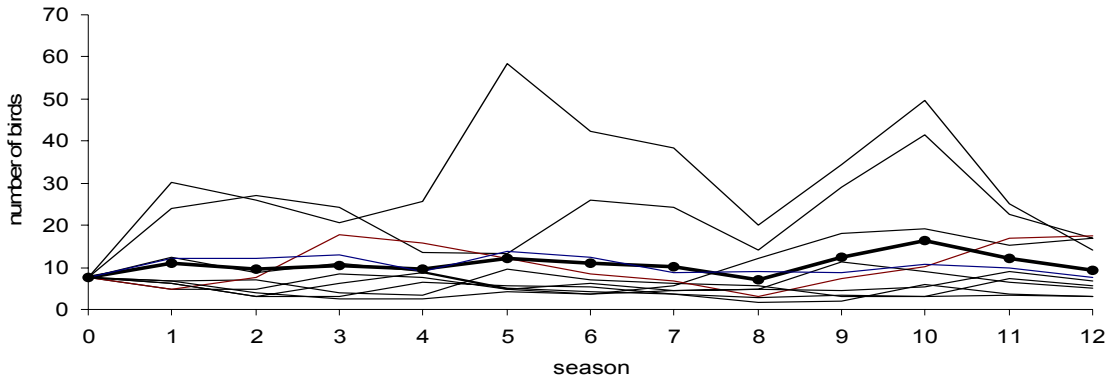

Fig. 5.2 Overview of stochastic simulation of the first ten runs of flock size; the bold line indicates the average of all simulation runs

3.2 Validation

The data used for validation were gathered over one year. Thus, the simulated values were compared with observed values in the field for a period of four time steps. Points of reference for the validation were egg production, bird offtake and flock size. Overall, observed and simulated values did show close patterns. Fig. 5.3 (a) presents the observed value and the average of 50 runs of egg production. The data for season 1 represent the model output after the first time step. The egg production changes were caused by the seasonal changes in egg production and flock size, which were affected by mortality, offtake rates and reproduction. Fig. 5.3 (b) presents observed values and the

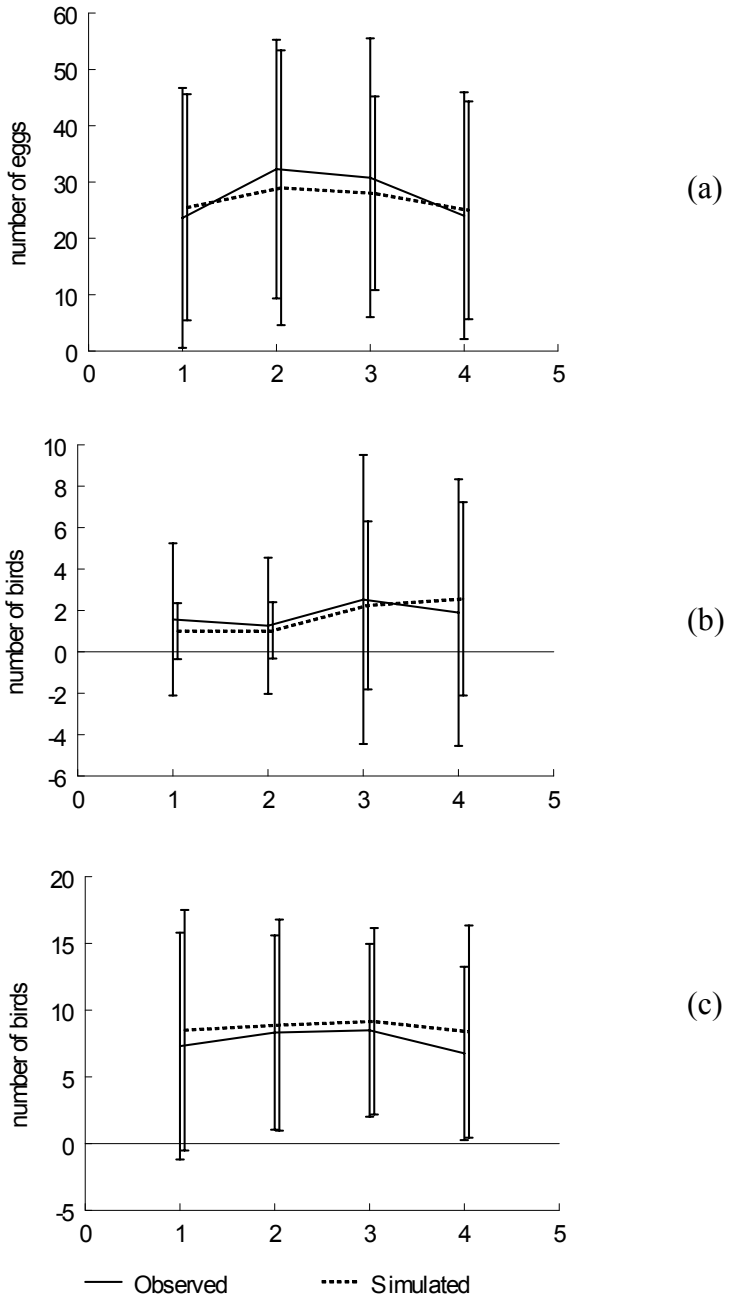

Fig. 5.3 Observed and simulated egg production (a), bird offtake (b) and flock size (c) over four time steps (seasons)

average of 50 runs for bird offtake. The bird offtake refers to the number of consumed and sold birds. Fig. 5.3 (c) shows observed values and the average of 50 replication runs of number of birds. The data for season 0 represent the input values for the first season and the data for season 1 represent the model output after the first time step. The number of birds fluctuated over the time steps but hardly changed at the end of the simulation period as compared to the beginning. The fluctuations in flock size were caused by different interactions in the different seasons regarding mortality, offtake, production and reproduction processes. For egg and bird offtake, the visual appraisal between simulated and

observed values showed hardly any difference between the two. The simulated flock sizes were, however, slightly higher (16-17%) than the observed flock sizes

3.3 Model application

Fig. 5.4 shows the simulated development of flock size for the base situation, daytime housing and NCD vaccination over 12 seasons. Housing showed great increase in flock size. NCD vaccination resulted in higher flock size than the base situation but lower than daytime housing.

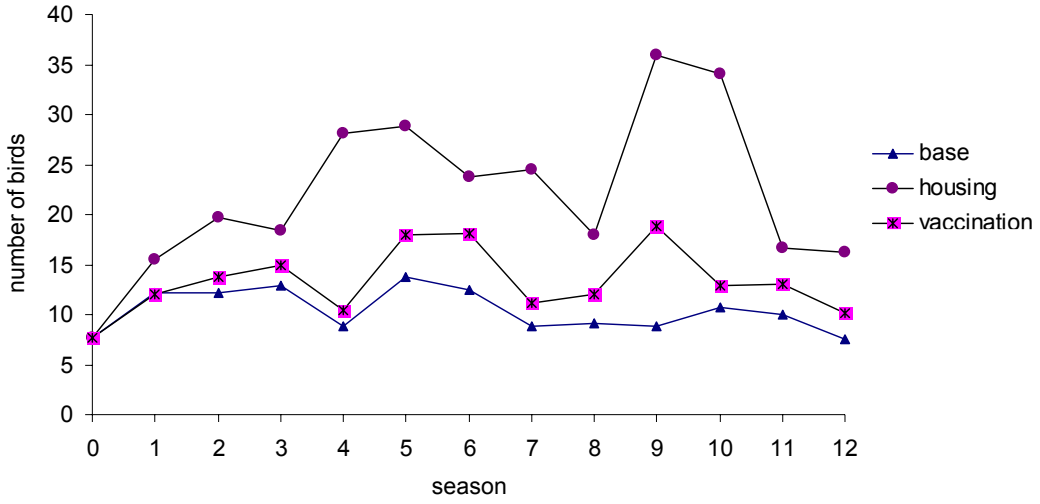

Fig. 5.4 Simulated effect of daytime housing and NCD vaccination (vaccination) on flock size development (average of 50 runs)

Costs, benefits, and net returns of daytime housing and NCD vaccination were compared with the base situation (Fig. 5.5). Daytime housing resulted in a tremendous increase in both costs and benefits. However it resulted in a 180 % decrease in net returns. The major cause of this decrease in net return was the additional feed needed. NCD vaccination resulted in the highest return.

Fig. 5.6 compares the daily labour required for the base situation, the daytime housing and NCD vaccination over the simulation period. Daytime housing increased daily hours spent on poultry by 507 % at the end of the simulation period. This was due to additional time spent on feeding, and sanitary activities in the shed. Vaccination increased workload by 200% at the end of the simulation period due to the additional labour required for the higher flock size.

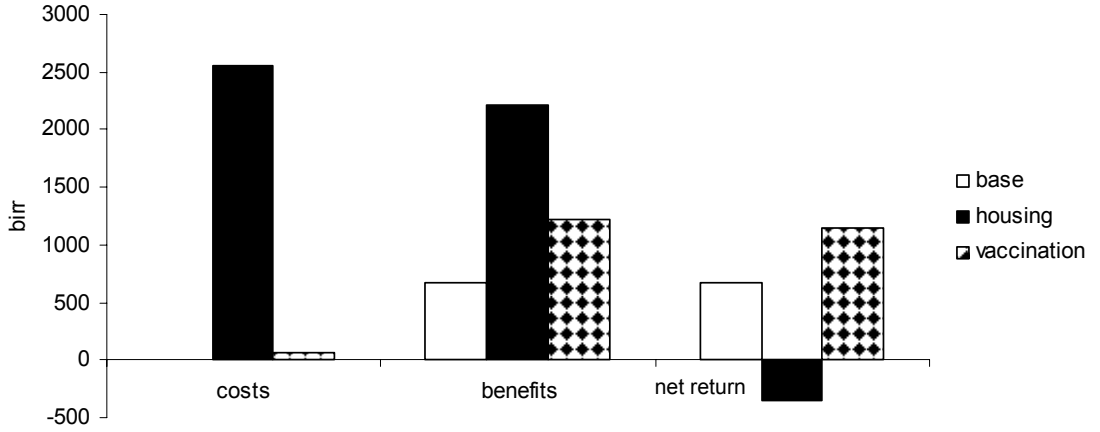

Fig. 5.5 Total costs, benefits and net returns for the base situation (base), daytime housing (housing) and NCD vaccination (vaccination) over the simulated period of 12 seasons

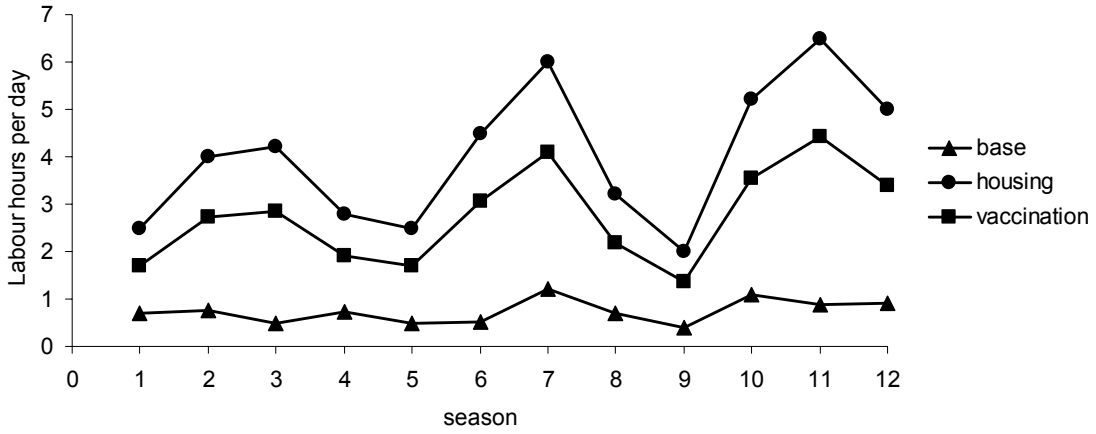

Fig. 5.6 Daily labour hours spent on poultry for the base situation (base), daytime housing (housing) and NCD vaccination (vaccination) over the simulated period of 12 seasons (average of 50 runs)

4 Discussion

A model can be judged on the basis of validity of the conceptual model and results of the operational validation (Sorensen, 1990). The wide range of household information from the field and literature enabled to properly design this village poultry model. The model integrates mortality, reproduction, egg production and offtake in such a way that flock dynamics parameters can be assessed. Stochastic modelling allows obtaining information about response variability which helps to make unbiased predictions under different management strategies (Konandreas and Anderson, 1982). Starting with the same initial conditions and management regime, an infinite number of different outcomes may result over a finite simulated time period. We used 50 replication runs to simulate the variation of outcomes of a given scenario. The variety of

possible outcomes in flock size occurred because of the variability in interactions in mortality, offtake, egg production and reproduction from season to season. For example, fluctuations of poultry offtake in Ethiopia are caused by dynamics of demand resulting from fasting periods and religious festivals (Aklilu *et al*., 2007).

