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Guide to chicken health and management in Ethiopia

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Guide to chicken health and management in Ethiopia

For farmers and development agents

Produced as part of the Chicken Health for Development (CH4D) project, funded by the BBSRC and the UK Department for International Development

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Acronyms

AI	Avian influenza
CAF	Chloramphenicol
CIA	Chicken infectious anemia
CRD	Chronic respiratory disease
CSA	Central Statistics Authority
DOCs	Day-old chicks
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
HE	Hemorrhagic enteritis
HPAI	Highly pathogenic avian influenza
IBD	Infectious bursal disease
IFP	Improved family poultry
LMP	Livestock master plan
LT	Laryngotracheitis
ND	Newcastle disease
NE	Necrotic enteritis
UE	Ulcerative enteritis

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Executive summary

Chicken production is an important agricultural activity in Ethiopia. Most farming households, and many others, keep at least a few chickens, which can play a key role in poverty alleviation, nutrition and food security. In addition, as chicken husbandry is mostly carried out by women and children, it can play a key role in household labour productivity and gender empowerment.

Increased production of chickens to improve food security is a major policy goal in Ethiopia and, although still accounting for a small proportion of total production, there is increasing semi-intensive and intensive production, often using introduced commercial and hybrid chickens housed in flocks of 50–1,000 birds.

Despite the long history of chicken production in Ethiopia, and many recent advances, there remain important constraints to productivity. These include the genetic resources available, the availability and quality of feed, limitations within the supply chain, including opportunities for marketing, and the high prevalence of disease and predation.

This guide provides an overview of chicken production and management in Ethiopia and of the health issues that impact productivity. Based on the extensive experience of the partners in the Chicken Health for Development project, including insights gained through the field work conducted for this four-year project, this guide offers locally specific information to improve chicken management and health across all scales of production. We hope that this guide assists those people responsible for chicken production in Ethiopia, including farmers, development agents and veterinarians, and enables enhanced productivity of the chickens and well-being for the people who rely on them.

1. Introduction

Overview of Ethiopian agricultural production

Agriculture is by far the largest sector of the Ethiopian economy, encompassing diverse economic and physical environments. Crops, fisheries and livestock are the most important sub-sectors within the agricultural sector, contributing the highest per cent of the agricultural GDP. Given the high incidence of rural poverty, agriculture, especially crop production, has a decisive role to play in enhancing food security in the country. However, low productivity of the already shrinking cultivable land, low productivity and rain-fed dependent crop production, a lack of tailored agricultural technologies and innovations, and a lack of readily available markets and expert services are among the major constraints attributed to the poor growth of agricultural production. As such food security remains a problem for many rural households.

The Ethiopian government has been designing and applying different programs that aim to combat poverty through transformation of subsistence, crop-dominated agricultural production to commercial enterprises. Commercialization usually entails an increase in productivity per area of land, and is often associated with technological innovation, population growth and urbanization. In 2012, Livestock production contributed about 47% of the agricultural GDP, and 18.8% of the national GDP of Ethiopia (ICPALD 2013). However, unlike crop production there has not been significant application of technology and improved management to the livestock sector, meaning there is considerable scope to improve production and productivity.

Poultry production is an important and integral part of most Ethiopian households in rural, urban and peri-urban areas. Poultry can play a key role in poverty alleviation, nutrition and food security. Chickens have a short production cycle, and can be reared flexibly and easily in a range of production systems, making them a good candidate to respond to the existing shortage in animal-source protein. In addition, as chicken husbandry is mostly carried out by women and children, it can play a key role in household labour productivity and gender empowerment. Hence, enhancing Ethiopian chicken production is of paramount importance to increase agricultural production and productivity throughout the poultry sub-sector.

Poultry systems in Ethiopia

In Ethiopia, poultry production is largely undertaken in the poultry sector is dominated by smallholder producers. However, chicken production varies in accordance with the local socio-economic and physical environment. Using criteria such as breed, size of the flock, management conditions, purpose of production, degree of commercialization and location, Ethiopian chicken production systems can be classified as village (sometimes also called traditional or backyard); semi-intensive, and modern (or intensive) production systems (Alemu and Tadelle 1997).

The government of Ethiopia is supportive of the development of the poultry sub-sector in the country. A livestock master plan and strategy targeting the improvement of the livestock sector, particularly the poultry sector, has been developed. The master plan aims to transform the existing village production system to improved family poultry (IFP). The strategy also recommends that the commercial production system be expanded to fulfil the increased demand for chicken meat and egg (MoA 2015).

Village systems account for 96.9% of Ethiopia's 50.38 million poultry population (CSA 2013). The system is dominated by indigenous chickens, and characterized by the production of a small number of low-yielding chickens (40–60 eggs/hen per year), an average flock size of 7–10 mature birds per household and with little or no additional inputs for feeding and health care, except provision of shelter during the night time. Hatching and brooding are entirely natural, by broody hens, but there is often very high chick mortality, of 25–88% (Tadelle et al. 2003). The target of production is mainly for home consumption (Tadelle 1996), but many farmers rarely consume their own birds or eggs, instead preserving them as a 'safety net' which they can sell when needed. Since the 1950s, much effort has been made to improve the productivity of the village system through distribution of small packages of exotic chicken breeds. But the emphasis on improving the productivity of local chickens through improving husbandry practices has been almost nonexistent.

Semi-intensive systems apply some level of production inputs, such as protein and energy feed supplementations as a backup for the scavenging feed resource base; minimal health care and vaccination; and construction of a house, feeder, drinker and nesting boxes from locally available materials. Mostly these systems concentrate on exotic (non-indigenous), dual-purpose chicken breeds, with the potential to lay about 150–200 eggs/bird per year. Depending on the available scavenging feed resources in the area, the flock size under this system ranges from 10–50 chickens. However, in previous Ethiopian development initiatives, the corresponding inputs were not packaged together with the exotic chickens distributed. As a result, the interventions were not effective in bringing the envisaged result: the expansion of improved family poultry (IFP) enterprises to supplement farm income and the nutrition of the community.

Intensive/modern systems apply standardized inputs in feed, healthcare and housing. Birds kept in this system are the highly productive hybrid chickens developed for commercial production. In North America, Europe and Asia, with hens of commercial layer breeds laying about 300 eggs/bird per year and commercial broiler (meat) chickens attaining 2–2.5 kg of body weight by 45 days of age. Depending on the level of production and scale of commercialization, there are two types of intensive chicken production: 1) *small-scale intensive*—a production capacity of 50–500 number of birds, currently emerging in urban and peri-urban areas of the country; and 2) *large-scale intensive*—a production capacity of more than 500 birds frequently based around investment from large companies (Wondmeneh 2004).

2. Relevance of chicken production

Chicken production provides many socioeconomic benefits at individual, household and national levels.

In most developing countries, including Ethiopia, village chickens make up the largest proportion of the national poultry population. They can be raised by smallholder-farming families, landless labourers and people with an income below the poverty line. Even with low inputs, village chicken production enables farmers to harvest the benefits of high quality protein in the form of eggs and meat from only scavenging feed resources.

Village chickens also provide some opportunities for income for smallholder farmers, through the sale of birds and eggs in local markets. Chickens have several advantages over other livestock. They can easily be transported, their market price is relatively stable, their production is flexible over a range of systems, including the use of peri-urban production, and is complementary to other livestock and crop systems. There are fewer issues with religious acceptability as chicken meat is not prohibited by major religions.

Village chickens also play a significant role in the rural community through its contribution to the cultural and social life of the people. The chicken dish *doro wot* is considered the national dish of Ethiopia and is prepared as a special meal for high status visitors or respected guests. As chicken husbandry is mostly carried out by women, children and the elderly, it contributes to family labour productivity and empowerment of the more disadvantaged groups of the community. For rural women, chicken production is a cash-in-hand livelihood activity to help households to buy consumables (sugar, coffee, salt); to pay social obligations such *edir* (burial associations), *equb* (informal savings and loan co-operatives), and other household utilities.

Modern chicken production is now a source of employment and income-generating activity in which many people are engaged. Young people of both urban and rural backgrounds have begun to establish micro-enterprises producing poultry and eggs, creating employment and income sources. Large-scale commercial poultry farms in Debre Zeit, such as Alema, Genesis and Elfora, have created employment opportunities and are major egg and meat suppliers to the capital, Addis Ababa. However, chicken production is constrained by various factors that directly or indirectly influence productivity.

3. Challenges and constraints of poultry production in Ethiopia

Genetic resources

Genetic resources are often cited as a constraint, due to the comparatively low productivity of indigenous chickens and unavailability of alternative breeds. The majority of Ethiopian chickens are low producing indigenous birds. The productivity of scavenging hens is low, not only because of their comparatively smaller size, slower growth rates and lower egg production, but also due to a long reproductive cycle due to the natural traits of incubation and brooding. High chick mortality, caused by disease and predation also contributes to the low output. However, much of the low productivity of indigenous stock can be attributed to the low management standards of the traditional production system and to the pressure of infectious disease. It has been observed that the provision of relatively 'low-tech' interventions, including vaccination, improved feeding, clean water and night-time enclosures, improves the production performance. Supplementary feeding of local chicken brings a considerable increase in egg production (Tadelle and Ogle 1996). It should also be noted that many of the genetic traits of local chickens, including the high genetic diversity, are adaptations that have made them highly successful in the current production system and that some, such as broodiness, are actively selected by farmers to meet the demands of the system under which they are kept. As such, replacing the indigenous chickens with exotic breeds that have higher productivity traits can only be successfully managed if the production system is also adapted to meet the higher input demands of the more productive birds.

The intensive chicken production system of the country is constrained by shortages and irregular supplies of day-old chicks of breeds that are suitable for intensive management conditions. Local birds generally do not adapt well to these conditions and it is generally uneconomic to keep indigenous chickens under intensive conditions due to their slower growth rates and lower feed conversion ratios.

Quality and availability of feed

Ethiopia produces a wide range of ingredients suitable for poultry feeding. It is a country where practically all crop types can be grown somewhere, providing the opportunity for a wide variety of alternative feedstuffs. Varieties of grain and protein sources are available (Alemu and Tadele 1997). But this does not mean that poultry feeds are available everywhere in sufficient quality and quantity; rather Ethiopia faces substantial problems in terms of feed shortages for poultry production. In this regard, the village chicken production system is affected by seasonality and variable quality of scavenging feed resources.