The operational validation showed that the behaviour of the simulated patterns corresponded well to the observed data from a monitoring study of village poultry in Ethiopia. The slightly higher simulated flock sizes could be explained by the fact that the model sets minimum limits for flock sizes and therefore less animals will be consumed or sold as predicted by the mean and the standard deviation for consumption and sales.

Prospective management options will be sustainable only if they fit the limited physical and economic resources of farming households. The example of simulation of daytime housing demonstrated the trade-off effects management options can have on production and economic performance of village poultry production. Daytime housing showed a positive response in flock output parameters but negative returns on the basis of a cost benefit analysis of the additional feeding. In addition, daytime housing increased labour hours spent on poultry by 5 times. NCD vaccination resulted in higher returns, although it caused lower flock increase than daytime housing. This is due to the relatively low (subsidized) cost of vaccination in Ethiopia.

Situation-specific information is needed on the effect of management options on production parameters. The input data used for the simulations were based on a field study in Tigray, Ethiopia. Where field data were not obtainable, some input values were based on literature. Because the fixed parameters can be set by the user, the model is very flexible and can easily be tuned to production characteristics distinct from the default values. Many scientists in developing countries are not able to use models effectively because of their limited understanding of programming languages, difficulty in finding the detailed model inputs, or inadequate technical support to address problems (Aggarwal *et al*., 2006). To increase the user-friendliness of the model and thus to accelerate its use, a simple menu driven version of VIPOSIM has been developed using macro programming facilities in Microsoft Excel®, an application which is commonly available with almost all computers.

The overall conclusion is that VIPOSIM assesses dynamics in village poultry in biological and economic terms and as such it can be used to analyse current and prospective management options. Village poultry systems are very similar throughout the world (Udo, 1997). The use of a simulation model is a relatively cheap and simple method to improve our understanding of flock dynamics. Modelling can give more direction to the type of village poultry data to be collected in order to study the behaviour of poultry systems and can help to identify the most likely management options. However, development and dissemination of a model does not guarantee its use by target clients (Vennix *et al*., 1997). Researchers should explore participatory methodologies to engage with their clients like farmers to use the model for joint learning to pave a more reliable path towards improving farm management. In this way, the model can be used as part of research and development approaches to understand possibilities of improvements in village poultry systems.

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Chapter 6

Learning with farmers through farm recording and modelling of village poultry in Ethiopia

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Abstract

The role of modelling in improving livelihoods of small scale farmers has been disputed and more recently it has been suggested that it be used as a tool in the joint learning of researchers and farmers. Few practical experiences are reported, however. This paper presents experiences from a farm data collection exercise for modelling village poultry management in Northern Ethiopia, and the following feed-back sessions on the data and model outcomes. Although farm data collection is an extractive process, and for that reason was hardly expected to interest farmers, the feedback sessions showed that the information generated was valuable as an entry point for discussion and learning on, for example, reasons for variation between households in poultry keeping performances.

Key words: Village poultry; Simulation model; Learning; Farmers; Ethiopia; Farm recording

1 Introduction

Agricultural researchers build models to understand the functioning of production systems, and to predict how they will behave under particular management regimes (Herrero *et al*., 1999; Ramsden *et al*., 1999; Van Paassen, 2004, Hilhost and Manders, 1995; Walker and Zoo, 2000). In recent decades, modelling efforts have also included behaviour of, and impact on, farming households (Dimes *et al*., 2003; Van Paassen, 2004). The relevance of models for small-scale farmers' reality in developing countries has, however, been questioned, mainly based on the argument that the models cannot capture the complexity of their livelihoods and would thus render technologies and assessment of technologies irrelevant for the farmers (Vennix *et al*., 1997; Dorner, 1997). Partly in response to this criticism, and with the increasing attention for farmer participation in technology development, there has been a growing interest in exploring opportunities of modelling as a more interactive research activity. These opportunities might help small-scale farmers in developing countries learn to analyse their production systems in new ways, and thus serve as a support tool for farmer decision making (Dimes *et al*., 2003; McCown 2002; Matthews and Stevens, 2002). Participatory approaches seek to foster joint learning by researchers and farmers about farming conditions in order to help both parties to explore farm improvement options jointly (Ashby and Sperling, 1994; Okali *et al*., 1994).

Recent initiatives explore the possibilities of integrating elements of risk and uncertainty in decision support models, and use scenario exploration to make models more relevant to farmers (Van Paassen, 2004; Matthews *et al*., 2000). However, it still remains a challenge to enhance communication between scientists and farmers and foster joint learning using modelling processes (Dorner, 1997). Few experiences are reported where target farmers have used models (Walker and Zoo, 2000).

This paper reflects on the engagement of development agents and research assistants with farmers in developing and using a model to assess the impact of management options on the dynamics of village poultry systems. The data collection phase, necessary to verify the data, and build and validate the model, and the feedback on the outcomes of the model, were the first steps in a research process through which the researchers aim to develop an effective use of modelling in interdisciplinary and participatory research relevant to the needs of small-scale farmers in Ethiopia.

2 Research context

The reported study is part of a project that aims to explore ways in which farmers and researchers can jointly learn about constraints and opportunities for village poultry improvement in Tigray, North Ethiopia. Table 6.1 summarizes the phases in the project. The first phase aimed at understanding the role of village poultry in the livelihood of households through individual and group discussions, and a cross-sectional survey of poultry keepers. The 2nd phase was to understand production systems and marketing arrangements of village poultry using a combination of marketing surveys and group discussions with producers, direct sellers, and intermediaries. The 3rd phase was the generation of household data for the model. The data were recorded by the farmers (or family members) in collaboration with extension agents. Phase 4, the first feedback workshops, aimed at sharing systematically collected data between farmers and researchers. Workshops in Phase 5 were used to identify farmers' constraints. Phase 6 consisted of modelling and simulation of the village poultry system using the household data. In phase 7, in a second round of feedback workshops, the outcomes of the model scenarios were shared with the farmers and used to identify options for improvement of poultry systems and future experimentation. This paper presents a description of practical experiences in using modelling for interaction between farmers and researchers. It focuses on the interaction over and participation in data collection through making of farm records in phase 4 to 7.

Table 6.1 The different phases in poultry research project in three villages (Enderta, Hintalo and Alaje) in Tigray

Phases and purpose	**Methods**
Phase 1: Understand socio-cultural and economic role	Individual/group interviews, cross-sectional survey, household records
Phase 2: understand production and marketing systems of poultry	Discussions with producers and market groups, and marketing survey
Phase 3: generation of farm data about poultry dynamics	Farm recording by household members and research assistants, workshops
Phase 4: validation of data, exchange of information	3 feed back workshops: one per village, 6 farmers per village
Phase 5: identification of constraints	6 workshops: two per village, 6 farmers per village
Phase 6: modelling the village poultry system for joint learning with farmers	Computer simulation model using farm data;
Phase 7**:** discussion of outcomes of the model	3 feed back workshops: one per village, 6 farmers per village

3 Putting processes into practice

3.1 Preparing and planning with the research team for Phase 4

3.1.1 Perceptions of research collaborators on the need for farmer feedback

The first step in the research process involved consultations of the leading researcher, first author of this paper, with the research team to be involved in the data gathering. The research team consisted of three development agents and three students. All six were to serve as research assistants. The perception of these research collaborators on the constraints in village poultry systems gave a first orientation on the research. Another purpose of the consultations was for the leading researcher to explain the thinking behind the research project. He sought to develop motivations for leaning with farmers and to point out the accountability of researchers to farmers, as outlined in the objectives of the research proposal. The development agents and research assistants, he presumed, would learn with the farmers and should become keen to do things differently.

During the consultations, the development agents were asked for their views on having feedback workshops using the data on household poultry dynamics. Development agents expected that the feedback would enable them to identify the kind of support farmers need in poultry production. Despite the fact that the development agents worked with these farmers, they acknowledged they had never sat together with farmers systematically to analyse the constraints in village poultry keeping. The development agents also mentioned that not all farmers have the same knowledge and motivation for their poultry. The agents thought that the feedback workshops would allow the research team to identify relatively better or poorer managers of poultry. The feedback processes would also give an opportunity for farmers to share experiences in poultry keeping.

The research assistants also speculated that farmers would become more motivated to seek explanations of the purpose of the research and be informed of the outcomes. This in turn would motivate the research team, since, as one of the assistants mentioned, he had also been an enumerator in a previous research project in which farmers described surveys as *'metitka hidma'*, which literally means *'suck and run'*. This illustrates the perception of farmers regarding the extractive way researchers operate, and the fact they leave without providing any incentives or feedback of value to the households they

got the information from. It was hypothesised that greater motivation on the part of farmers would result in better collaboration with researchers and better quality of data.

3.1.2 Planning of the first feedback workshops

In the first workshop, farmers would be presented the information collected via the extensive household level recording of flock dynamics (Aklilu *et al*., 2007). Nobody had experience in setting up and implementing such a workshop and every step was reviewed and planned. During the preparation session the main issue was how to communicate with farmers about the data. The purpose of presenting the data was not only to validate them but also to use them as an entry point to discuss with farmers the reasons for variation between households. Presenting systematized data on poultry keeping from the sample households seems quite straightforward, but in this case, approximately 80 % (105 of 131) of the farmers were illiterate. Not only would they not be able to read the numbers but research collaborators expected that they would have difficulty in interpreting the results as well. The option of reading out the numbers was considered because researchers had the experience that farmers were better listeners than readers. However, the amount of information would not permit effective comparison among farmers of the different variables of the poultry keeping performances. The option of involving the sons and daughters, who are young school children, was also discussed at great length. The school children are literate and might in general be more open minded, but research collaborators saw some drawbacks. The development agents had the experience that children have little influence on the way their parents do things. One of the development agents said that in the local tradition, the opinions of elderly people and experienced colleagues are respected. A father was therefore not expected to pay a lot of attention to the knowledge of schoolchildren, less so when it would be relate to the father's main source of livelihood and income, agriculture.