There are some poultry feed processing plants located in and around urban areas, particularly Addis Ababa, and in other parts of the country where there are government chicken multiplication centres, and agricultural colleges and universities. Although their target customers are commercial producers, the feed is often poor in quality and expensive.

Poor institutional linkage

In Ethiopia, institutions engaged in agricultural development do not have well-established links to each other or the developing poultry industry. As such, research outputs that could potentially contribute to the development of the sector are not readily available to the main industry stakeholders or to rural producers. This includes research relevant to increasing the production potential of indigenous chickens (for example, see section on feeding) that have demonstrated promising results in trials, but are not implemented more widely.

Limited production capacity

Institutions engaged in chicken production and development, such as research institutions, regional multiplication centres and private commercial poultry farmers, have limited capacity to meet the growing human population and the associated increased demand for meat. The extension system has been attempting to enhance production and productivity of the poultry sector, especially the village system which has been contributing to the largest share of egg and chicken meat supply of the country. However, the interventions are often piecemeal, failing to incorporate necessary inputs and account for local husbandry practices.

Disease and predators

Disease: In Ethiopia, the presence of endemic infectious diseases affect production in two main ways. Firstly, periodic disease outbreaks may result in the loss of almost the entire flock in the village chicken production systems. Secondly, the constant presence of infectious disease can lead not only to illness and death but also reduce productivity. Infectious diseases, such as Newcastle disease, salmonellosis, fowl cholera, coccidiosis and fowl pox, are the major causes of morbidity and mortality in village poultry. Vaccine packaging in large (up to 1,000) multi-dose vials that are not cost-effective for small producers, and a lack of veterinary service or an organized village level delivery system are major barriers to implementing vaccination for economically important poultry diseases in village chickens. Disease is also a major problem for large-scale poultry farms. The level of biosecurity implementation as a measure to prevent the entry of disease causing agents into intensive farms is low, due to limitations in knowledge and skill, as few producers have access to training.

Predators: Predators are among the major constraints that cause chicken deaths, especially in the village production system. Snakes, rats, dogs, cats and foxes are the main predators that cause losses of younger birds. Wild birds (eagles, hawks, etc.) during the dry season and wild cats (locally known as *shelemetmat*) during the rainy season are the most dangerous predators that attack older chickens.

CH4D findings: Constraints to chicken health and production

The Chicken Health for Development project explored constraints to chicken health and production with backyard and semi-intensive chicken farmers in and around Debre Zeit. Many farmers, particularly those involved in backyard production, ranked diseases as the most important constraint. Supply of feed was also a major constraint for both groups, but particularly for semi-intensive producers. Farmers in both groups reported they had difficulty accessing agricultural and veterinary inputs and expertise, but they also reported that they very much wanted access to such inputs and expertise. As Debre Zeit is a focus of chicken production in Ethiopia, access to such inputs and expertise will be an even greater problem in most other areas. Interviews with animal health experts suggested that they often did not recognize the farmers' wish for access to their expertise. Hence, there is a very important role for development agents and veterinarians across Ethiopia to meet the needs of farmers. Whilst improved access to technologies such as vaccines, medicines and improved genetics will be important in the future development of chicken production in Ethiopia, it is important to recognize that the impact of many of the identified constraints can be reduced through implementation of the recommendations provided within this guide. For example, implementation of basic biosecurity practices could reduce the impact of a range of infectious diseases and provision of simple housing could reduce predation.

See: Sambo, E., Bettridge, J., Dessie, T., Amare, A., Habte, T., Christley, R.M. 2015. Participatory evaluation of chicken health and production constraints in Ethiopia. P*reventive Veterinary Medicine* 118: 117–127. http://dx.doi.org/10.1016/j.prevetmed.2014.10.014) [open access].

4. Village chicken production

Poultry production systems

Although various factors constrain chicken production in Ethiopia, this manual emphasizes those factors directly related to management practices that can be easily implemented and bring direct benefit to individual farmers. As such it is important to identify characteristics of different chicken production systems so that appropriate interventions may be made.

Village chickens are the most common type of livestock in many rural areas; almost every household, including those who have few labour resources and little or no land, normally keep some chickens with the following characteristics:

- Mainly indigenous (local) chickens with low productivity (but sometimes interbred with exotic stock).
- Few chickens per household (commonly 7–10 mature birds), with the daily feed requirements predominantly obtained by scavenging (including household waste and village leftovers).
- The required investment is minimal, with most of the inputs generated around the home (including the labour inputs).
- Chicken production is typically aimed towards home consumption and savings (a living bank) for small expenses such as school fees and medicines.

The husbandry of this system is often poor and is characterized by flocks of multi-age groups kept together with other chicken breeds (exotic hybrids) and animal types.

Figure 1: Chickens are frequently kept with other livestock and working animals.

Management of the chickens

The village system is dominated by traditionally managed local chickens and most rural people obtain little economic benefit from poultry keeping. Research suggests that the application of improved husbandry practices and improved basic resources such as better chicken selection, improved housing, availability of feeds and feeding, improved health management and predator control could improve production and productivity. Support by locally tailored training and extension services can help to maximize the benefits from the production system. The following section presents a detailed discussion of some improved management and husbandry practices that villagers can take into consideration.

Selection and reproduction

In the village poultry production system, the stock composition is varied in terms of age and sex. In some cases, households keep excess cocks and unproductive hens that contribute little to output. Households in the village system slowly improve their stock by selecting chickens against production and reproduction parameters. Farmers know which bird is a good layer; has good mothering behaviour and hatching ability, and a high growth rate (see chicken selection criteria below). However, they should always take into consideration that the size of the flock should match the size of the house, the amount of feed they can produce or afford to buy, the feed resources in the environment (scavenging feed resource base) and the level of other necessary inputs.

Reproduction is one of the major purposes of village chicken production. One cock can serve 7–12 hens to produce fertile eggs meant for hatching. Similarly, hens should be culled when production performance is reduced due to old age. Therefore, when surplus cocks reach a marketable size they should be sold, slaughtered for meat or given away as presents. Large numbers of cocks may eat the scarce feed resources, as well as fight between themselves and with the hens causing stress and reducing the hens' egg productivity. Furthermore, the size of the flock should match the purposes for which they are kept and may be affected by the opportunities to realize the gains from increased numbers (for example, in terms of access to markets).

Chicken selection criteria

1. **Good hatching ability** select hens with good egg incubating behaviour.
2. **Mothering behaviour**: flightiness/ability to escape/protect chicks and herself from predators.
3. **High growth rate**: maintain chicks with fast growth rate and cull chickens showing poor growth and any dwarf birds. Birds with delayed sexual maturity or surplus cocks that reach slaughtering age should be culled.
4. **Select eggs for hatching**: average size, good shell quality (without any deformity or cracks), clearly defined shape (broader bottom with sharper tip).
5. **Hatched chicks (day-old chicks; DOCs)**: good body condition, without deformity in the legs or eyes. Also, chicks should be keen to eat and drink.
6. **Disease resistance**: Select chickens with good disease resistance – i.e. breed from those that survive disease outbreaks.

In Ethiopia, the previous extension system distributed exotic chicken breeds, normally one cock, or a combination of one cock and a group of pullets. However, the type of chickens distributed was unfit for the scavenging production system. Hence, the extension interventions should select exotic chicken breeds with the ability to adapt and reproduce in the local system, or improved indigenous birds adapted to local conditions and disease challenges.

Housing

Poultry housing in the village production system varies with flock size, local knowledge on the construction and maintenance of the house, socioeconomic situations of the household, and availability of construction materials. The 'housing' in this production system is usually very rudimentary. There is often no separate housing purposely constructed for chickens. Frequently, the chickens roost in family dwellings or the kitchen which brings with it the risk of increased transmission of zoonotic infections (zoonotic infections are those that can be transmitted from animals to people). Perches and brooding and egg laying nests are generally constructed from locally available materials. The main role of the house in most village systems often is only to provide a night time enclosure. In some cases, people in some rural parts of Ethiopia let the chickens roost overnight in trees located in the home compound.

To maximize the benefits from the village production system, people should be trained so they may change or develop existing practices. A low-cost house that is constructed separately reduces the risk of exposure of the owner to zoonotic diseases directly transmitted from chickens to people. Similarly, uncontrolled human interaction may expose the chickens to disease-causing agents. The house should preferably have a run area, and can be constructed properly from locally available materials. A house can help to protect the chickens from risks related to predation (see section on Predator control), bad weather, and theft, as well as decreasing the risk of transmission of some infections by reducing the interactions with other chicken flocks. However, accommodating too many chickens in a small area has a negative effect on health and growth, and exacerbates the development of parasites, such as red mites, worms, lice and fleas. Hence, it is essential to accommodate the appropriate number and type of chicken in a house.

Figure 2: Examples of village poultry houses constructed from locally available materials.

Preparation of a separate place for chicks, furnished with locally available brooding materials, is important to reduce chick mortality and can increase productivity by decreasing the time that the hen spends brooding. Figure 3 shows alternative brooding areas prepared from localy available materials, used to replace the natural brooding hen in areas where electric power is unavailable. Care must be taken while using locally made brooders that chicks are at the correct temperature and can move towards or away from a heat source.

Figure 3: (A) Charcoal brooder.

(B) Hay-box brooder.

Feedstuffs and feeding

In the village production system, chickens almost entirely depend on the scavenging for feed, making it difficult to estimate the amount of consumption and utilization. However, chicken crop content analysis indicates that the feed is often deficient in protein, energy and calcium (for shell production in layer birds) (Tadelle and Ogle 1996). This, along with other management-related problems limits the egg production of local hens to 40–60 eggs/bird per year. In addition, the amount available and the nutrient levels in the scavenging feed resource varies across regions and with the season of the year. Feed may be very limited between the rainy seasons, when there is long period during which the land over which the chicken normally scavenge is covered by crop plants. In this regard, a 30 g/day per bird supplementary feeding of local birds with feed containing 15 g of maize as an energy source and 15 g of Nug cake as a protein source can bring an increase in egg production to 60–100 eggs (Tadelle et al. 2006). Supplementary feeding at least twice a day (early in the morning and late in evening when chickens are going out and returning from scavenging) helps to improve disease resistance, proper body development and production levels of the birds (see Table 4).