3.1.3 Developing a language for communication

The first challenge of the team was to select appropriate variables. The farm records contained a number of variables, measured at intervals of 2 weeks over a period of approximately 3 months (Aklilu *et al*., 2007). The 10 key variables for feedback (validation and entry point for discussion) were related to losses, consumption, sales, egg production and replacement flock. The information on the variables concerned production (flock size, eggs laid),

reproduction (incubated eggs, hatched eggs), mortality (diseases losses, predation losses) and offtake (bird and egg sales and consumption).

After identifying the variables, team members developed symbols and a format that could be used to visualize the information for each selected variable. Fig. 6.1 shows examples of the symbols that were used; they were sketches, pictures taken with a digital camera, cards, and flip charts. Working with such representations was totally new to the university researchers and development agents on the team. It forced them to think through what information was relevant for the farmers and how to select and reduce the information to the most essential.

The farm comparison required re-organizing the symbols. Cards and real pictures were used to represent number of birds and eggs, for example, three cards with an egg representing three eggs. To distinguish between farms, cards of different colours were used, with a unique colour for each farm (Fig. 6.2). Ten posters were prepared for the ten selected variables. In each of them, six farms were compared. The different posters showed for instance that farm F had the highest number of incubated eggs. Farm D did not hatch any chicks although it incubated some eggs. Another observation was that Farms A and B incubated

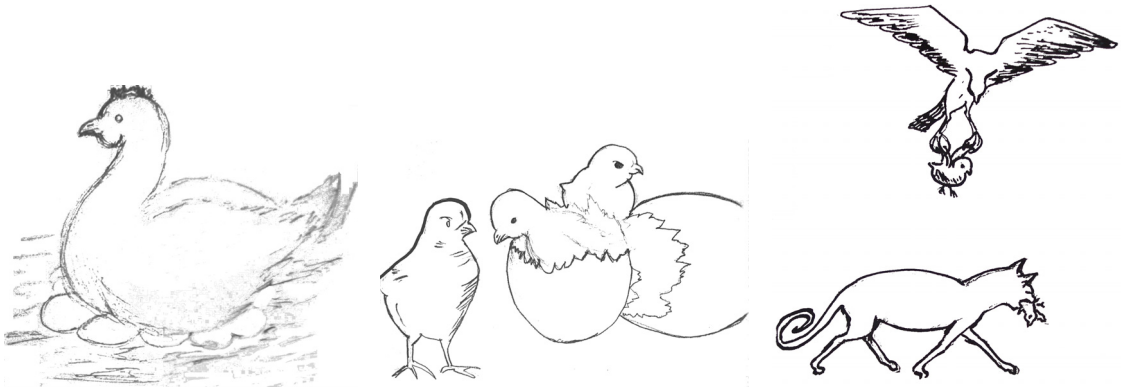

Fig. 6.1 Examples of symbols (cards) representing incubation, hatching and predation

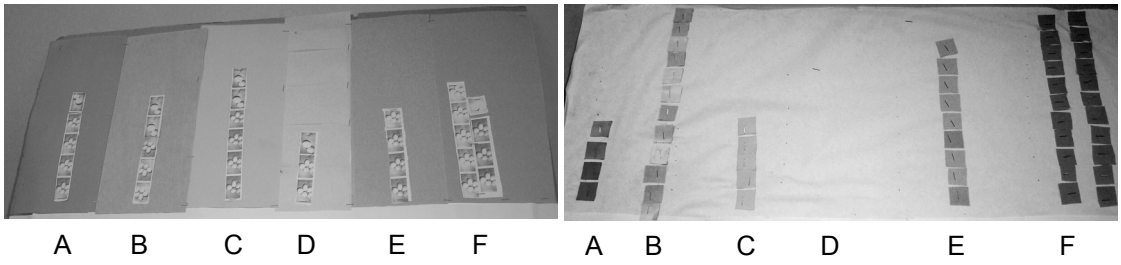

Fig. 6.2 Visualising comparison between two of the ten selected variables: number incubated eggs (left) and number of hatched eggs (right) in six households (letters represent farmers)

approximately the same number of eggs, but farm B was much more successful in hatching than farm A. Farmers would be asked what they thought of the differences and what the explanation for the differences could be. This was expected to stimulate farmers to think about the management and performance of their flocks.

3.2 Phase 4: The first feedback workshops

3.2.1 The participants

Who and how to select participants for the feedback workshops was a major concern for the research team members. In total 131 households participated in the research, but not all of these could be invited to the workshops. Hence, the research team decided to work with three sub-samples of six farmers to ensure active participation of each member. In an open discussion the researchers identified three male and three female farmers based on their overall impression of the farmers and the variation in their poultry data. Apart from these six farmers the seven members of the research team took part in the workshop. The three development agents came from these villages and farmers were familiar with them. They were expected to play an important role in raising questions. To support in documentation and observation, three students from a local university participated in the workshop. These students had stayed in the villages for three months and were familiar faces for the farmers. In the workshops, the students took notes and, photographs, and observed the process. The principal researcher facilitated the workshop.

3.2.2 The workshop program and process

The workshop was implemented in a series of steps. First, the facilitator explained that the goal of the workshop was to share information and experiences among farmers and between farmers and researchers in order to explore opportunities to improve village poultry keeping. The second step introduced feedback tools to farmers: the ten posters. They were displayed and the information on the posters was explained by the researchers (Fig. 6.2). Farmers were then given time to observe the posters and they could freely move to view the different posters more closely. The researchers also moved around and gave explanations in answer to queries by farmers.

This way the research team presented in very simple form a comparative analysis of the differences among six farms. The facilitator then asked the

farmers what they thought explained the differences between the farms for the particular variable displayed on a poster. From this emerged an exchange of experiences and opinions. For example, farmers who had been relatively successful with hatching of eggs talked about factors they felt were important for good hatching results, such as pre-incubation storage period, storage condition of eggs before incubation, where and how to incubate eggs, and how to get fertile eggs (Box 6.1). Other discussions took place. These included, among others, how to decrease mortality and increase egg production.

Box 6.1 Information exchange of farmers regarding hatching and its management

After looking at the posters, participant farmers realized that some households had better hatching results than others. This stimulated discussion among the farmers about hatching management. A farmer who had low hatching results described her problem as follows: *"I have mostly faced problems in hatching. A broody hen may or may not hatch the chicks. Several times, incubation has put me at a loss. But I need the chicks. I have always tried to improve, without much success so far. I set 10-12 eggs for hatching. Usually less than half of them are hatching and some times not at all. I once thought the hen was the problem. Then I borrowed a good (broody) hen from a neighbour. But this did not solve the problem."*

The facilitator asked another farmer who had better hatchability to share his experiences. He said: *"I feel I have good experience with hatching. Old eggs are not good for hatching. Fresh eggs are best. But not all the eggs incubated are fresh. If you have only one local hen, it takes almost a month to lay 12 eggs. Only the eggs that are laid in the last 15 days are good for hatching. Fortunately, a hen cannot distinguish between its own and others eggs. So, you can collect eggs from other hens and let the broody one sit on it. Eggs stored in flour do not hatch. An open cold pan is the best for this. For incubation, the best bedding is teff (*) straw (local crop). I do not think rags, soils, or ash suit hatching eggs. Broody hens like corners, separate and dark places."*

Another participant then brought in her experiences for improving hatchability;
"If you have false eggs, chicks can never come out. You need a cock to get true eggs. Some people think they will get true eggs if there is a cock in their neighbourhood. I prefer to have my own cock in my flock. I always manage to have one. That is why the hatching in my farm is good. If you do not have your own cock, you can borrow one for a few weeks. Purchasing or borrowing a cock has some problems. The cock may come with diseases. But raising one's own cock is the best option. Even if you use true eggs, they may not be all hatched. For example, small or big eggs do not hatch. Medium or normal eggs are the best. Normally, practice up to 12 local eggs can be incubated. *But only 7-8 Ferenji (**) chicken eggs have to be incubated. Ferenji eggs are big and hence more of them would not fit the local broody hen".*

(*) teff is a local grain crop (Eragrostis tef); (**) Ferenji chickens is the local term for foreign, improved breeds

3.3 Phase 5: Workshops to identifying constraints in village poultry systems

In order to find opportunities for improvements in the village poultry system, the next step was to identify constraints considered relevant by the

participating farmers. The constraints would then be used for simulations with the VIPOSIM model (Aklilu *et al*., submitted). For this purpose, six workshops were held in three locations, involving the same six farmers in each of the villages. Since researcher and farmers now knew each other quite well, not much introduction was needed and the contact was open and easy. Assistants and development agents played similar roles in preparation and implementation as in the feedback workshops.

For the identification of constraints the farmers were first asked whether they would want to expand their current small-scale poultry. Then, they were asked as a group what constraints prevented them from expanding their scale of production. The farmers came up with a range of constraints and often they referred to what they noticed during the year-long farm recording, which shows the importance of the recording phase for farmer learning. The constraints mentioned by farmers included lack of market, shortage of labour and feed, disease, predation, low production by local birds, neighbourhood conflict, damage of garden and crops, theft, lack of knowledge (e.g. of reproduction management), shortage of space and housing, lack of financial capital, and effect on family members' health.

In the following workshop, the participants were asked to individually identify the three most important constraints. These served to prioritize among the constraints. For this, different sketches representing the different constraints were laid on the floor. Each participant was given three cards and was asked to put the cards on what they perceived the three most important constraints. After a farmer had placed the cards, the selections were documented and the cards were picked up so the next farmers coming into the room would not see what others had selected. This was to avoid a follower effect. Table 6.2 shows an example of a farmer prioritization. The exercise showed that farmers prioritized different constraints. For example, while disease was important for some, predation was given higher priority by others. In concluding this workshop, the researchers informed the farmers they would come back next meeting with suggestions for improving management options.

Because the research team members had in earlier discussions agreed that the terms 'computers' and 'models' were not understandable to farmers they explained they would use calculations to explore how different management options for overcoming constraints could possibly increase production and cost reduction. None of the farmers, and even some

development agents, had ever seen or heard of computers, let alone computer models. The principal researcher had explained to the development agents and assistants about the computer and computer models beforehand.

Table 6.2 Individual rankings by six participant farmers in the workshop in Hintalo Wajirat, Tigray

Constraints	Farmer					
	1	2	3	4	5	6
Market		√			√	
Labour			√			
Feed	√		√	√	√	√
Disease		√	√			√
Predation	√			√	√	
Neighbourhood conflict						
Low producing breed	√	√				√
Theft						
Damage on backyard garden/crops				√		

3.4 Phase 6: Using the model to build scenarios for village poultry management

The computer model, Village Poultry Simulation model (VIPOSIM), built with data from the farm records and previous studies, was used to simulate village poultry production under various scenarios (Aklilu *et al*., submitted). VIPOSIM was also employed as a tool for learning with farmers about effects of different potential improvements in their village poultry system. The constraints identified during the farmers' workshops served to select options in the model. Because the farmers had different constraints and priorities, the simulations were done for individual farms, using the farm records of the specific farm as a base scenario. The simulations were carried out for each of the six farms in the three different locations (i.e. 18 scenarios in total), including the information on the different levels of market access (Aklilu *et al*., 2007). Fig. 6.3 shows an example of results for two of the six households in one of the locations. The outcomes of the simulations were discussed with the research team.