Young chicks need protein-rich feeds or mixtures from simple supplementary sources such as soybean, maggots, snails and termites. Young chickens should be fed separately, away from the adult birds. It is best for them to have a special diet and not to have to compete with the adults for feed. It is very important for small chicks always to have access to clean water, as they may easily die from dehydration or infection.

Clean water should also be provided at all times to all birds. Regularly changing the water and cleaning feed and water containers helps to prevent disease and infections through dirty feed and water.

Constructing feeding and drinking equipment from locally available materials is a relatively simple and low-cost measure that farmers can take to minimize wastage when they practice supplementary feeding of the chickens. Supplementary feeding is one of the most important ways to increase the production and productivity of the village production system.

Figure 4: Feeding village chickens:

(A) Floor feeding;

(B) Locally constructed feeder.

Figure 5: Locally constructed chicken drinkers.

Proper management should focus on hygienic measures including proper cleaning of drinking and feeding equipment, brooding and laying nests, and the house. The house, perch, brooding and laying nests should be thoroughly cleaned and must be treated with a disinfectant such as lime, especially when there is a disease outbreak. The bedding/litter material should be kept clean and as dry as possible, particularly for houses without perches. Fresh and treated straw or hay should be put in the nests at least weekly.

In this production system, brooding is usually done naturally by a hen. Surplus eggs are also a valuable product for sale or consumption. Hence, brooding and laying nests should be properly constructed and placed in an easily accessible place, to help to increase hatchability and decrease egg loss.

Figure 6: Locally-constructed laying nests.

Health management

Infectious diseases are major problems that may be introduced easily into the flock through contaminated materials and sick birds. This is the main reason why poultry producers should not buy chickens from live bird markets or from uncertified or unknown sources, especially during outbreaks of disease. When birds are purchased or gifted from an outside source, it is important to place them in quarantine for two weeks in a room/shed or cage, so that they do not mix with the host flock (Figure 7), and to observe the new birds for any signs of sickness. The same structure can be used for the isolation of sick birds if quarantined chicks are not occupying it. Ensure that the structure is appropriately disinfected after use, and take appropriate hygiene measures whilst birds are in quarantine. This includes washing hands after the handling sick and quarantined birds, and always finishing the performance of routine tasks with the healthy flock, such as feeding or cleaning, before treating those in quarantine.

Figure 7: Locally constructed isolation/quarantine cage.

Vaccination is one means to prevent disease in the flock. Vaccinating the whole flock against economically important diseases, such as Newcastle disease (ND), fowl typhoid and fowl pox, helps prevent mortality in the scavenging system. Although vaccinating village chickens is not a common practice in Ethiopia, vaccines for the diseases mentioned above are produced locally at the National Veterinary Institute (NVI; see Annex 4 for address). Vaccination for ND is practiced in the form of campaigns by the Ministry of Agriculture in a sporadic manner in some areas of the country. This is mainly carried out when there is an outbreak in an area or suspicion of disease in the coming season.

However, lack of awareness, poor animal health services and farmers' poor perception of vaccine efficacy are among the major factors affecting implementation of vaccination programs.

In serious disease conditions poultry farmers should isolate or kill the affected birds(s) and consult the veterinarian, development agents (DAs) and other experts in the locality. After appropriate investigation, the farmer should give drugs or/and implement any management measures recommended by the veterinarian. Farmers often traditionally use local medicinal treatments such as *Melia, Garlic, Hot Pepper, Lepidium sativum (feto)* which have unproven efficacy but are unlikely to lead to any harm. However, medicines formulated for human use and especially antibiotic drugs (including chloramphenicol (CAF) and tetracycline (TTC)) are unlikely to be effective against most diseases, such as those caused by virus or parasite infection. In the case of antibiotics, their use can pose risks to people as the drug may stay in the meat. In addition, overuse of antibiotics in animals may mean that these drugs become less effective in animals and people as bacteria may become resistant to these drugs.

Dead birds (or parts from dead birds) should be burned or buried deep enough (about one metre) to prevent dogs and other animals from digging them up and spread the disease. If there are many sick animals, the cause of the disease must be established before introducing new birds or vaccinating surviving chickens, to ensure that appropriate measures are put in place to reduce the chance of further outbreaks.

In addition to the measures mentioned above, farmers should refrain from traditional practices that increase the spread of disease within and beyond the village. Examples of poor practice which may lead to spread of disease include the:

- Selling of birds, including the sick ones, whenever there is suspicion of disease in the flock;
- Disposal of dead birds in communal village areas or water sources, or the feeding of carcasses to pet animals, such as dogs and cats;
- Failure to regularly, if at all, clean chicken shelters; and
- Sweeping of the litter from the shelters away from the compound.

For the benefit of all chicken keepers in the community, it is necessary that village poultry producers refrain from such kind of dangerous practices.

Newcastle disease vaccines for village use

Vaccination rarely yields 100% protection and even less so under village production conditions (Spradaw 2005). Nevertheless, there is a significant increase in the survival of village chickens when vaccination programs are implemented for economically important diseases (Tran 2000). A major problem is identifying diseases correctly, as many chicken diseases have a similar appearance. Vaccinating against the wrong disease will not give chickens protection, and can cause farmers to lose faith in the vaccines.

Newcastle disease is a disease that causes huge mortality internationally. Implementing vaccination against this disease depends on the local conditions in each country. Recently, the National Veterinary Institute (NVI) of Ethiopia has developed a 50 dose vial Newcastle vaccine known as I2. It can be transported even with limited cold chain and storage facilities, although the efficacy of the vaccine is increased if it is stored at a temperature of 4–8 °C. Compared to previous Newcastle vaccines, it is also less costly and easy to use for the village system, as it is prepared in a smaller dose.

Oral administration of this vaccine generated a higher immune response. Horizontal protection of chickens (meaning that chickens can spread the vaccine within a flock to some extent) is also possible because the vaccine virus replicates and is excreted in the droppings, and the birds are then infected or re-infected by the vaccine virus from the environment (Adwar and Lukešová 2008; Alders et al. 1994). It can also be administered via eye-drop, drinking water, certain feeds and injection. It is important to use the right route, method and frequency of administration, and instructions accompanying the vaccine should be carefully followed to achieve maximum benefit.

Predator control

Predators are a major cause of chicken loss in village production systems. Losses to predators can be overcome through proper implementation of recommended control strategies. Proper predator control strategy should always consider the age and breed of the birds in the production system. Local chickens are sometimes selected for ability to prevent themselves and their baby chicks from being taken by predators; but this is not always true for all indigenous chickens. In some villages, where losses to predators are high, common selection criteria include:

- Plumage colour: farmers prefer to rear chicks which are not easily seen by predators. Keeping white feathered chickens is not common.
- Good brooding hens: farmers prefer hens with good brooding ability and hens with fighting ability when predators threaten baby chicks.

These two criteria exercised by farmers have their own drawbacks, because when selecting chickens for the above characteristics, other merits, especially production performance, might be lost. Keeping mother hens brooding chicks for a long time also will cause reduction in the annual egg output of the hen. Therefore, to overcome this problem and to allow farmers to have selection criteria of chickens only based on their production performance, the following predator prevention mechanisms are suggested below.

- Construction of a house and keeping the chickens inside during times of the day when predators are common (early in the morning and late in the afternoon).
- Raising of chicks using artificial brooding materials and keep them inside.
- Observation of chicks periodically until they reach maturity and protect themselves.
- If the predator is only a single source, the use of a trap or hunt it down (in case of cat, dogs and other wild animals).
- Feeding of chickens well to prevent them from ranging far from the house, which increases exposure to predation.

Recording sheet

Record keeping about hatch date, health, vaccination and treatment, mortality, egg production, brooding behaviour and hatching ability and the like is very helpful for planning the necessary management practices at the appropriate time and manner. Additionally, economic information—such as the money spent for vaccination and drugs, or feed supplements (if any); income earned from the sale of eggs, unproductive hens, and male birds; eggs and chicken consumed and/or gifted to relatives (calculated market price during the time) etc.—is highly beneficial to monitor the economic performance of the chicken flock, and over time can allow a cost/benefit assessment of any new practices introduced. Hence, the farmer should record the above information both for individual birds, which can help with selection of the best stock for breeding; and for the whole flock. This information is simplest to record in the following manner.

For individual birds;

1. ID of the bird: ____
2. Date of hatch: ____
3. The amount of egg lay/clutch: ____
4. Hatching ability: ____
5. Brooding behaviour:____

For the whole flock

1. Type of vaccine(s) administered if any: ______________________________

2. Money spent for vaccination/drug purchase: __________________________

3. Income earned:

a. from the sale of egg: __________________________

b. from the sale of chicken: __________________________

4. Disease incidence: ____

5. Mortality: ____

Simple rules for better management of village systems (from www.loyno.edu)

The farmer should:

- Receive training in poultry rearing/basic manage (house and housing, feeds and feeding, and health care);
- Provide an appropriate house or shelter with perches inside the house;
- Clean and disinfect the house on a weekly basis;
- Give unlimited access to clean water and make sure that feeding meets the nutritional needs of the birds;
- Vaccinate birds regularly according to the advice of local vaccinators or veterinarians (where possible);
- Monitor the birds' health by daily observation and watching their behavior (mostly early in the morning and late in the afternoon while birds out for and back from scavenging);
- Isolate a bird when it becomes ill and visit the veterinary clinic or other experts in the field for assistance; or kill the bird;
- Report disease to veterinarian promptly;
- Manage the flock size, making sure that it corresponds to the feed and space available;
- Check the reproduction status of each hen once a month, give right care to hens that are brooding and kill or sell non-productive birds, i.e. cockerels and old hens that have stopped laying;
- Provide nests, and check nests for eggs two times a day (layers);
- Protect the chicks by using a day basket during day and a night basket during night and separate young chicks from adults when they are fed; and
- Make calculations of production costs and income and make sure that production is profitable.

Training and extension

A good extension approach and tailor-based training are the two most valuable inputs to improve poultry production and productivity in Ethiopia. To bring improvements to the system, these activities must be given by professionals and continuous assessment and improvement has to be in place.

The extension approach should include demonstration of good experiences/practices performed by farmers. In order to disseminate such good technologies to a given community, development agents (DAs) should carry out continuous follow up and technical backup. The technology can be disseminated to the community through at least two ways. The first is through a farmer-to-farmer technology dissemination approach, and the second means of technology dissemination is through continuous involvement of the government or private companies. A farmer-to-farmer approach is the main means of technology transfer in many parts of the country, and can be most effective if the value added by the technology in those model farmers is tangible.

A good extension system will not succeed unless it is supported by tailor-based training of all stakeholders. The training should be given by professionals with good experience in poultry production. The training should include issues related to; breed and productive chicken selection, housing, nutrition, management, disease control and bio-security for a village production system. Those factors mentioned above are different for different breeds and ages of chicken. A single training event is not likely to change the production system, but customized training needs to be provided to farmers periodically in order to update their awareness and also to incorporate new scientific outputs related to the local production system.

Both extension and training on chicken production should be approached in such a way that engages the farmers. If the training and extension are not in line with the required type or timing (season) of the intervention, the level of success will be low.

5. Semi-intensive chicken production

The semi-intensive production system is mostly practiced in rural and in semi-urban areas. Birds are fed with (often sub-standard) formulated feed and confined in a house for a period of a day, and otherwise left out to forage within the home compound. The characteristics, type and level of input used was discussed above in the section on village production systems.

Previously, the government of Ethiopia attempted to promote the semi-intensive system by distributing improved chicken breeds to the rural farmers. The chicken breeds used included American and European breeds or modern commercial hybrid laying breeds (Rhode Island Red (RIR), White Leghorn, Bovan Brown, Rhode Island White, Lohmann Brown, Isa Brown and Fayoumi). Many of these breeds do not adapt well to rural farmers' management conditions, having been developed for housed commercial production systems. Breeds such as the White Leghorn, because of being white in colour, are readily attacked by predators, and the eggs of RIR have poor hatchability. A further problem with the program was that the small number of birds distributed to the farmers contributed little additional household income, which did not make it worthwhile for farmers to make the necessary investment in the production system to keep these exotic birds.

Later, to minimize this constraint, different institutions have made considerable attempts to find more suitable and sustainable ways to encourage semi-intensive chicken production. Debre Zeit Agricultural Research Centre has been promoting a dual-purpose chicken breed that helps to bring a valued economic benefit by smallholder farmers involved in the practice.

A 50-day old dual purpose Potchefstroom Koekoek chicken technology package has been provided to 11 households in Dodota and Huruta woredas in the Oromiya region. Over 90% of the chicks survived to maturity. About 70 eggs were produced per hen housed. Every household involved in the package has earned ETB 2,400–10,000 during the trial (Teklemedhin et al. 2013, unpublished report).

Figure 8: Semi intensive production (A= Bovan Brown, B= Dual Purpose Koekoek).

6. Commercial chicken production

Globally, the largest number of chickens are reared in commercial poultry production systems. But the use of this production system in developing countries like Ethiopia is very rare and is limited to urban areas. It is characterized by dedicated housing and equipment for chickens and a comprehensive feeding program. Even though the poultry production system in Ethiopia is based mainly on the scavenging village production system, there are a growing number of commercial poultry producers. The capacity of commercial poultry producers varies according to the area they are located, technical know-how and the resources required to start intensive poultry production. Therefore, most commercial poultry production in Ethiopia is comprised of small and medium-scale producers.

Figure 9. Commercial chicken farm.

Poultry management in commercial farms

In commercial production systems, management of chickens plays a crucial role in their performance and profitability. Good management will help disease prevention and control. The most critical management period to achieve the best performance for laying birds is that from hatchery to the start of the laying period.

Poultry management is a set of activities performed to improve the health and productivity of chickens in the flock. The major activities in poultry management are preventive healthcare, brooding conditions, rearing management, growing, and laying conditions. This can be achieved only if the basic management activities (proper ventilation, feeding and watering programs) are implemented properly on the farm. In Ethiopia, achieving optimal management performance is very difficult. The main reason behind this is a lack of awareness about poultry production and limited access to training in poultry rearing and management available throughout the country. Improper housing conditions, limited and poor use of quality feed and vaccines, and a lack of trained staff are major problems that arise due to lack of training.

Effect of breed in chicken management

Breed selection plays a vital role in poultry management. It is mainly related to the adaptability of the breed to the environment. Many commercial chicken breeds might not be suitable for the tropical environment of Ethiopia. Therefore, it is important to perform adaptability trials to Ethiopian conditions prior to import to the country. The national poultry research case team is the primary advice provider on exotic breeds, and the only research institute which performs adaptability trials on chickens prior to recommending them for any production system. Most chickens with high genetic merit related to productivity are extremely sensitive to changes in the diet and to ambient temperature, and require skilled stockpersons to manage them.

Temperature, ventilation and light management

Temperature management: temperature in the house needs to be maintained for high production and productivity. This can be approached through a well-structured housing system that allows ventilation of the house to regulate the temperature. Different age groups of chickens require different environmental temperatures to survive and to attain maximum performance. In the early stage (1–4 weeks of age) naturally achieving the temperature required by chicks is very difficult and artificial heating is needed to simulate the natural brooding; this is called artificial brooding. Artificial brooding in small-scale production systems can be achieved using infrared bulbs, canopy brooders and hay boxes. Hay boxes are used in areas where there are regular electricity shortages and in rural settings.

A brooding guard is important to confine chicks in a limited space so they cannot stray too far from the heat sources and to prevent unnecessary wastage of heat. It can be prepared from iron sheets or any washable materials that can be cleaned and disinfected between batches. Brooders should not have corners (so must be circular) to prevent unnecessary huddling of chicks in the corners, which can result in death of trapped chicks.

Figure 10: A well designed brooding system incorporating heating.

If there are problems with heat management in a house the birds will display distinct behaviours. For instance, if the temperature is below that is required, chicks will tend to huddle around the heat source (Figure 11). Where the temperature is too high, the chicks will disperse away from the heat source and start drinking more water. They may also show open-mouth breathing, opening of their wings and decreased feed intake. This will affect production performance and can lead to feather pecking or cannibalism. Therefore, it is advisable to follow a standard heat program to improve production (Table 1). Temperature regulation in very warm areas can be achieve by ventilating the house, increasing access to clean cold water, planting trees for shade and pouring cold water onto the roof as required during hot conditions.

Figure 11: Insufficient heating leading to huddling of chicks.

Table 1: Ideal temperature requirements of chicken

Age of chickens	Ideal temperature (OC)
First week	35
Second week	30
Third week	26
Fourth week and above	23

Management of lighting: light management mimics seasonal conditions which are relevant to biological development. Day length and light intensity affects the development of the reproductive system. The difference in day lengths and light intensities between the rearing and the laying phases is the principal factor responsible for controlling and stimulating ovarian and testicular development. The effects of light are predominantly on the rate of sexual maturation and egg production.

In the first 48 hours of life the light should not be interrupted, but from then until four weeks of age the light should go off for one hour each day, which helps chicks to adapt to darkness if the power goes off suddenly. Laying hens should get light for 16–18 hours per day. The amount of light needed depends on the area of the house. In broad terms, each Watt of light bulb power is enough for 0.37m^2 of floor space.

In Ethiopia, there are 12–13 hours of daylight throughout the year. Therefore, it is only necessary to use additional artificial lights for the remaining 4–5 hours to meet the standard for laying hens. This can be achieved by using the two most common types of artificial lightings; namely incandescent and fluorescent. Even though it is expensive to install, fluorescent light has advantage over incandescent globes in its efficiency and durability. The colour of the light rays also has an effect on chicken productivity. For example, green and blue lights improve growth and lower the age of sexual maturity, while red, orange and yellow lights increase the age of sexual maturity, and red and orange lights stimulate egg production.

Ventilation management: ventilation of poultry houses is important to maintain an adequate supply of oxygen, while removing carbon dioxide, ammonia, other waste gases and dust. In a small-scale commercial poultry production system, this can be achieved by constructing the house to facilitate natural ventilation. Natural ventilation works best in poultry sheds where the long axis runs east to west, to avoid heating of the sidewalls by the sun during the morning and afternoon. It also should take the local conditions (temperature, humidity, rainfall etc.) of the area into consideration (seek advice from poultry specialists in the area).

Ventilation management is directly related to the stocking density of the house. In highly dense poultry houses there will be a high volume of droppings, with high ammonia production and moisture content. These conditions can only be solved by maintaining the stocking density at the recommended standard and improving the ventilation of the house. The stocking density for broiler chickens is recommended to be between 12 and 15 chicks per m^2. Table 2 provides the standard stocking conditions in areas where the temperature is 23–26^{0}C.

Table 2: Stocking density per m^2

Type of chicken	Age in weeks		
	0–8 weeks	8–18 weeks	18–72 weeks
Laying hens	14	12	7–9
Breeder flock	14	10–12	6–8
Dual purpose	14	10–12	6–9
Broiler	10		

Cannibalism and feather pecking

Feather pecking and cannibalism are a problem in most small-scale commercial poultry production systems in Ethiopia. It is not unique to village production and is still a major problem in commercial production where several strategies have been used to combat it. These problems are related to management and can occur in flocks of any age, although it mainly depends on the behaviour of the breed. There are many risk factors which contribute to the occurrence of cannibalism in a healthy flock. The most common risks that expose chickens to cannibalism are:

- Overheating of poultry house (Higher temperature than recommended)
- High stocking density in the house, which hinders behavioural expression
- High light intensity and long lighting time
- Deficiency of minerals in the feed

Identifying the problems that lead to pecking and cannibalism is very important. However, identifying and addressing the underlying problem might take some time, so it is important to be able to apply emergency anti-cannibalism measures to help prevent loss. The following three measures can be taken as a response to pecking/cannibalism:

- Beak trimming
- Use of environmental enrichment-simple practices such as provision of branches with leaves and distributing feed around a house requiring birds to forage although for them to express more natural behaviours and discourage pecking.
- Darkening of the poultry house

Feeds and management of feeding and watering

Providing chickens with clean water and a balanced feed is very important to the health of poultry, as well as to maximize production. The feed should have high nutritional content and fulfil the nutrient requirement of chickens, which varies with age and production stage. The amount of water and feed provided to chickens should depend on the availability and cost of feed ingredients. Feed-related problems are among the major constraints that hinder poultry production in Ethiopia, especially for intensive and semi-intensive producers. The common problems are the high cost of feed and poor knowledge of the correct formulation of feed. Feed should be prepared from locally available ingredients to decrease the cost of the feed.