The simulated effects of these management options were expressed in terms of changes in flock size (number birds), egg production and financial returns (the mathematical procedures of the simulation are presented in Aklilu *et al*., submitted). Although VIPOSIM can simulate for a period of up to three

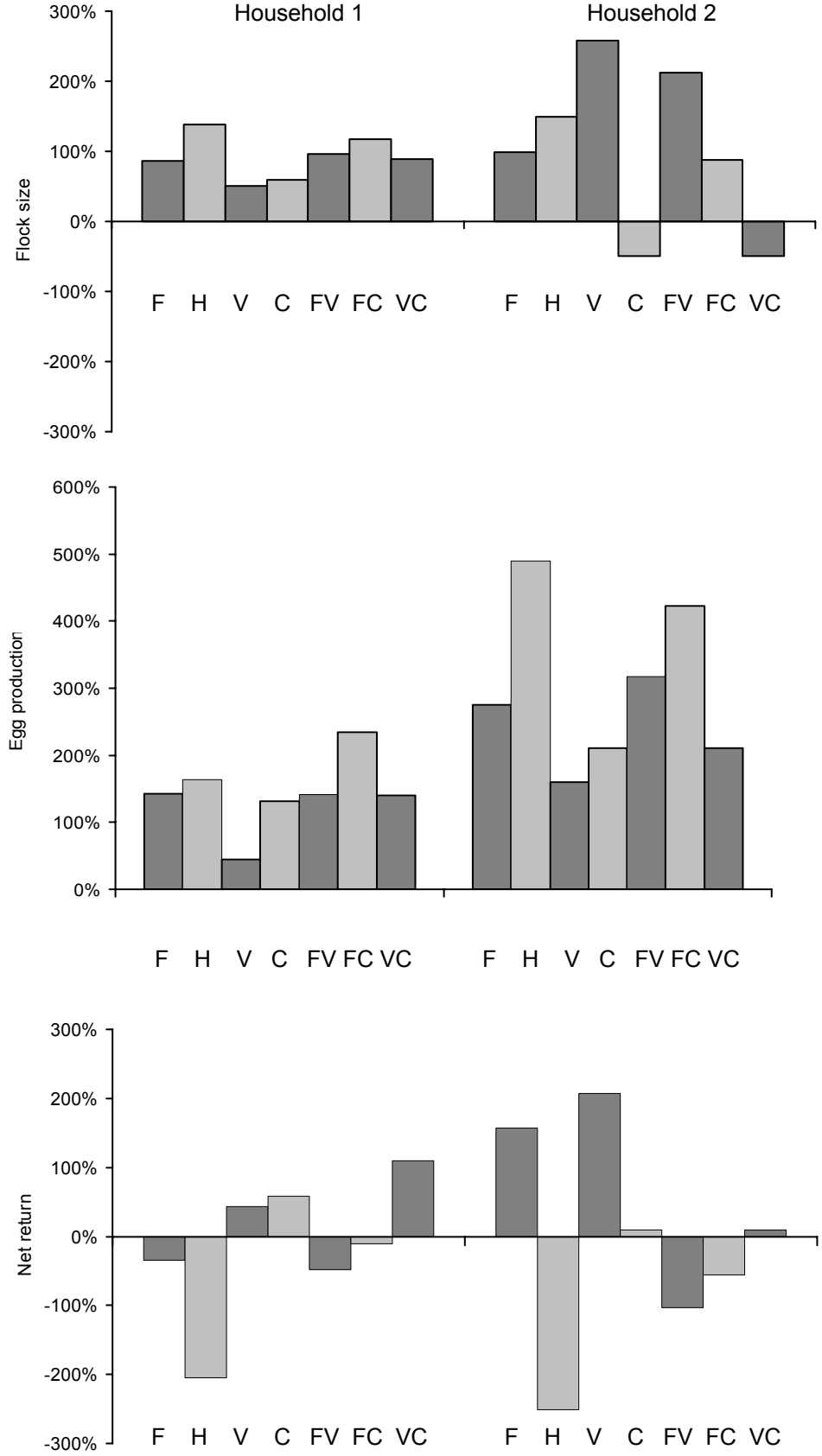

Fig. 6.3 Effect of supplementary feeding (F), fully confining (H), NCD vaccination (V), crossbreeding (C), Vaccination combined with supplementary feeding (FV), supplementary feeding combined with crossbreeding (FC), and Vaccination combined with crossbreeding (VC) on flock size, egg production and net return for two households in Hintalo *woreda* in terms of % of change in relation to base situation

years, including four seasons per year, the research team had decided that a simulation period of one year would be most effective in the communication with the farmers. The effects of the management options on production and economic performance turned out to be different with the different households. For example, in household 1, daytime housing resulted in relatively larger increase in flock size than other management options, but showed negative net returns (Fig. 6.3). For this household, vaccination combined with cross-breeding resulted in the highest net return. This is due to decrease in mortality through vaccination accompanied by increase in egg production through cross-breeding. For household 2, vaccination resulted in the largest increase in flock size as well as in net returns. Feeding and housing were not profitable for both households, although they considerably increased flock and egg production. In locations that had better market access, feeding and housing resulted in relatively higher returns as compared to the more remote locations. For a given option and household situation, net return was higher in areas with higher prices of birds and eggs.

3.5 Phase 7: Presenting simulated scenarios to farmers and their reactions

VIPOSIM presents simulated outputs in terms of numbers graphically or in a tabulated form. To communicate the results with the farmers, the researchers developed pictorial symbols, similar to the symbols developed for the comparison of farm variables (Fig. 6.4).

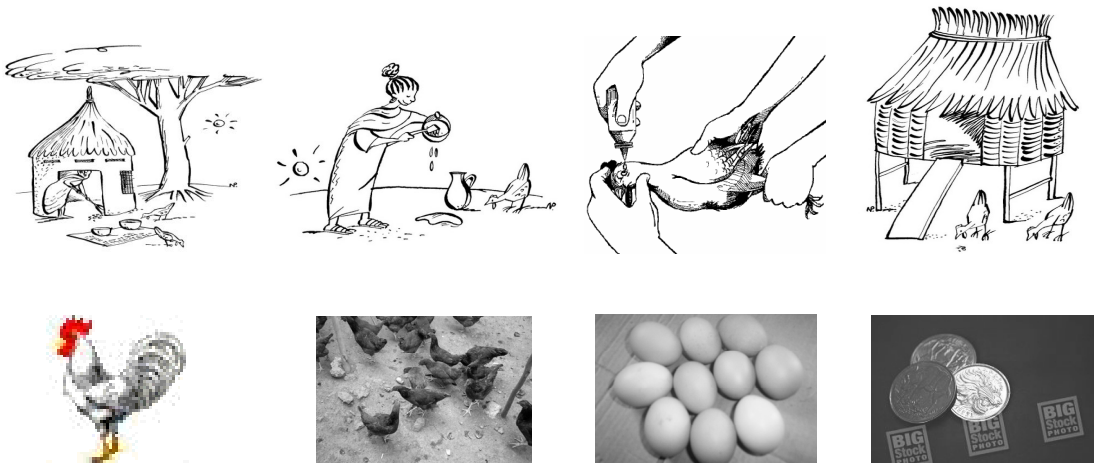

Fig. 6.4 Examples of symbols used for presenting results of simulating management options. Symbols for options represent free ranging (existing system), supplementary feeding, vaccination, daytime housing, and use of improved breeds and outputs to farmers. Symbols for outputs represent number of cards with the different symbols

The farmers were only exposed to outcomes of the simulations from the six farms in their own village. After the presentation of the outcomes of the scenario related to their own farm, the respective farmer was asked what he or she thought of it. Box 2 presents an example of the farmers' opinions about the option of vaccination. When asked whether they would use the identified better options, farmers raised issues about availability and accessibility. Many of the farmers' considerations related to institutional aspects of accessibility to the service or input needed. For example, when they understood that the model indicated that vaccination would be promising, they complained about the way vaccination is organized. They demanded that vaccination be carried out at individual household level, unlike the current arrangement in which households are required to collect their flocks and bring them together in one centre. In response to the option of using improved breeds, some farmers also expressed their dissatisfaction about the hatching behaviour of the improved breeds; unlike the local ones, they did not hatch and rear their own chicks. They also expressed discontent about the long process and requirements of getting access to credit which they need to acquire improved breeds. The farmers learnt from the scenario modelling that for some of them particular options (e.g. fully confined poultry) recommended to them by the extension service may not actually be profitable. This made researchers and farmers aware of the variation in situations faced by those in remote locations where prices are low, and both groups became sensitive too and critical of blanket recommendations. This was as important a learning experience for researchers as for farmers.

Box 6.2 An example of farmers' reaction to use of vaccination

To one of the households, simulation showed that vaccination was a promising option with a relatively higher net return. When the head of the household was asked whether she could use vaccination she said: "*When kinbil (Newcastle Disease) comes, it takes the whole flock. I know vaccination can save a lot of our chickens from kinbil. When extension workers want to vaccinate, they tell us to gather the birds and take them to the collection centres. Some people do not want to go to the collection centres to get their chickens vaccinated. If only a few chickens are collected the extension staff does not vaccinate. This is really a problem. I am always fearful that disease may snatch our birds. The problem with chicken diseases is that we do not know when they come. When they come, they do not give notice. There is no time to take them to market. Markets are only once a week.*"

4 Discussion

The participation of farmers and researchers in developing a model – and the reflection thereupon - yielded a number of valuable experiences. The project can be seen as a mechanism enabling better interactions among farmers and between farmers and researchers. The mechanism consisted of a model used to

explore the effect of improved technology options in the management of village poultry. The lively exchange and generation of insights by both researchers and farmers indicate that the model increased the quality of participation. The model generated and systematized data and these data proved a good entry point for discussion with farmers. This increased the meaningfulness of the information resulting from the process. Among striking instances of emergent information was, for example, that the farmers did not in most cases really question the relevance or potential of suggested technologies, but pointed to the constraints in accessing or applying technology in their context. Put another way, their expertise lay in contextualization and not in mechanisms as such.

Experiences have shown how both researchers and farmers can learn from each other while generating and discussing data. The experiences also show that in order to be able to achieve this learning effect, it is important to pay serious attention to what information researchers share with farmers and how it is presented. Two elements seemed especially valuable in stimulating the exchange of information: 1) the visualisation of quantitative information and 2) using information from individual farms that differed in performance rather than using averages.

The model also proved useful in enriching the participatory character of the technology development process. Because of the use of the model it was possible to generate scenario output for individual farms, which contributed to the motivation of farmers to discuss the output. Another result of using the model was that researchers and farmers realised constraints and options for improvements varied between farmers and villages. This is an important insight as, so far, research and extension works on the basis of general recommendations and does not distinguish between different farmers or villages. This is an important insight and the explanation for the difference needs to be further studied to understand the implication for technology development and diffusion of improved options. This understanding is thus essential to develop a strategy to scale-up the use of improved technologies, and also to explore how the process of developing improved technologies, like the one described in this chapter, can be scaled-up. In this respect it is important to point out that the research team worked only with a small sample, i.e. 18, of the 131 farmers initially participating in the farm recording exercise (Aklilu *et al.*, 2007). While having used the approach successfully with this small sample of farmers it is essential to think through how larger groups of farmers might benefit from the process.

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Chapter 7

General discussion

1 Introduction

In agriculture and natural resource management the complexity and range of dimensions of problems are often such that they cannot be tackled by a single individual or discipline. Traditional livestock research is largely disciplinary in orientation, mainly focusing on the development of technologies to increase biological production at individual animal or herd level (Conroy, 2005). However, the majority of livestock farmers are found in resource-poor environments. In these farming systems, livestock technologies have had little or no impact on production and productivity at farm level (Ashly *et al*., 2000). Research and development has generated technologies that farmers find unprofitable, too risky and labour intensive, or difficult to implement (Udo and Cornelissen, 1998).

This thesis has explored the combination of various research approaches to addressing the low applicability of conventional livestock research to low-resource farmers. The first is systems thinking and the second is gaining a better understanding of social and cultural dimensions through technography (including use of participatory methods). The thesis has then sought to join these two approaches. To this end, a unified methodological framework (the context-mechanisms-outcome configuration) was adopted to structure and analyse the research process.