Starting from day old to the end of its production time, layer chickens consume more than 35 kg of feed while broiler breeds, given a shorter lifetime, consume between 4.5–5 Kg of rationed feed. In the early stage of production (the first week), chicks should be provided with their rationed feed using plain materials, such as crushed grains, because they cannot digest the feed given to older chickens. Excess protein and calcium can be detrimental to the growth of young chicks; therefore, feeds designed for layer hens should never be given to birds under six months old. It is also important to provide chickens with small amount of feed periodically, to increase efficiency of consuming the feed and to prevent selective feeding. Chickens also require grit (for example, crushed washed limestone) to enable them to digest their feed.

The water requirement is directly preoperational to feed consumption. In normal conditions, chickens should take 2–2.5 times the amount of water in relation to the amount of feed. But water intake is highly influenced by the environmental temperature, water delivery system and type of production. Good water management involves the constant availability of clean water, regular changing of water in manual watering systems, particularly when there is an increase in ambient temperature or contamination of water by litter materials. Farms using automated systems should ensure continuous supply of water and regular maintenance and cleaning of the system.

Table 3a: Drinker requirement (edge length per bird in cm)

Chicken type	Chicks	Grower	Adult/ finisher
Layer	1.5	2.0	2.5
Broiler	2.2	2.8	3.5

Table 3b: Feeder requirement (edge length per bird in cm)

Chicken type	Chicks	Grower	Adult/ finisher
Layer	4	6.8	10
Broiler	5	12.5	15

Table 4: Example of commercial feed rations a supplement for village production

Feed ingredients (Kg)	Type of chicken					Supplementation
	Layer	Grower	Chicks	Broiler (starter)	Broiler (finisher)	(for village production)
Maize	47	55	43	47	54	65
Nug cake	10.55	15	15.6	20	13	19.7
Wheat middling	16	13.6	14	19	17	15
Soya meal cake	15	12	23	7.5	10	-
Premix	0.5	0.5	0.5	0.5	0.5	-
Lysine	0.3	0.3	0.25	0.7	0.4	-
Methionine	0.15	0.1	0.15	0.3	0.2	-
Limestone	7.0	1.0	1.0	0.4	0.2	-
Bone and meal	3.0	2.0	2.0	4.3	4.3	0.3
Salt	0.5	0.5	0.5	0.3	0.4	
Total	100	100	100	100	100	100

Hygiene management

Hygiene management is also key to improving production and productivity. Hygiene management is a set of activities that are implemented in the farm to reduce disease and to improve the hygienic status of the product, reducing the risk of transmitting certain infections to humans. The following simple rules should be implemented in poultry houses to achieve hygienic production.

Hygiene management rules:

- Maintain clean poultry houses, surroundings and equipment to reduce contamination of the house, improve health and limit parasites, dust, microbial exposure, and reduce vermin and fly loads. Removal of residual feed from feeders is an important practice, critical to the health of the flock.

- Sanitize sheds between flocks to minimize the risk of disease spread to incoming flocks.
- Maintaining high flock health status is essential, and routine vaccination programs for key diseases are usually necessary for intensive production. A proper vaccination schedule and protocol should be established with expert advice.

To implement hygienic measures, proper sanitation materials should be in place on every farm. The most common materials used in the implementation of hygiene management in the farm are listed in the section on biosecurity.

Litter materials and management

The main purpose of litter material in the poultry house is to absorb fecal waste from birds and to make the floor of the house easy to manage: it also serves as a bedding material for the chickens. It is vital to establish good management practices for poultry house litter materials. The most common litter materials used in most parts of Ethiopia are wood shavings and chopped teff straw, both of which are usually available and suitable. If these materials are not locally available, it is possible to use another material that is light, friable, non-compressible, absorbent and quick to dry, of low thermal conductivity and cheap; provided that it does not harm chickens or put them under stress. Examples include sawdust, shredded paper or wheat hulls, but a wide range of other materials can be used. The recommended depth for litter is between 10 and 20 cm; which is equal to the length from the tip of the middle finger to the lower joint of the hand. Dust particles in the litter capable of causing health problems in the birds are derived from dried feces, feathers, skin and litter; their adverse effects arise because of their direct effects and because they carry bacteria, fungi and gases. However, wet litter is generally recognized as having a much greater negative impact on performance, carcass quality, health, animal welfare, and overall profitability. Ideally, litter should be managed to have approximately 25% moisture. Management of the drinker and ventilation systems is critical in maintaining proper litter conditions.

The used litter, which comprises the original litter material, poultry manure, feathers and spilled feed, needs to be adequately disposed of, to minimize spread of disease.

Stockpersonship

People are responsible for improving husbandry of farmed chickens, but may fail to provide adequate conditions for birds if they don't have appropriate training in poultry production and management. If proper training is not given to people who are responsible for looking after the chickens, it can put these workers under stress, as well as potentially exposing their birds to adverse situations that are likely to cause stress and decrease in outputs. The first task for poultry staff is to learn how to carry out routine checks on the birds, so they can identify what is normal in the flock, and what are signs of trouble. Good stock attendants minimize the risks to their animals' health and welfare. By doing this, they allow production to reach its full potential. Staff should be able to identify quickly any changes in the flock and in the birds' environment, and any physical, chemical or microbiological threats (hazards), such as damaged equipment, mouldy feed or infectious disease, and should prevent problems from escalating.

Records

Record keeping is one of the good management practices which allow the poultry manager to identify the problems and their solution. This allows managers to quickly identify any deviations from normal behaviours, such as feed consumption, growth or egg production, which are indicative of a problem that needs attention. Recording the cause and its attempted intervention is important for preventing a recurrence of the problem. Recording sheets are important to record major activities, problems identified, equipment repairs, deviations from equipment settings, and any staff issues. Records of production, growth, feed, egg weights, mortalities, treatments given, and response to treatments should be maintained. See Annex 3 for examples of record sheets.

Selection of layer chickens

Layer chicken selection begins in the hatchery and continues to the laying stage. Different selection criteria can be applied at different stages. Most of the time, selection is performed at three stages of development; namely hatching, growing and laying.

The selection criteria at the hatchery are:

- Proper body condition
- Normal gait
- Healed navel
- No abnormal behaviour, for example depression
- Chicks should also be selected based on the production merits of the parent stock (hens for laying purpose and males for fattening)

Selection of birds will continue throughout their developmental stage and the common selection criteria in chicken above eight weeks include removal of:

- Birds with growth retardation which disturbs the uniformity of the flock
- Chickens that develop gait problems
- Male chickens (from a flock of layers).

In the laying stage, birds should be selected based on their productivity. Birds which show abnormalities and chickens with emergency problems also should be culled from the flock to improve production level. Unproductive chickens are characterized by:

- Eyes becoming smaller and losing their shiny appearance
- The beak not closing properly
- The gap between the two hip bones above cloaca being smaller than two finger-widths
- The gap between the hip bone and the breast bone being less than two finger-widths.

7. Chicken health

Major routes for disease and pathogen transmission

Pinpointing the major routes of disease transmission is very important for disease control because it helps to identify the gaps and tackle them efficiently. This section discusses some major routes of disease transmission.

Transmission of disease can occur in several ways:

- Through infectious agents shed in feces transmitted indirectly or directly to other birds.
- Through droplets from respiratory or other body secretions of birds entering via the respiratory tract or eyes.
- Through vertical transmission via the reproductive tract to eggs and chicks
- Via cannibalism of dead infected animals.

Several factors are associated with disease transmission (risk factors) including:

- Movement of infected animals and materials between households or sheds, including contaminated feed or tools.
- Movement of animals and materials between villages or commercial farms. This may include bringing in infected animals from market, hence the need for quarantine procedures.
- Poor hygiene and biosecurity practices, including allowing water, feed and litter to be contaminated.
- Contact with other animals, including other livestock, wild birds and rodents that may carry pathogens.
- Poor disposal of old litter and carcasses.

Husbandry practices should be developed to reflect these routes of transmission and to reduce the risks. In an extensive village system, it is not possible to eliminate risks entirely, but good practice can reduce disease and help increase productivity.

How infectious disease spread in the flock

Pathogenic organisms are microscopic; they are not visible to the naked eye. Yet they can be found in large numbers in dust, in water droplets suspended in the air, and in fecal contamination. Enough pathogenic organisms to be an infective dose can be contained in an invisible amount of contaminated material. Such a small amount of contaminated material can be on equipment, clothing, footwear, or, even hands. By this means, the disease easily can be carried from one flock to another.

When a bird is infected with a pathogenic organism, there may or may not be obvious signs of disease. Nevertheless, that organism is reproduced in the bird then shed in great numbers from the infected bird into the environment through body excretions, including feces or moisture droplets from the respiratory system. The organisms contained in these excretions contaminate the materials in the surrounding environment, which then carry the infection to the next bird. If this bird becomes infected the cycle of transmission then continues. As the pathogenic organism passes through more and more birds, its numbers in the environment multiply rapidly. Interventions that can block or reduce transmission, such as good hygiene and biosecurity, can be effective in preventing the spread of disease within a flock or a village. As discussed in previous sections, the Ethiopian poultry sector is constrained by several diseases which are endemic in most part of the country. Therefore, this section focuses on some diseases of chicken of importance in Ethiopia.

Major diseases of poultry in Ethiopia

There are different diseases which can affect chicken. These diseases are of bacterial, viral, fungal and parasitical origin.

Viral infections

Newcastle disease

Newcastle disease is a viral disease that can spread rapidly through a flock. It is the first disease which is suspected during any disease outbreak in Ethiopia. Several different strains of virus exist and are circulating in Ethiopia, ranging from mild strains to ones which can cause 100% mortality in an unprotected flock.

Symptoms: the mild form of the virus generally causes respiratory symptoms (nasal discharge, coughing), and low mortality; but the severe one generally causes high mortality, with respiratory and nervous system problems including twisting of the head (torticollis; Figure 12), green diarrhoea and swollen heads.

Diagnosis: Mainly by serology (hemagglutination inhibition or HAI test).

Transmission: Infected birds shed virus in the feces, which is probably the main mode of transmission between birds in a scavenging environment. Virus can also be transmitted directly between birds through the air and in discharge from the nostrils, if birds are in close contact, such as in an intensive farm. The disease can also be transmitted from wild birds, chicken carcasses, and materials, such as feed, water, footwear, clothing, equipment and litter.

Prevention/control: prevention of Newcastle disease is best achieved through a vaccination program that is tailored for the local conditions and disease status. Vaccination is the only cost effective means of disease prevention in all production systems but its application in most developing countries is very limited (see vaccination section). Vaccination, coupled with good hygiene and husbandry practice, is the best way to prevent and stop the spread of Newcastle disease.

In the case of an outbreak of Newcastle disease, increased biosecurity measures should be implemented rapidly to stop spread to neighbouring farms. Sick chickens should be culled, and carcasses burnt or buried deep enough so that scavenging animals, such as dogs, cannot dig them up. Healthy birds should be isolated and closely monitored for signs of disease. Selling apparently healthy birds from a flock where Newcastle disease is present is one of the major routes of spread of disease into other areas, as birds may carry the virus for 3–5 days before showing any signs of sickness. Therefore, selling live birds should be avoided. Chicken houses should be cleaned with disinfectant, as should any tools and equipment, and bedding should be burned. It is advisable to wait for around six weeks before bringing any new chickens onto the farm.

Newcastle disease is very similar in appearance to another viral disease, Avian influenza. Avian influenza may occasionally spread from birds to humans. In any suspected cases of influenza, it is very important to take good hygiene precautions after handling sick chickens, washing hands with soap and water, and using face protection, if possible, to avoid breathing in the virus. Birds should not be eaten if there is suspicion of disease in the flock.

Figure 12: Torticollis (twisting of head) due to Newcastle disease.

CH4D findings: Newcastle disease in Ethiopia

- The CH4D found much lower levels by HAI testing than previously described.
- We believe that NDV is primarily an epidemic disease in Ethiopia with outbreaks causing high mortality, but with low levels between disease outbreaks.
- Previous studies have measured NDV in or immediately after outbreaks.
- If outbreaks can be prevented by vaccination and other controls, the impact of NDV may be decreased.

Newcastle disease in Ethiopia

Year reported	Location	Test	Seroprevalence
2005	Southern Ethiopia and Rift Valley	HAI	19.8% (n=283)
2005	Central Ethiopia	HAI	32.2% (n=180)
2007	East Shewa	HAI	11.0% (n=316)
2010	Amhara	HAI	64.1% (n=729)
2012	East Shewa	ELISA	6.0% (n=450)
CH4D	Horro (Horro Guduru Wellega)	HAI	1.0% (n=605)
	Jarso (East Haraghe)	HAI	0.5% (n=615)

Infectious bursal disease (IBD) or Gumboro

Cause: IBD is an immunosuppressive disease caused by a Birna virus 1. Virus strains can be divided in classical and variant strains. The virus is very stable and is difficult to eradicate from an infected farm. The disease is considered endemic in most part of Ethiopia.

Transmission: IBD virus is very infectious and spreads easily from bird to bird via droppings. Infected clothing and equipment may also act as a mean of transmission within and between farms.

Clinical signs: IBD infection may result in a chronic or acute form of disease. In both cases the infection targets the Bursa of Fabricius leading to the loss of B lymphocytes which are the cells that produce antibody. The main effect of

IBD is that birds become immunosuppressed and susceptible to many other infections as they produce little antibody and of course will respond poorly to vaccination. Infection in young birds of less than three weeks old typically leads to chronic infection. Acute IBD occurs in birds around 3–6 weeks of age and causes both immunosuppressive and a disseminated infection with damage throughout the body. Affected birds are listless and depressed, become pale and often huddle together. Usually, entry of IBD to a previously unaffected farm may result in a mortality rate of about 5 to 10% (but it may be as high as 60% depending on the pathogenicity of the strain involved). In subsequent infections on the same farm, mortality is lower and eventually, with successive attacks, there is no mortality noted.

Diagnosis: both serology (ELISA) and molecular methods can diagnose infection in a flock.

Treatment and control: No treatment is available for IBD. Vaccination of parent breeders and/or young chicks is the best means of control and is widely applied on most commercial farms in Ethiopia. The induction of a high maternal immunity in the progeny of vaccinated breeders, together with the vaccination of the offspring is the most effective approach to successful IBD control. Application of control in village production systems is not currently practical in Ethiopia.

CH4D findings: IBD/Gumboro

- As with Newcastle disease we found much lower levels of IBD endemic in villages than previously described.
- Previous studies had focused on Gumboro outbreaks due to importation of exotic birds into areas without disease; CH4D examined flocks when there was no evidence of an outbreak.
- Although levels are low, it suggests Gumboro persists within villages and may cause outbreaks under poor conditions such as prolonged rains or drought.

Year reported	Location	Test	Sero prevalence
2010	Amhara	AGID	51.1% (n=775)
2010	West and southwest Shewa	ELISA	76.6% (n=351)
2012	Various, centred on multiplication centres around the country	ELISA	83.1% (n=2597)
2012	Amhara	ELISA	73.5% (n=400)
2012	East Shewa	ELISA	94.0% (n=450)
2012	Debre Zeit	ELISA	82.2% (n=276)
CH4D	Horro (Horro Guduru Wellega)	ELISA	5.1% (n=604)
	Jarso (East Haraghe)	ELISA	2.1% (n=612)

Marek's disease

Marek's disease is caused by a herpesvirus that can lead to a range of pathologies. Classical Marek's disease affects the nervous system leading to paralysis typically leading to birds with a 'hurdle jumper' appearance. Infection may also lead to eye infection. Classical Marek's is most likely to be seen in low intensity production environments. In commercial production, the neoplastic or tumor-forming disease is more prevalent. This is caused by more virulent variants that have evaded older vaccines. Infection leads to transformation of lymphocytes in the blood causing them to become cancerous. This leads to lymphoma or cancer of the blood system which is usually fatal. Marek's disease virus may also persist or become latent within the chicken where it can persist for life or re-emerge to cause lymphoma. The virulent form of Marek's disease virus is easily transmitted in feather dust in commercial production leading to spread throughout flocks.

Symptoms: Gray eyes and blindness, lameness, paralysis, unthriftiness.

Transmission: The Marek's disease virus can spread via feather dander, dust, feces and saliva. Herpesviruses are robust and can persist for several months in poultry houses. Infected birds carry virus in blood for life and remain a source of infection for other birds. In intensive commercial production, the virus is easily spread by feather dander and dust as birds are kept in close proximity to each other in enclosed housing.

Diagnosis: Both the paralytic and lymphoma-forms of the disease can normally be diagnosed based on their clinical signs. Serology (ELISA) and molecular methods, such as PCR, can be used to detect carrier birds.

Prevention/Control: There is no treatment for Marek's disease. Preventive strategies include vaccination at hatchery. Affected birds should be culled to prevent transmission to other birds. A range of mainly live attenuated vaccines are usually delivered via spray in commercial hatcheries. In the USA DNA-based and live vaccines for Marek's disease virus are delivered to the developing embryo in *ovo*. Vaccination is important for commercial production but is of less value in village systems.

Figure 13: The paralysis in Marek's disease is caused by lesions of the affected nerves. The picture shows classical Marek's 'hurdle jumper' paralysis in a village chicken in Horro region 2012.

CH4D findings: Marek's disease

- Marek's disease virus has not previously been reported in village chickens in Ethiopia.
- We found 20–30% of birds were seropositive indicating the disease is endemic and circulating in villages.
- Marek's disease virus is likely to cause paralysis in village chickens but may also lead to infected carrier birds.
- It is important to cull affected birds to prevent further transmission in flocks.

Fowl pox

Fowl pox is slowly spreading viral disease affecting chickens. It is endemic in poultry in Ethiopia. The disease is mainly observed in commercial farms and among exotic chickens kept under a scavenging system.

Symptoms: Fowl pox causes raised scab-like lesions on un-feathered areas (head, mouth, legs, vent), reduced production and, in the case of the wet form of the disease, high mortality rates high due to lesions in the mouth and windpipe. These lesions in the mouth and windpipe cause impaired feed intake, increase susceptibility to secondary bacterial infections and, ultimately, death.

Transmission: Air-borne transmission of the Fowl pox virus can occur via dust or dander. The air-borne virus can enter the blood stream through the eye, skin wounds or the respiratory tract. Another possible route of transmission is via the bite of insects (including mosquitoes and other biting insects).

Prevention/Control: There is no treatment for Fowl pox. Preventive and control strategies include reducing the local insect population, reducing skin trauma from fighting, and vaccination in endemic areas. Supportive care and appropriate antibiotic therapy may provide protection from secondary bacterial complications.

Avian influenza

Avian influenza (AI) is a Type A influenza virus. Influenza is an Orthomyxovirus with an RNA genome that allows it to change, or evolve, rapidly. Influenza viruses can be carried by many birds but particularly waterfowl such as ducks. AI can be found as a High Pathogenicity (HPAI) or Low Pathogenicity (LPAI) variant. AI can be transmitted to humans (zoonotic infection).

Symptoms: AI presents as a similar disease to Newcastle disease. Birds may have respiratory distress, diarrheoa, swollen head, torcolitis and, in HPAI variants, high mortality.

Transmission: The infection is transmitted via feces and other secretions (such as respiratory secretions) between birds in a flock. Transmission into flocks can be from introduction of infected chickens, or from wild birds or other animals such as rodents.

Diagnosis: Serology. PCR or by growing the virus in embryonated eggs.

Prevention/Control: There is no treatment for AI and vaccination is extremely difficult due its variability. Affected birds should be culled and incinerated or buried along with any bedding or litter. Prevention of contact between wild birds and chickens reduces the likelihood of transmission into a flock. New birds brought into a flock should be held in quarantine to prevent potential introduction of AI.

Bacterial diseases

Infectious Coryza

Coryza is caused by the bacterium *Hemophilus paragallinarum*. It is a common problem in some parts of Ethiopia.

Symptoms: Signs of coryza include swelling of the head and wattles, nasal discharge, rattles, egg production drop and diarrhea.

Transmission: Coryza is transmitted from bird to bird through direct contact, and via contaminated feed and water. Birds which have recovered from the disease remain carriers.

Prevention/Control: Careful attention to sanitation and biosecurity is the only option for prevention and control in Ethiopia. Measures such as avoiding mixing of flocks and the use of an appropriate antibiotic may be helpful. However, birds tend to relapse once medication is withdrawn. Vaccines are not available.

Escherichia coli

Escherichia coli (*E. coli*) is a bacterium that can act as a cause of both primary and secondary bacterial disease. It is a common inhabitant of intestinal tract of birds and mammals, but some variants can cause disease in largely healthy birds whereas others can lead to secondary, or opportunistic, infections following a viral infection. The disease is not specific to a particular body system and may affect a range of organs and systems. The disease mainly occurs among immunocompromized birds, such as those with an underlying viral infection, and young chicks, but it can also affect other age groups and chickens with good health status.