To understand the multiple dimensions of livestock development, a systems approach has been advocated (Udo and Cornelissen, 1998). This includes a problem definition of an animal production system in relation to its economic, ecological and social context, and is based on perspectives from the different actors involved, in-depth study of specific system components and their interrelationships, and interpretation of the results in relation to the context. This is convergent with the context-mechanism-outcome configuration advocated by Pawson and Tilley (1997) as a framework for applied social research based on realist assumptions. Linking social and technical aspects often seems to present methodological challenges and one reason to adopt the CMO framework is that it allows researchers from both animal science and social science backgrounds to work with a single methodology. The CMO framework gives explicit attention to description of the context or environment in which the technology and its users are embedded and related with. It accommodates qualitative description and analysis (for which this study used a technographic approach) and maintains 'functional' system and process

thinking. According to Pawson & Tilley (1997) the CMO configuration is a cycle through which the researcher passes, sometimes repeatedly, until satisfactory results are obtained. The thesis therefore addressed the underlying reason for limited impact of livestock technologies (output) in terms of context (limitations associated with socio-cultural, economic and ecological environments of farmers) and mechanisms (problems associated with optimising various poultry production system scenarios). The thesis also explored the extent to which limited understanding of context and the linkage to the mechanism of poultry keeping can be addressed by use of participatory approaches. Using participatory methods, farmers' perspectives have been drawn into the understanding of the context and its relation to the mechanism through participatory approaches, thereby enhancing the 'visibility' (for researchers) of the constraints affecting mechanisms. The participatory approach in this thesis, therefore, offers ways to link insights from different disciplines and stakeholders in a single analytical process (Conroy, 2005, Gibbon, 2002, Brewer, 1999).

Constraints and prospects of village poultry development as they were identified in the study by farmers and researchers are good examples of the need for integration of social and animal sciences. As is the case with many smallholder mixed farming systems, research efforts to improve village poultry production tend to focus on the technical aspects of poultry keeping, in the belief that it is these that constitute the principal constraints (Rushton and Ngongi, 2002). From involving the farmers through discussion of scenario outcomes, it became obvious that many constraints are to be located in the context, i.e. the institutional, material or cultural environment. Service supply, such as vaccination and credit schemes (chapter 6), emerged as an important contextual constraint for improvement of technical parameters of the mechanism.

As just argued, the CMO configuration is implicit in the systems approach, and lends itself well to a realist approach to social science analysis. In surveying and concluding the present study, it is appropriate to ask two basic questions - how accurately have context, (candidate) mechanisms and outcomes been described, and how well warranted are the claimed links between context, mechanism and outcome? In this study much responsibility for accuracy of description, and testing whether a village poultyr model sustains plausible, desirable and feasible outcomes, has been placed on participatory methodology as a key (technographic) tool, and in particular on

farmer involvement in warranting model outcomes. The main purpose of this final chapter is to offer a review and assessment of the context, mechanisms and outcomes of small-scale poultry systems in Tigray, as captured through the convergence of modelling and farmer participation.

2 Context, mechanisms, outcomes reviewed

2.1 Village poultry development: contextual issues

The research process enabled the researcher better to understand the context of village poultry in Ethiopia in terms of its relationship with poverty, and constraints, and opportunities for poverty reduction.

2.1.1 Linkage between village poultry and the poor

One component of the context of village poultry is to understand whether and how poultry production relates to poverty. Often, it has been claimed that if the poor can acquire poultry this would help them to move out of poverty (Dolberg, 2001; Holman *et al.,* 2005; Dossa *et al.,* 2003; Kristjanson *et al.,* 2004; Peacock, 2005). Poultry are particularly associated with the self-reliance of women (Sonaiya *et al*., 1999; Guèye, 2000; Bravo-Baumann, 2000; Devendra and Chantalakhana, 2002).

This study confirmed that village poultry play important roles in the livelihoods of rural poor households, economically, nutritionally and socio-culturally. Various local expressions or proverbs noted during group discussions and individual interviews with farmers attest to the linkage between poultry and the poor (chapter 2). The expression '*poultry are* the *first and the last resource a poor household owns' sees* poultry keeping as a first step on the ladder to climb out of poverty. The phrase also suggests that poultry are capital that households can use for recovery when falling into extreme need, because of drought for example.

A significantly larger proportion of female-headed households than male-headed households had only poultry and no other animals (chapter 2). Thus, female-headed households, who are poorer than male-headed households, were more often focused on poultry only. Further evidence of the affinity between poultry and the poor is that the poor struggle by any means to get access to poultry keeping. In Ethiopia, many poor households lack capital to

purchase foundation poultry stock. The financial resources in poor households are so limited that many struggle to purchase a hen to start their own flock. Often, the poor do not have access to credit and lack the means to acquire livestock (Morris, 1988; Kinsey, 1994; Tegegne, *et al*., 2002). For cattle and small ruminants, sharing is widely used (Ifar, 1996; Bosma *et al*., 1996). This study discovered that poor households, especially the female-headed ones, use sharing arrangements to acquire poultry. It was quite surprising to find that sharing is practised, for an animal with such a relatively low value. The existence of poultry sharing illustrates not only the high degree of poverty among sharers (who were mostly female-headed households) but also their determination to have some stake in poultry rearing as a guard against extreme destitution. Programmes like Heifer International (HPI, 1998) use animal-in-trust schemes to promote livestock for smallholders. They use this existing sharing system as entry point for supporting poor households, through providing them with live animals on credit where offspring are then redistributed to other needy households. Poor farmers in Tigray have already created their own scheme of this sort.

Households valued most the possibility of cash income from poultry keeping (chapter 2). The households situated in a closer proximity to the regional capital had a better market access and larger flock size than those in more remote locations. A previous livestock census in Tigray also showed that with increased remoteness, the proportion of households keeping poultry decreased (BoANR, 1999). Poor households are involved in poultry keeping where, in particular, they see opportunities for it to generate income. This contextual finding is important that it suggests that not all model scenarios are appropriate across the board, and that market access may determine what specific optimising mechanisms it is relevant to seek to trigger.

Even if products are not sold poultry still contributes to rural livelihoods by contributing to household consumption. Nutrition of the poor is improved by home consumption of poultry (Otte *et al*., 2005). Poultry are more convenient as a source of human food than cattle. Meat from large ruminants may spoil before it can be consumed, unless it is widely shared outside the household. Costs prevent cattle meat from being a regular item of the diet. Information on household consumption also confirmed the special relevance of poultry to the poor. The poultry consumption per family member was larger for female-headed households than for the male-headed households by 25%. It is unlikely that female-headed households have higher levels of general well-being than

male-headed households. Larger poultry consumption per family member in female-headed households is probably the result of lack of other sources of animal protein. Female-headed households lack possibilities to purchase other livestock animals than poultry. Ehui *et al.* (2000) found that in Ethiopia wealthy households are more likely to buy live sheep for festivals than the poor. Wealth and gender are linked since female-headed households are disproportionately present in the group of poor households (Chapter 2).

2.1.2 Economic context

Another aspect of the context of village poultry keeping is market situation. The importance of markets in relation to the way farmers manage poultry production became clear through the farmer group discussions in the first phase of the research. Following up on information from the farmers, the market study (chapter 3) further substantiated the constraining factors. Distance to markets influences poultry marketing organization. With better market access, the marketing chain between producers and consumers is shorter, leading to higher prices for both live birds and eggs, due to reduced involvement of intermediaries in the marketing chain. Prices for birds and eggs were respectively 68% and 25 % lower where there was low market access. The marketing constraints were related to low population densities in rural areas, remoteness of poultry producers from the main urban market centres, and poor communications leading to high transport costs. There was relatively higher involvement of traders further away from Mekelle. Where there is a a long distance between producers and markets, intermediaries are the main beneficiaries. It appears that women are the main losers when dependent on marketing arrangements in remote areas. Unlike large animals, that can be moved large distances on the hoof, small animals such as poultry require transport (Otte and Upton, 2005). Road network and communication facilities are often poor (Abbott and Makeham, 1990). Mobile communication about pricing is not practiced. Peri-urban producers have a clear advantage due to their market proximity. Costs of produce marketing and input delivery are lower than those for more remote rural producers. Hence intensive poultry production systems often develop close to towns. The development of a proper road network and better rural transport would relatively improve households' involvement in poultry keeping and contribute to betterment of livelihoods through cash income to be derived from it. Tools like market mapping could also be used to help members of market groups to understand their own marketing system (Hellin *et al.*, 2005). Marketing group formation could

significantly reduce transaction costs for the producers by organising transport and access to information, and by eliminating middlemen and increasing farmer negotiating power. This could also be beneficial for consumers as well, through lower prices when buying directly from producers (Niamir-Fuller, 1994). Marketing group formation can be time consuming and requires facilitation and organizational skills. This can be achieved through involvement of an outside agency, like an NGO with marketing skills, and through capacity building among interested farmers. Female-headed households, for whom poultry keeping constitutes a major source of livelihood, are probably willing to spend time on organizing poultry marketing. For the more well-off farmers, poultry keeping is only a secondary activity. They are less likely to invest time in such activities, but may however be interesting partners for poorer female-headed households in mobilizing resources and bulking up produce. Poultry sharing arrangements (chapter 2) may present an interesting entry point to pursue such ideas.

2.1.3 Socio-cultural context

The socio-cultural environment is also an important part of the context in which village poultry keeping operates. In Ethiopia, socio-cultural elements affect village poultry keeping by driving the dynamics of demand and consequently management of flocks. Religious festival days are associated with increased poultry consumption and, consequently, sales, and fasting periods are associated with decreased consumption. These patterns cause strong fluctuations in prices of poultry products. Prices increase at the onset of festivities and decrease in fasting periods. It is not possible to change the demand pattern. The only option is to cope with the existing situation. Ideally, households increase and downsize their flock according to prices. The fact that predictability of price fluctuations is high, since it is based on socio-cultural events may be an advantage (Thomsen, 2005). On the other hand, it provides little flexibility, and stocking up for the peak periods in market demand requires relatively lengthy storage of eggs. The local practices of storage in pottery, however, preserves consumption eggs without spoilage over a long period until they sell them. The need for regular cash-income may, therefore, result in a more serious constraint in stocking up for periods of high demand. This adds in particular to the constraints for the poorest farmers. The preferences of the local buyers for birds in terms of feather colour, comb structure, and breeds is another example of social-cultural context with implications for improving the poultry system and might imply a future challenge for poultry breeders.

2.2 Exploring mechanisms for improved poultry production

The common flock size of 5 to 20 birds seems to be the limit that can be kept by a family without special inputs in terms of feeding, housing and labour (Sonaiya and Swan, 2004). These small flocks scavenge sufficient feed in the surroundings of the homestead to survive and to reproduce. Larger flock sizes can easily arise once mortality is reduced through vaccination and improved hygiene. Any significant increase in flock size often leads to malnutrition if no feed supplement is provided. Larger flocks must forage at greater distances, which may involve damage to neighbours' vegetable gardens and also susceptibility to predation. An Ethiopian saying relates to this - *" a good neighbour keeps cats but a bad neighbour keeps chickens''*. Urban households in Ethiopia also keep poultry because they have clearly separated compounds. In the rural areas compounds are not common. Any move to fence in or enclose the poultry involves the need to provide a balanced ration.