Symptoms: *E. coli* infection can result in non-specific signs including ‘sick bird syndrome’, mortality, diarrhea, respiratory signs and lameness. In young birds, it may cause a systemic infection throughout the body (colibacilosis), or it may specifically target the air sacs (air saculitis) or the heart and liver with fibrinous lesions. It may also infect the reproductive tract of mature hens leading to 'egg peritonitis'.

Transmission: *E. coli* is an environmental pathogen spread by contaminated air, water, feed, and litter and from bird-to bird via feces.

Prevention/control: Prevention and control requires attention to strict sanitation in the hatchery and on the farm. This requires thorough and proper implementation of bio-security and hygienic measures.

Figure 14: Air saculitis (A), perihepatitis (B) and pericarditis (C) caused by *E. coli*

Avian salmonellosis

Cause: Avian Salmonellosis is caused by the Gram negative bacterium *Salmonella* enterica. Salmonellosis in the chicken takes two main forms. The first are two severe systemic or typhoidal diseases; Pullorum disease caused by *Salmonella* Pullorum and fowl typhoid caused by *Salmonella* Gallinarum which can result in high mortality in birds of all ages. The second form is infection by variants such as *Salmonella* Typhimurium or Enteritidis. These can cause severe disease in chicks, but can persist without disease in older birds. This latter type of Salmonella can cause disease in humans and can be transmitted from chickens to people by feces or poorly cooked meat and eggs.

Transmission: Pullorum can be transmitted vertically by infected (carrier) breeder hens through their eggs. Chicks that hatch from such infected eggs will have typical pullorum disease (white diarrhoea) and high mortality. Infected chicks can also infect other chicks via droppings.

Fowl typhoid is typically a disease of adult chickens, with high mortality and morbidity. It is transmitted horizontally through infected droppings, dead bird carcasses and infected clothing, shoes, utensils and other fomites used on the farm.

Other forms of *Salmonella* are mainly transmitted via infected droppings.

Clinical signs: In chicks, Pullorum causes a typical white diarrhoea and high mortality. Infected (carrier) adult breeders do not show clinical signs of the disease but may have internal lesions in the ovary (misshaped, dark coloured follicles).

In adult chickens, fowl typhoid causes listlessness and sulfur (yellow) coloured diarrhoea. Affected birds have generalized infection with swollen livers, spleens and kidneys, with haemorrhages in these tissues. Mortality is usually 25–60%.

Treatment and control: Treatment of pullorum disease is supportive only and will not lead to cure. Treatment is undesirable from a standpoint of eradication. It is far more practical to control the disease by elimination of infected carrier breeder hens. Blood testing of breeder chickens by the serum plate or tube agglutination test with suitable S.

Pullorum antigen will detect infected carrier birds which can then be culled. If effectively implemented, such control measures will stop the incidence of egg-transmitted pullorum disease. If hatching eggs from pullorum-free breeders are kept free from contamination from infected eggs (from infected breeders) or from contaminated equipment, Pullorum-free flocks can be developed.

The best control method for fowl typhoid is eradication of infected birds. Breeder flocks should be blood tested and typhoid carriers eliminated. Such 'test and cull' approaches have been successful in largely eliminating the disease in North America and western Europe.

Vaccination for *Salmonella* is largely practiced in developed poultry industries to reduce the risk of foodborne zoonotic infection. However, vaccination may be employed for fowl typhoid (with cross protection for Pullorum disease). The live attenuated 9R vaccine was developed 60 years ago but is still effective and has previously been used in Ethiopia.

Figure 15: Fowl typhoid (*Salmonella* Gallinarum) in a commercial layer farm.

Infection results in high morbidity and mortality. On postmortem examination birds have hepatosplenomegaly (enlargement of spleen and liver) with white spot/mottled lesions. Here there are also lesions in the ovary leading to misshaped developing eggs (University of Liverpool).

CH4D findings: Salmonellosis in Ethiopia

- We found seroprevalence rates of between 75–90% for *Salmonella*; much higher than rates of around 40% previously recorded.
- A small number of birds had very high antibody levels which may reflect carrier birds within flocks.
- Our finding suggests salmonellosis is a larger endemic problem than reported and may contribute to mortality described as fengele.
- *Salmonella* may also pose a zoonotic risk.

Mycoplasma

Cause: Four species of *Mycoplasma* may cause disease in chickens but *Mycoplasma synoviae* (MS) and *Mycoplasma gallisepticum* (MG) are the most important.

Symptoms: Avian mycoplasmosis may result in a range of symptoms though most frequently present as respiratory disease. MG infection typically leads to chronic respiratory disease whereas MS lead to a more acute disease. Both can lead to co-infection with *E. coli* which, in turn, leads to airsaculitis and a range of signs as previously described. MS can lead to infection and inflammation of joints in the legs and wings which can lead to a creamy exudate within the joints and extending into tendons. In some cases, 'breast blisters' can be formed on the breast/stern bone area of the chicken.

Transmission: Vertical transmission (via the egg) from MS-infected breeder hens is the major mode of transmission of MS. Horizontal transmission from bird to bird and by infected equipment, clothing, shoes, egg boxes and other fomites occurs with both MS and MG. Both can also be transmitted via dust in commercial production.

Diagnosis: Serological tests including agglutination or ELISA, or via molecular detection via PCR.

Prevention/control: *Mycoplasma* infections can be treated with antibiotics with variable degrees of success (for example: tetracycline, erythromycin, tylosin, tiamulin) but prevention and eradication of MS and MG following testing is more effective. Some vaccines are produced but their efficacy is limited and are used infrequently.

Figure 16: Colisepticaemia in a broiler chicken exacerbated by infection with *Mycoplasma gallisepticum*. Note: pericarditis, perihepatitis and airsacculitis

Fowl cholera

Cause: Fowl cholera is caused by the non-motile Gram negative bacterium *Pasteurella multocida*.

Transmission: Transmission of fowl cholera is mainly from bird to bird by water or feed contamination. Vermin (rats and mice) also appear to play a role in contamination of water and feed with *P. multocida*.

Clinical signs: Acute fowl cholera is a rapid septicaemic disease of high morbidity and mortality. Birds will frequently show inflammation of the spleen and liver accompanied by lesions and, at latter stages, diffuse hyperaemia, haemorrhage and inflammation. The acute disease can easily be mistaken for fowl typhoid.

In chronic forms of *P. multocida* infection the affected birds are frequently depressed and have decreased appetite. Chronic fowl cholera does not cause high mortality, although there will be an increase in deaths. A swollen face including the comb and wattle is a common feature of chronic fowl cholera.

Diagnosis: Both bacterial culture and PCR can detect *P. multocida* but further typing is needed as only avian-specific variants cause Fowl cholera, whilst strains associated with sheep and cattle rarely cause disease in avian species and vice versa.

Treatment and control: Treatment with appropriate antibiotics can be successful in halting mortality and restoring egg production but chronic carrier birds may remain in flocks of chickens after treatment meaning disease often reappears when treatment stops. As such antimicrobial therapy is often ineffective. As with *Salmonella*, removal of carrier birds from flocks and prevention of bird-to-bird spread is essential. Rodent control is also very important to prevent reintroduction of the infection. Vaccines, including killed bacterial vaccines or bacteria, are often effective as part of control strategies.

Figure 17: Swelling of facial area and green diarrhea due to chronic fowl cholera.

CH4D findings: Fowl cholera in Ethiopia

- We found seroprevalence rates of between 80–90% for Pasteurella - higher than rates of around 65% previously recorded.
- Our finding suggests Fowl cholera is a larger endemic problem than reported and the acute form may contribute to mortality described as fengele.
- Chronic infection and carriers within the flock are likely to be an issue for productivity.

Parastic diseases

Coccidiosis/*Eimeria*

Eimeria spp. are protozoan parasites of poultry which affect all breeds and age groups that cause coccidiosis. There are seven species of *Eimeria* known to infect chickens; the pathogenicity of these varies considerably, with some causing disease and affecting production, and others being largely asymptomatic. All *Eimeria* species are widely distributed in Ethiopia and may affect poultry production. The presence of *Eimeria* oocysts in the feces of chicken does not necessarily mean that infection is the direct cause of illness, but does show the flock is infected. Chickens infected with *Eimeria* but not showing clinical disease may have decreased productivity and be more susceptible to other infections. The severity of lesions with *Eimeria* species may depend on several factors, including the age of affected birds, the infective dose of the parasite and the presence of concurrent disease.

Clinical signs: Disease can be divided into three groups based on the disease caused:

Severe: *E. brunetti. E. necatrix* and *E. tenella*

Moderate: *E. acervulina, E. maxima*

Mild: *E. mitis, E. praecox*

Clinical signs:

- Infection can lead to diarrhoea or dysentery, reduced food and water intake, weight loss and visibly depressed birds.
- Coccidiosis can be life-threatening to birds as infection can lead to bloody dysentery in severe cases.
- Milder disease leads to general poor health including susceptibility to other infections and reduced productivity.

Transmission: Coccidia are transmitted via the fecal-oral route. Coccidial oocysts (eggs) are present in infected feces or the environment where feces is present (e.g. litter) and can be spread in blowing dust, boots, clothing, equipment. Birds ingest the eggs in feed, water, litter or soil and become infected. The eggs can survive up to four years in the environment.

Diagnosis: Diagnosis is usually via detection of oocysts in feces by microscopy.

Prevention/control: Control should include the improvement of housing conditions, good litter management, avoiding wet litter conditions and overcrowding. If indicated, coccidiostats (ionophoric antimicrobials) may be incorporated into the feed. Care must be taken that meat or eggs from recently treated birds do not enter the food supply chain as residues of these drugs can remain and can affect human health. Vaccines may be used but they are not always effective for all species and are expensive.

Figure 18: Bloody diarrhoea, a frequent feature of coccidiosis caused by *Eimeria tenella, Eimeria necatrix* and *Eimeria brunetti*.

These severe infections can lead to significant bird losses. Other Eimeria species lead to mild disease or carriage without apparent illness.