Although herd or flock expansion may be based simply on the processes of reproduction and growth, the initial investment requires cash savings or credit supplies to purchase the inputs (mixed feeds, drugs, improved breeds and housing) for increased future production. This requires production of a marketed surplus to pay for productive inputs. There can be trade-offs in production and economic performance. This needs a systematic analysis to determine costs and benefits.

This thesis presented a model for such analysis. The model integrated both production and economic parameters to assess the effect of alternative management options on village poultry (chapter 5). The example of simulation of daytime housing demonstrated the trade-off effects management options can have on production and economic performance of village poultry production. While it showed a positive response in flock output parameters, daytime housing resulted in negative returns because of costs of feeding and housing. In addition it also increased workload. Thus, the use of additional inputs requires caution as for example in cases of remote areas, costs of production are often greater than benefits.

2.2.1 Modelling and simulation

An important entry point for sharing between researchers and farmers – and thus increasing the understanding of context and mechanism - was

modelling and simulation. The model was based on information from the literature and aimed to assess the impact of different management strategies on the dynamics in village poultry systems (chapter 5). This research attempted to use modelling and simulation beyond solely scientific purposes for engaging researchers and farmers to learn about village poultry keeping in Northern Ethiopia (chapter 6). The simulation with farmers started with identification of household level constraints. The farm records showed that the mechanisms, i.e. the poultry systems, varied importantly between farmers. Households had different flock and egg utilization patterns. But also, they experienced different constraints with different importance. For example, while mortality from disease was a main cause of bird losses for some households, for others it was predation. Yet, for others while mortality from disease or predation was not high, egg production per hen was low. Thus, the simulations had to be done for each participant individually. When households are treated as a homogenous group (e.g. using averages), options will not be equally relevant to all and will result in low use or adoption in practice.

The individual household level simulation is a new role of modelling potentially relevant not only to village poultry but also to other farming practices. While household cases have to be treated individually, it does not mean that group learning is less relevant. Although decision making about actions (changes in management practices) are thus household specific, the learning can be shared among group members. On the contrary, for learning it is probably more important to have diversity in the group. Besides, the model can be used by experts to understand household specific farming situations and provide relevant suggestions for future interventions. Credit organizations can also use the model by identifying most likely effective technical inputs or options to capitalise (through *ex-ante* analysis), on the basis of which credits could be configured for individual households. One can question how to reach individual farmers given their large number and diverse situations. This can be taken as one of the challenges for scaling-up of individual household approaches in exploring options for village poultry keeping. In this case, up-scaling scenario explorations might be a promising approach.

When farmers were given a preview of the effect of the options in their household poultry production through the use of the model, they realized that many of the options (e.g. fully confined poultry) recommended to them by the extension service may be unprofitable. The farmers' reactions to simulations gave the message that farmers evaluate technologies not only in terms of their

biological, technical and economic performance but also in terms of institutional aspects. When asked whether they would use the relatively better options, farmers raised issues in relation how practically to access them. Most of the issues address institutional aspects, particularly related to the extension service. For example, when they knew vaccination is promising from the simulation exercise, they then began to complain (informatively) about the way vaccination is organized. Regarding use of breeds, they expressed discontent about the process of getting access to credit to buy foundation stock. Thus, while the model considers production and performance to assess technologies, farmers then add in additional criteria related to the institutional context.

The model is based on farm-level situations. But the input from the farmers clearly indicates that the institutional context is important for practical improvements to have effect. In effect, showing (through a model) how different mechanisms might function prompted farmers to return to the analysis of context, where (as argued above) many of the most important constraints are to be found. The model however does not integrate these levels and has therefore no possibility to identify constraints and options for improvement other than as a trigger for discussions in which these constraints and options come into focus. Elaboration on possiblities to arrive at a more enabling environment go beyond the scope of a technical study, but are exactly where farmer action may be needed (e.g. through mobilization of farmer organizations). In the continuation of the research process these issues will be further pursued and scenarios for improvements at these levels – whether through formation of cooperative action groups, or via privatisation of services - are likely to be the subject of more detailed discussions with farmers and policy makers.

In general, this thesis has argued that if the key to outcomes lies in better understanding of interaction between context and mechanisms then the combination of technography (better to characterise context) and modelling (better to explore potential mechanisms) makes a powerful analytical combination, setting the scene for more focused action by both farmer groups and development organizations.

2.3 Some reflections on (research) outcomes

From the various empirical chapters, it can be concluded that the farmers were effective in providing crucial detail on both context (production and

marketing conditions) and mechanism (e.g. the poultry production system, as reflected by the model). In providing information to further improve the model, they not only contributed quantitative information (data on eggs and poultry dynamics, through the farm recording) but also helped elaborate the functioning of the mechanism in its context (e.g. lease arrangements of poultry, details on traditional consumption patterns).

2.3.1 The research process and the integration of research methods

A major value of the technographic approach (Richards, 2003) was the methodological value in relation to problem analysis. The research process was not highly structured in the beginning but left open on purpose. Both methods and research issues were not predetermined but were rather developed on the basis of exploratory interviews and discussions. To integrate the views of farmers, the research process was designed in such a way as to combine multiple methods: open interviews with individuals and groups, household records, workshops and surveys. The added value of these methods can be expressed in terms of the rich and complementary socio-economic and technical information generated and the experience sharing (learning) that took place among farmers and between researchers and farmers about village poultry keeping.

The qualitative methods (individual and group interviews) used at the beginning of the research determined site selection and household sampling and defined research issues. This was then used as an input for the design of the survey. When respondents are directly allowed to participate in the research process this may result in unexpected findings. Thus the primary value of the research process is that problem analysis is generated from systematic fieldwork rather than from secondary literature. More specifically, the use of the open-ended methods gave the farmers the opportunity to inform researchers of their own understanding of village poultry keeping, which was then tested for validity by constructing survey instruments and administering them to representative samples of the population, avoiding biases. The sharing of the results of these studies further consolidated the value of the findings.

The combination of methods allowed identification of locally relevant socio-economic dimensions of village poultry keeping such as market access, gender and wealth status, and sharing, which would otherwise have gone un-addressed and un-noted. These factors have implications for the technology

used (e.g. options to use improved breeds, feeds, and health control techniques). A logical option, in the eyes of researchers, would be to increase numbers of poultry in combination with the use of improved breeds. However the study indicated that this would not necessarily be a successful initiative if market access was not considered. Without improving access to the market opportunities to increase benefits from poultry are limited for the most marginal households, i.e. female-headed households in remote villages. Thus any development-oriented initiative aiming at improving poultry production has to consider the relations of the producers with the market. The open-ended group discussions enabled exploration of the poultry sharing systems. The formal household survey thereafter helped to bring to light the magnitude of poultry sharing in male- and female-headed households. This showed that female-headed, poorer households were more dependent on accessing poultry through sharing arrangements than male-headed households.

Information on household wealth could not have been obtained through surveys by an outsider. This required qualitative methods and close interaction with the local council, community members, and extension staff, and reflected understanding of local criteria and their context. Once this information was acquired, wealth status was related with poultry keeping through the survey. The survey showed how household wealth affects poultry keeping in terms of use of improved breeds and housing facilities.

The open-ended methods discovered socio-cultural aspects of poultry marketing and consumption. Family traditions were found to affect consumption of poultry products within the household. Customarily, the meatiest and most nutritious parts of the birds are served to men, not to women and children. The open discussions enabled researchers to consider religion both as a constraint and as an opportunity for keeping poultry. Cultural traits (buyers' preferences) were also found to affect poultry marketing (e.g. feather colour, comb structure). Information from farm records generated an understanding of how fasting periods and festivities are associated with poultry sales and consumptions. In addition, the marketing survey provided information on how fasting and festivities affect prices. The modelling approach enabled the thesis to integrate various production and economic data in such a way as to explore management options in village poultry.

2.3.2 Mutual learning

The value of the methodological approach adopted by this thesis can also be expressed in terms of the opportunities it created for interactions between researchers and farmers. The value of the approach for joint-learning outcomes was realized through the use of farm recording and modelling. The research activities were planned and implemented in such a way that they could contribute to the learning process.

2.3.2.1 Farm recording

One of the entry points for interacting with the farmers was farm recording (chapter 4). Although farm recording is an effective tool for researchers in monitoring farm performance and measuring effects of technology interventions (De Groot, 1996; Abdel-Aziz, 1996; Flamant, 1997), its value for farmers has been questioned. In this study, however, the farm recording was also valued by farmers, in order to learn about the poultry dynamics on their own farm and that of others. The feedback workshops in which the research team shared their information with the farmers turned out to be crucial events in the process. Not only did researchers interact with farmers, farmers also considered the exchange of ideas and information among themselves as very relevant for understanding their own practices. The presentation to farmers of variations in the different parameters of their poultry system stimulated discussions among the participants, for example, on what involves good hatchery management. This is like the farmer field school system or learning groups in which farmers also talk with each other about the success of their practices The feedback of research reverts to farmers, and exchange of experiences in turn informed the researchers about local hatching practices. For example, the use of teff straw as a good bedding material for incubation and hatching was a new insight to the researchers. The process has also improved farmers perception of data (collection) in which they participate through farm recording.

Farm recording was also taken as an entry point for learning about how farmers participate in research. Thirty five farmers (20%) were either semi-engagers or dropped out of the research. Interviews by the principle researcher with these farmers revealed a number of factors that influenced farmer participation (chapter 4). It transpired that researchers needed to understand the religious and customary norms of the community and adjust the data collection tools and procedures to fit these norms. For example, knowing about

the sensitivity of data on consumption is important in order to collect accurate data. Guaranteeing confidentiality of the participants' information in general is likely to affect participation in research. The percentage of poor farmers dropping out or semi-engaged was similar to that among the group of better-off farmers. However the reasons why they dropped out were different.

2.4 Opportunities for village poultry development

In Ethiopia, large scale commercial poultry production has not yet developed. Such systems account for only 1% of national poultry production (Tadelle *et al*., 2002). In the short term this is an opportunity for smallholders to supply poultry without much competition. In the long-term, smallholders might need to integrate free-range resources and also increase productivity by slowly intensifying their production systems in order to remain competitive with commercial poultry producers.

The research presented in this thesis has produced a range of insights useful for further research but also for more direct development-oriented activities. The simulations carried out with the farmers (chapter 6), showed which available technology options are attractive for individual farmers. These could be used for further participatory technology evaluation and adaptation. As such, they could become elements of a continued collaborative research process with farmers of which the presented study is only the first stage. More generally, the findings of the study indicate options for up-scaling and intensification of poultry keeping. In locations with better market access, feeding and housing resulted in relatively higher returns as compared to the remote locations. Thus households with better market access may opt to increase their scale of poultry production with more use of inputs. In order to minimize risks, the move towards intensification may be done gradually, involving experiential learning and critical analysis, as household-specific constraints are likely to remain important. If households have relatively poor market access, it is a less risky option to maintain a relatively lower scale of poultry operation using scavenging resources in a free-ranging system.

3 Conclusions

This thesis has explored the combination of several approaches to address the issue of how to improve village poultry keeping among low-

resource farmers. The first approach involved systems thinking and the second was to gain better understanding of social and cultural context through technography (involving the use of participatory methods). The thesis then sought to join these two approaches. To this end, a realist methodological framework (the context-outcome-mechanism configuration) was adopted to unify the analysis. The farmers were both effective in providing detail on the context (production and marketing conditions) as well as providing feedback on candidate mechanisms introduced into the modelling process. In providing information to further improve the model, farmers not only contributed quantitative information through farm recording, but also sharpened understanding of the functioning of actual poultry production mechanisms (e.g. lease arrangements of poultry, and details on traditional consumption patterns). A major value of the technographic approach was its methodological value in problem analysis. The research was not highly structured in the beginning. Neither methods nor research issues were predetermined but were rather developed after exploratory interviews and discussions. The model was enriched and checked with farmers. The information that farmers brought in on the functioning of poultry rearing mechanisms greatly enriched the social-component, and revealed the importance of considering a technology in terms of its technical and social interactions. The involvement of the farmers produced un-expected outcomes: exchange of information and mutual learning between farmers and researchers. Finally, the process can be seen as a first step for farmers and researchers to interact in a systematic, structured way, in seeking opportunities to improve village poultry systems.

The overall issue addressed in this thesis was the question how to arrive at technology interventions that are more relevant to small-scale farmers in developing countries. The present study has indicated that through the combination of multiple approaches and methods researchers can arrive at better understanding of constraints affecting farmers' reality. This implies more relevant problem definition and therefore a potentially more effective technology development process. The findings and experiences of the study confirm that village poultry research and development are not only about finding technical solutions by animal scientists but also involve addressing household livelihoods, institutional and policy issues from a social science perspective. In relation to impact of research in the field, i.e. for poor farmers, the results have implications for interdisciplinary and interactivity in education and training of scientists and extension staff. Last but not least, the thesis shows that researchers and farmers can engage profitably in problem analysis and

design, for their mutual benefit, and to contribute to increased effectiveness of the research.

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Summary

Summary

The production systems of the rural poor are often complex, and based on linking together different livelihood opportunities. Low-intensity poultry keeping is such a livelihood opportunity. To improve poultry systems, it is necessary to keep in mind a large number of local complexities. Modelling approaches are used for examining systemic interactions and improvement scenarios for complex farming systems, however, often without reference to real life externalities as faced by farmers. The thesis explores ways in which farmers can contribute actively to the development and application of a village poultry system model. A more general objective of the thesis was to learn about farmer management processes and how potential improvements could be identified. The approach used was the technographic approach: i.e. seeking to describe not only the technical processes but also the human agency and social relations that go to make up a technology. In our case, technography serves the specific purpose of seeking to understand which technical and social variables need to be addressed in order effectively to integrate modelling and farmer participation. Understanding what farmers can learn from data collection and model scenarios was a research question that became inherently related to the approach. As the technography progressed, with participation of farmers, we also realized the relevance (for the researcher) of understanding what motivates farmers to participate in basic data gathering.

Poultry keeping practiced by rural households using family labour is referred to as village poultry keeping. In most developing countries, village poultry makes up the largest proportion of the national poultry population. In Africa, over 70% of poultry products come from village poultry. In Ethiopia, this is even 99%. If village poultry are significant for their nutritional or economic value, they also play a significant role in human society through their contribution to the cultural and social life of rural people. Often, it is said that, if the poor can acquire poultry, this can help them to move out of poverty. Poultry are particularly associated with the self-reliance of women. Village poultry has been relatively neglected by the research and development community despite its potential role to improve poor people's livelihood.

It is widely accepted that research aimed at improving agricultural and natural resources management is likely to be most effective when local people have a voice and are involved in their own development. In this thesis it is hypothesized that the combined use of participatory and formal approaches

will allow researchers and farmers jointly to learn about farmer conditions in order that the two parties can help each other to explore village poultry improvement options. This study aims to integrate participatory, survey and model-based approaches to socio-technical analysis and mutual farmer-researcher learning about constraints to and opportunities for village poultry development in Ethiopia.

The study took place in Tigray region, Northern Ethiopia. The major religion in Tigray is Orthodox Christianity. Religion influences livestock consumption and marketing through its festivals and fasting periods. Tigray is also one of the poorest regions in Ethiopia. In Tigray, 75% of the population lives under the poverty line, which is much higher than the national average (45%). Female-headed households constitute nearly 30 percent of this region's population. Rain-fed crop production together with livestock production is the main activity for 85% of the population. Enderta, Hintalo and Alaje located in Southern zone of Tigray were chosen as study areas. These districts constitute the major suppliers of eggs and chickens to the regional capital, Mekelle. There are variations between these districts in their access to information, market and infrastructure facilities. They have different access to roads and population densities. There are variations between these districts in their access to information, market and infrastructure facilities. They have different access to roads and population densities.

Based on the technographic approach, the study used multiple methods such as individual and group open interviews, a cross-sectional stratified random survey of 180 households, farm recording of 131 households, a market survey, and village poultry modelling. About 3000 farm records were collected over a period of 12 months from 131 producers to obtain quantitative data on sales and consumption. Ninety-three semi-structured interviews with 58 producer-sellers and 35 intermediaries and 12 group discussions with these market actors were conducted to explore organization, price dynamics and socio-cultural aspects of poultry marketing. In total, 928 producer-sellers and 225 intermediaries were monitored monthly to examine participation of gender in poultry marketing. Six research assistants, two in each location, were involved in supporting farmers in the farm recording process. Each research assistant visited about 30 households twenty times from September 2003 to August 2004 to monitor not only flock dynamics but also farmers' participation in the process. The principle researcher also had a one-on-one meeting with the research assistants every month and group discussions every three months with

them to share their experiences on farmer participation in the research across locations. In a case study, the researcher interviewed and interacted with 30 farmers that semi-engaged or dropped out and also held discussions with the district agricultural officers to learn about experiences with farmer participation in previous research projects. This study also developed a dynamic stochastic model, Village Poultry Simulation Model (VIPOSIM) to explore management options in village poultry systems. The model integrates quantitative relationships of mortality, egg production, reproduction, offtake, and their interactions in a series of mathematical equations. The model was validated with data from Tigray. A total of three feedback workshops, one per location, were organised to share between farmers and researchers data collected through farm recording. Six farmers made up a learning group in each location. Another round of three feed-back workshops, one per location with the same learning groups was organised in which outcomes of simulation scenarios were shared with the farmers and used to identify options for improvement of poultry.

Village poultry significantly contributed to the livelihoods of poor households: economically as starter capital, as a means to recover from disasters, as an accessible protein source and for disposable income and exchange purposes, and socio-culturally for mystical functions, hospitality and exchange of gifts to strengthen social relationships. The various local expressions noted during group discussions and individual interviews with farmers proved the linkage between poultry and the poor. For example, the expression '*poultry are* the *first and the last resource a poor household owns*' explained that poultry keeping is the first step on the ladder for poor households to climb out of poverty. It also indicated that it is the capital that households can use for recovery when falling into poverty. It was found that a significantly larger part of female-headed households had only poultry and no other animals. Thus, female-headed households, who are poorer than male-headed households, were more often focused on poultry only. In Ethiopia, financial resources in the poor households are so scarce that these households are often unable to purchase a hen to start their own flock. Poor households use sharing arrangements to start poultry keeping. The sharers could be the primary target group for support when planning and implementing village poultry development.

Households situated in a closer proximity to the regional capital had a better market access and larger flock sizes than those in the more remote

locations. Distance to markets influenced poultry marketing organization. With increasing market access, the marketing chain between producers and consumers was shorter which was associated with higher prices for both live birds and eggs, because of reduced involvement of intermediaries in the marketing chain. We observed a price reduction of 68% for birds and 25% for eggs in the low market access location compared to the high market-access one. Lack of information for producers and relatively high profits for the intermediaries are representing transaction costs that actually provide opportunities. These costs may be reduced through improving access to information and better infrastructure and organisation of the poultry producers. The development of a proper road network and transport could relatively improve households' involvement in poultry keeping.

Socio-cultural constraints also affect village poultry keeping especially in the context of Ethiopia by causing dynamics of demand and consequently management of flocks. Religious festival days are associated with increased poultry consumption and sales, and fasting periods with decreased consumption. These patterns cause strong fluctuations in prices of poultry products. Prices increase in the onset of festivities and decrease in fasting periods. Ideally, households increase and reduce their flocks according to prices. The fact that predictability of the price fluctuations is high, since they are based on socio-cultural events is an advantage. However, in Ethiopia, the planning of production in relation to periods with high demands may be difficult due to the many fasting periods and festivities.

The study also explored ways for interacting and joint learning with farmers. The first entry point was to understand what farmers can learn from data collection. This focused on the experiences of the researcher with the farmers in data gathering through farm recording. Thirty five farmers (20%) were either semi-engagers or dropped out of the research. The data collection showed that researchers need to understand the religious and customary norms of the community and if necessary adjust the data collection tools and procedures to fit these norms. For example, asking about consumption is more sensitive than sales because consumption is perceived as wastage. Family nutrition researchers have to realize that they might collect inaccurate data and underestimate consumption of livestock products. Guaranteeing confidentiality of the participants' information affects participation in research. Paying enough attention to farmers' perceptions in processes of participatory research can form

a basis for capturing valid on-farm data as well as for local development through joint learning.

The second entry point was how to use the data taking process for learning with farmers. During the data collection process, farm recording information was presented back to farmers not only to validate the data but also to use it as an entry point to discuss with farmers the reasons of variation between households. This stimulated farmers to think about the management and performance of their flocks. Not only did researchers interact with farmers: farmers also considered the exchanged ideas and information among themselves as very relevant for understanding their own practices. For example, the presentation to farmers of variations in hatchability stimulated discussions among the participants on what involves good hatchery management. This is like the Farmers Field School system.

A third entry point for sharing between researchers and farmers was modelling and simulation. Information from literature was used for development of a village poultry model. The model assesses the dynamics in village poultry systems in biological and economic terms and as such it can be used to investigate current performances and to explore the impact of management options. This research attempted to use the model and simulation beyond solely scientific purposes for engaging researchers and farmers to learn about village poultry keeping. The simulation with farmers started with identification of household level constraints. The farm records showed that different constraints had different importance to the participants in a learning group. The individual household level simulation is a new role of modelling potentially relevant not only to village poultry but also to other farming practices. While household cases have to be treated individually, it does not mean that group learning is not relevant. Although decision making about actions (changes in management practices) are household specific, the learning can be shared among group members. The model can be used by experts to understand household-specific farming situations and provide relevant suggestions for the future. Credit organizations can also use the model by identifying most likely effective technical input or option (through *ex-ante* analysis) on the basis of which they might allocate credits to individual households.

This thesis has explored two approaches to address the values of village poultry keeping to low-resource farmers. The first is systems thinking and the

second is gaining a better understanding of social and cultural dimensions through technography (including use of participatory methods). The thesis has then sought to join these two approaches. To this end, a unified methodological framework (the context-mechanisms-outcome configuration) was adopted. The farmers were both effective in providing detail on the context (production and marketing conditions) as well as on the mechanism i.e. the model. In providing information to further improve the model, they did not only contribute quantitative information through the farm recording, but also to the functioning of the mechanism (lease arrangements of poultry, details on traditional consumption patterns). The research was not highly structured in the beginning. Both methods and research issues were not predetermined but were rather developed after exploratory interviews and discussions. The model was enriched and checked with farmers. The information that farmers brought in stressed the importance of considering a technology on its technical and social interactions and its context. The involvement of the farmers has produced un-expected outcomes: exchange of information, and learning of farmers and researchers.

Samenvatting

Samenvatting

Huishoudens op het platteland in ontwikkelingslanden hebben vaak kippen op hun erf in een extensief houderijsysteem. Deze erfkippen kunnen vooral voor arme huishoudens een belangrijke bestaansbron zijn. Kippen dragen bij aan het inkomen en zijn een dierlijke eiwitbron, daarnaast zijn ze een onderdeel van het sociale en culturele leven van deze huishoudens. In Afrika komt meer dan 70% van de productie aan eieren en kippenvlees van erfkippen. In Ethiopië is dit zelfs 99%. Desondanks zijn erfkippen ondergewaardeerd in onderzoeks- en ontwikkelingsprogramma's. Bij het verbeteren van erfkippenhouderij is het belangrijk om de complexiteit van de lokale productie- en consumptiesystemen te begrijpen. De onderzoekshypothese van dit proefschrift is dat een combinatie van participatieve en conventionele onderzoeksbenaderingen aan boeren en onderzoekers de mogelijkheid geeft gezamenlijk te leren en zo effectiever mogelijkheden voor veranderingen in erfkippenhouderij te exploreren. Dit onderzoek had als doel het integreren van participatieve werkmethoden, monitoren en modelleren voor een sociaal en technische analyse, en zo gezamenlijk leren van boeren en onderzoekers aangaande mogelijkheden en beperkingen van erfkippenhouderij te bewerkstelligen. Het onderzoek heeft een combinatie van 'technography' en systeembenadering toegepast met als onderzoeksraamwerk context-mechanisme-uitkomst.

Als onderzoeksgebied werden drie districten in Tigray in Noord-Ethiopië uitgekozen. Deze districten verschilden in infrastructuur en toegangsmogelijkheden tot de markt. Tigray is één van de armste gebieden in Ethiopië, met 75% van de bevolking onder de armoedegrens. Bij 30% van de huishoudens staat een vrouw aan het hoofd van het huishouden. De belangrijkste godsdienst is de orthodox christelijke. Deze religie kent vele feest- en vastendagen welke een grote rol spelen in consumptie en vermarkting van dierlijke producten. De gebruikte onderzoeksmethodes omvatten individuele en groep interviews, een enquête bij 180 huishoudens, het monitoren van de dynamiek van de erfkippenhouderij bij 131 huishoudens, een marktonderzoek en een modelstudie. Van de 131 huishoudens zijn ongeveer 3000 data verzameld over een periode van één jaar. De marktsituatie is verkend via maandelijkse interviews met 58 huishoudens en 35 tussenpersonen, en 12 groepsdiscussies met deze markt-actoren over een periode van één jaar. In elk district werden de boeren in het registreren van de data ondersteund door twee onderzoeksassistenten. Deze assistenten hielpen niet alleen met het noteren van gegevens maar zij waren

actief betrokken bij de deelname van de boeren in het onderzoeksproces. Ook zijn een 30-tal boeren geïnterviewd welke tijdens de monitoring periode hun medewerking stopten. Voor het exploreren van management opties voor erfkippenproductie is een dynamisch stochastisch model ontwikkeld. Dit model integreerde eiproductie, reproductie, sterfte, en verkoop en thuisconsumptie van eieren en kippen op basis van literatuurgegevens. Het model is gevalideerd met de verzamelde veldgegevens uit Tigray. Drie terugkoppelingsbijeenkomsten met boeren werden georganiseerd voor het bespreken van uitkomsten van de productiegegevens. Daarna zijn drie terugkoppelingsbijeenkomsten met boeren georganiseerd om de uitkomsten van modelsimulaties te bespreken.

De resultaten toonden aan dat erfkippen een bijdrage leverden aan het bestaan van de huishoudens. Economisch gezien vormen kippen een startkapitaal, helpen ze bij het herstel van de huishoudeconomie na een ramp, leveren ze een bijdrage aan het inkomen en worden ze geruild met nadere benodigdheden. Ook leveren ze een bijdrage aan de dierlijke eiwitconsumptie van huishoudens. Op sociaal-cultureel terrein hebben kippen een functie bij godsdienstige ceremonies, in het tonen van gastvrijheid en bij het uitwisselen van geschenken. Lokale gezegdes tonen de rol van kippen voor de armen, bijvoorbeeld: 'kippen zijn de eerste en laatste hulpbron voor arme huishoudens'. Huishoudens met een vrouw aan het hoofd, dit zijn de armste huishoudens, hadden vaak alleen kippen en geen andere landbouwhuisdieren. Een deel van de arme huishoudens had niet genoeg geld om een kip te kopen, zij lenen kippen en delen de opbrengsten met de eigenaar. Deze huishoudens kunnen een belangrijke doelgroep zijn voor ontwikkelingsprojecten met kippen. De groepsgrootte van de kippentomen liep uiteen van ongeveer 6 tot 12. In het district het dichtst bij de regionale hoofdstad Mekelle was het aantal kippen per huishouden groter dan in de meer afgelegen districten. Afstand tot de markt was van invloed op de marktorganisatie. De marktketen was het kortst in het district het dichtst gelegen bij Mekelle en ook waren de prijzen voor eieren en kippen hier het hoogst. Verbetering van de infrastructuur en een betere organisatie van de huishoudens kan de kosten voor het naar de markt brengen verminderen, met name in de gebieden met slechte toegang tot de markt. De jaarlijkse cycli in religieuze festiviteiten en vastendagen hebben grote invloed op de vraag naar en de prijzen van eieren en kippen. Het plannen van de productie in relatie tot de periodes van grote vraag is moeilijk vanwege het grote aantal belangrijke religieuze periodes.

De wisselwerking met boeren en het gezamenlijk leren aangaande verbetering van de erfkippenhouderij kende drie stadia. Ten eerste toonde het verzamelen van productiegegevens door de onderzoekers het belang aan van het kennen van religieuze en andere gewoontes en percepties van de betrokken huishoudens en het aanpassen van de onderzoeksmethodieken hieraan. Een tweede stadium was het terugkoppelen van de gegevens in de vorm van productieresultaten per huishouden. De informatie-uitwisseling hierover tussen boeren onderling en tussen boeren en onderzoekers gaf boeren de mogelijkheid het management van hun kippen en de resultaten daarvan beter te begrijpen. Het derde stadium was de uitwisseling van de resultaten van modelsimulaties met als doel het identificeren van ontwikkelingsmogelijkheden op het gebied van erfkippen en hun bijdrage aan de huishoudens. De huishoudens verschilden in hun uitgangssituatie, niet alleen in het aantal en type kippen (lokale, kruisings- of Rhode Island Red kippen) en hun managementsysteem maar ook in problemen in hun omgeving. Modelsimulaties gaven dus verschillende uitkomsten. Interventies rondom mogelijke veranderingen in erfkippenhouderij zijn specifiek voor elk individueel huishouden. Het model kan gebruikt worden om specifieke uitgangssituaties beter te begrijpen en om specifieke scenario's voor de toekomst te ontwikkelen.

Door de combinatie van verschillende benaderingen en methodieken is er een meer volledig beeld ontstaan van de beperkingen en mogelijkheden van erfkippenhouderij. De toepassing van de verschillende methodieken was niet altijd vooraf gepland. Het was vooral een sneeuwbaleffect waarbij een methode gebruikt in een bepaalde fase voortbouwde op kennis opgedaan in een voorafgaande fase. De boeren waren in staat gedetailleerde informatie te geven zowel in relatie tot de context van de erfkippenhouderij als de mechanismen. De inbreng van informatie door de boeren onderstreepte dat onderzoek en ontwikkeling op het gebied van de erfkippenhouderij niet alleen gaat om het vinden van technische oplossingen maar ook om die passend te laten zijn in de sociaal-technologische context. Het onderzoek maakte daarmee duidelijk dat het verbeteren van erfkippenhouderij ook het zich kunnen richten op de bestaansmogelijkheden van de huishoudens en de institutionele omgeving die boeren moet ondersteunen, omvat.

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Aklilu Hailemichael

July 2007

Curriculum Vitae

Aklilu Hailemichael Asgedom was born on November 28, 1971 in Adua, Tigray, Ethiopia. He studied for a BSc degree in Animal and Range Sciences between 1993 and 1997 at the then Mekelle College of Dryland Agriculture and Natural Resources, now Mekelle University, Tigray, Ethiopia. After completing his BSc in 1997, he was appointed as staff member in the Department of Animal and Range Sciences in the same year. He was responsible for assisting in teaching and research in relation to livestock production. Under the sponsorship of a collaborative project 'Mekelle University-Larenstein International Agricultural College, (MU-LIAC)', he did his MSc with the Animal Production Systems Group, Department of Animal Sciences, Wageningen University, the Netherlands. He received his MSc degree in Animal Science in January 2000. His thesis was entitled "Modeling impact analysis in village poultry production systems."

After his MSc, he rejoined the Department of Animal and Range Sciences at Mekelle University as a lecturer, mainly teaching livestock production related courses such as poultry production, dairy cattle production, animal product processing and apiculture. Apart from lecturing, he was involved in research and public-service in related areas. In 2002, he was awarded a PhD fellowship from the project 'Participatory Approaches and Upscaling (PAU)', financed by Rockefeller Foundation and coordinated by the Technology and Agrarian Development Group, Department of Social Sciences, Wageningen University. His PhD study "Village poultry in Ethiopia; Socio-technical analysis and learning with farmers" was done under the supervision of the Technology and Agrarian Development (TAD) Group, Department of Social Sciences and the Animal Production Systems (APS) Group, Department of Animal Sciences.

List of publications

Aklilu, H.A., Udo, H.M.J., Almekinders, C.J.M., and Van der Zijpp, A.J. accepted. How resource poor households value and access poultry; village poultry keeping in Tigray, Ethiopia. Agricultural Systems

Aklilu, H.A., Almekinders, C.J.M., Udo, H.M.J., 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(3): 165-168

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Completed Training and Supervision Plan Aklilu Hailemichael Asgedom

Description	Department/Institute	Month/year	Credits
I. Orientation			
WIAS, Introduction Course	WIAS, Wageningen	February 2003	1
CERES, Introduction and presentation tutorials	CERES, Utrecht	May 2003	5
Proposal development and literature review	Wageningen University	September 2002-June 2003	4
II. Scientific and Professional skills			
PAU/TAO-Cornell workshop, participatory approaches and upscaling	WICC, Wageningen	22-26 August, 2002	1
Facilitating change in upsealing of participatory approaches	Boxmeer	10-18 October, 2002	2
Techniques for Writing and presenting Scientific papers	Mansholt, Wageningen	27-29 December, 2002	4
Advanced statistics course 'Design of Animal Experiments'	WIAS, Wageningen	25-27 December, 2002	1
Sharing experiences on PhD research on participatory approaches and up-scaling	PAU program, Malindi, Kenya	13-18 June 2004	1
Development of teaching and research facilities, Research visit to University of kwazulu Natal	Petermarisburg, South Africa	30 September-5 October, 2005	1
Learning in PAU: Support to Analysis and PhD thesis write up	PAU program, Jinja Uganda	24-28 January 2006	1
Developments in poultry research, Research visit to Central Avian Research institute	Izatnagar, U.P, India	15 April – 5 may, 2006	1
III. Seminar Presentations			
"Farmers participation in research: experiences from village poultry research in Ethiopia. "	VAD Conference, Frankfurt, Germany	23-28 July 2006	4
"Socio-cultural and economic factors affecting village poultry "	Innovation Africa Symposium, Kampala, Uganda	20-24 November, 2006	4
"Values and challenges of interdisciplinary research experiences from research on village poultry"	TAO, Wageningen	13 February, 2007	2
"Village poultry keeping; socio-technical analysis and learning with farmers in Ethiopia"	APS, Wageningen	12 March, 2007	2
"Village poultry keeping: beyond flocks and animal science"	AITVM international workshop, Montpellier, France	20-23 August, 2007	4
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Cover design by Fokje Steenstra and Aklilu Hailemichael. The picture on the cover is taken by Aklilu Hailemichael in Alaje *woreda* of Tigray, North Ethiopia. It shows a middleman collecting eggs at the roadside from farmers. This is a typical village poultry marketing system in Ethiopia

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