CH4D findings: Eimeria in Ethiopia

- We found Eimeria oocysts (eggs) in around 55% of fecal samples examined.
- All seven Eimeria species were found, in some cases more than one in an individual bird.
- Generally, the numbers of eggs were low.
- In most cases, we believe Eimeria is a problem leading to reduced productivity and increased susceptibility to other infections.

See: Luu, L., Bettridge, J., Christley, R.M., Melese, K., Blake, D., Dessie, T., Wigley, P., Desta, T.T., Hanotte, O., Kaiser, P., Terfa, Z.G., Collins, M. and Lynch, S.E. 2013. Prevalence and mo-lecular characterization of Eimeria species in Ethiopian village chickens. *BMC Veterinary Research* 9:208 DOI:10.1186/1746-6148-9-208 [open access].

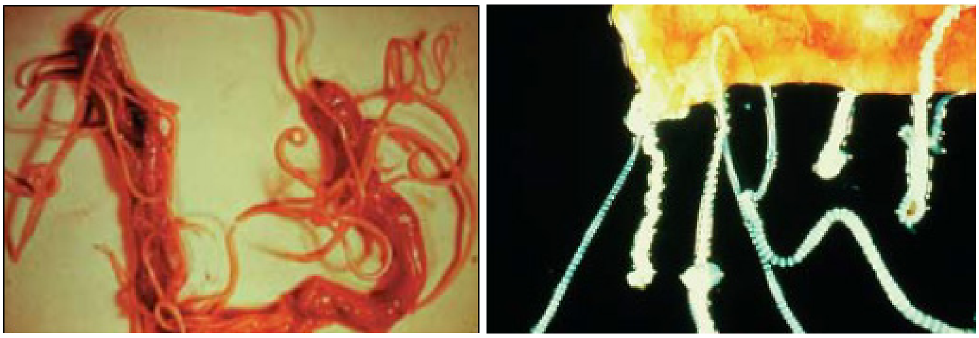
Endo and ectoparasites

There are various worms (endoparasites) and external parasites (ectoparasites) which affect chickens, the most common and important of which are described here.

Endoparasites

A number of worm species can be found in the gastrointestinal tract of chickens. Clinically important species include large roundworms, such as *Ascaridia galli* (Figure 19 A) which can measure 5–10cm in length, the caecal worm, *Heterakis gallinarum*, and multiple *Capillaria* species. Tapeworms (Figure 19 B), such as *Raillietina* species and *Davainea proglottina* found in the small intestine can also cause severe clinical disease.

Figure: 19 A) Large ascarid roundworm found primarily in the small intestine. B) Tapeworm species in the small intestine.



The gapeworm, *Syngamus* trachea, can be found in the trachea and lungs of infested birds, with high burdens causing breathing difficulty (breathing with open beak) and cyanosis.

Clinical signs: The clinical signs associated with heavy intestinal worm burden are non-specific, but include loss of weight, appetite, condition and productivity, and in some cases diarrhoea with or without passage of worms or worm segments.

Trasnmission: Worm eggs shed in the feces are directly picked up by chickens in contaminated feed or water, or with certain worm species, require an intermediate host, such as an earthworm or beetle, which can be readily eaten by the chicken when scavenging. Worm eggs can survive in temperate conditions in the environment for many months.

Diagnosis: Diagnosis is by clinical signs, the visible presence of worms and the identification of worm eggs in feces by microscopy.

Prevention/control: Strict sanitation is important for reducing the burden of worm eggs in the environment and the risk of re-infestation. Chicken housing and roosting areas, including nests should be regularly cleaned, in particular with the removal of soiled litter and feces. Food and water bowls should be cleaned daily. Alongside these important hygiene measures, birds can be treated with a suitable anthelmintic according to manufacturer's instructions and under the advice of a veterinary or poultry specialist.

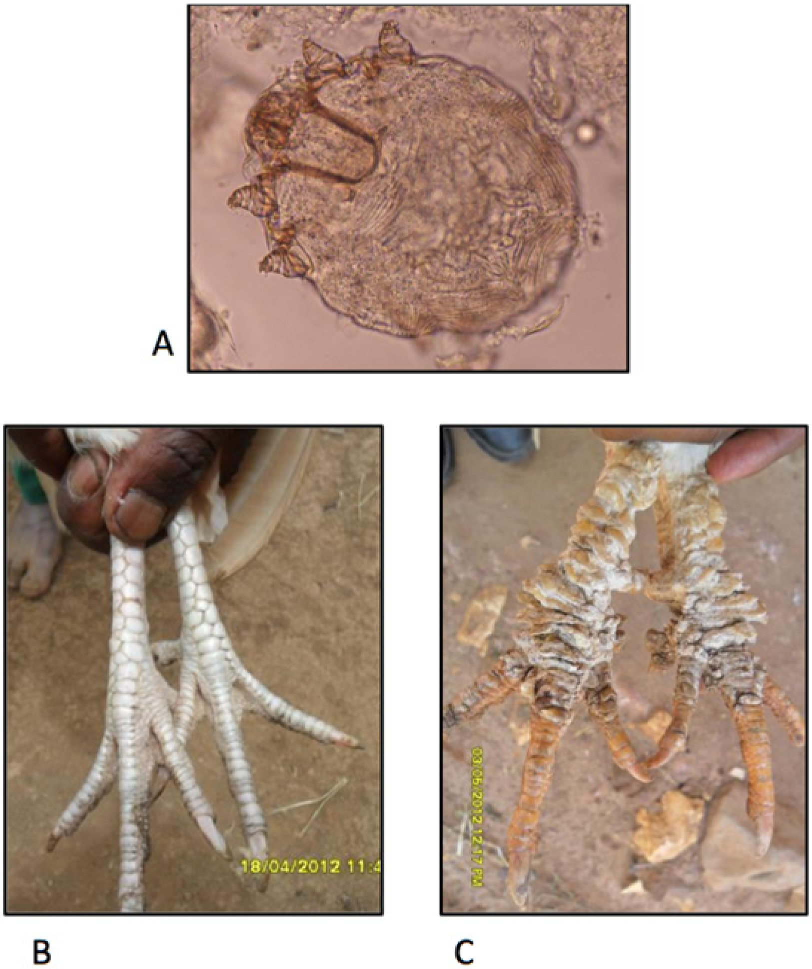
Ectoparasites

Infestation with external parasites is a common problem in village flocks. Clinical disease is often associated with heavy infestation with one or more species of ectoparasite, leading to poor health and reduced productivity. In severe cases, particularly affecting chicks and young birds, heavy ectoparasite burdens can lead to bird losses.

Scaly leg mites

Scaly leg mites (*Cnemidocoptes mutans*) are common microscopic parasites that burrow and live within the skin of the birds' feet and legs (Figure 20 A). Heavy infestation will cause raised scales, crusting and distortion of the skin (Figure 20 C), which in severe cases can lead to malformation, lameness and secondary infection of affected tissue. Scaly leg mites are transmitted by direct contact with infected birds.

Figure 20: A: Female scaly leg mite (*Cnemidocoptes mutans*) under light microscopy (400x) B) Normal appearance of legs and feet in an unaffected bird C) Severe crusting and malformation caused by chronic infestation with scaly leg mite.



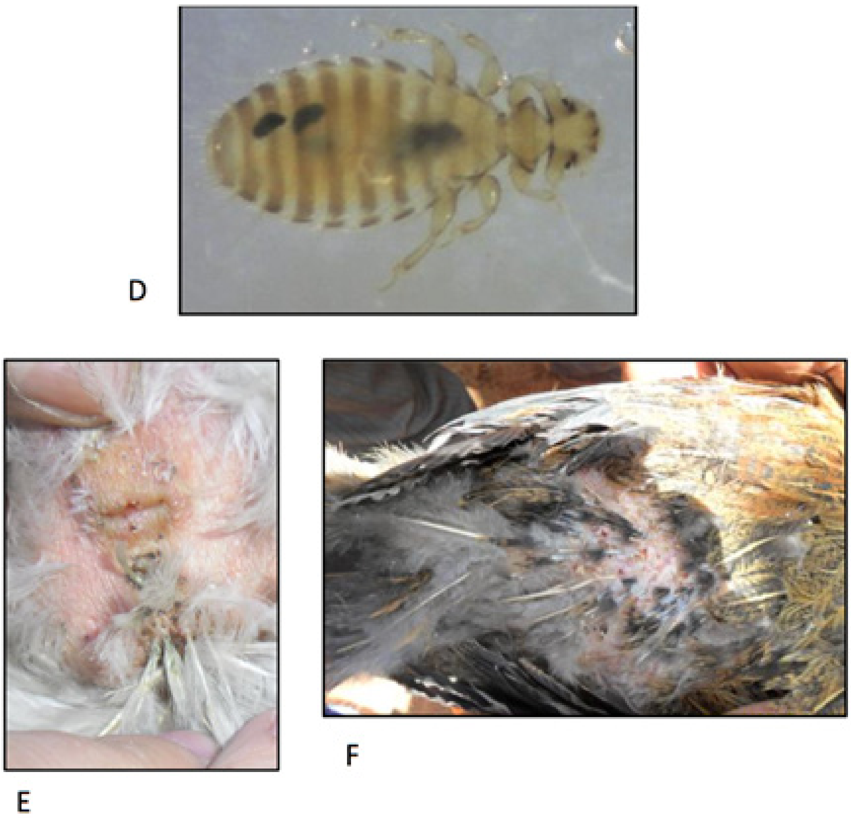
Scaly leg mite is difficult to treat. Treatment involves a combination of softening the scales, via gentle regular washing, together with application of treatment to suffocate or kill the mites, such as Vaseline, paraffin or mineral oil, or an insecticide. Any insecticide treatment must be used in accordance with the advice of a veterinary or poultry specialist and with adherence to any recommended meat and egg withdrawal periods. Any selected treatment may take several months to be effective.

Lice

Chewing lice are small, rapidly moving, yellow/brown parasites, often visible to the naked eye, which can be found over the entire skin and feathers of the bird (Figure 21 E). Lice will feed on feathers and skin, and will draw and feed on blood reached through their chewing action. All species spend their entire life on the bird, laying clusters of eggs which are visible on feathers. Species commonly found include *Menacanthus stramineus, Menacanthus cornutus, Menopon gallinae, Goniodes gigas* and *Goniocotes gallinae*.

Lice are transmitted mainly through direct contact between birds, though heavy infestations and overcrowding can lead to transmission via shared infested bedding and roosts.

Figure 21 D) The yellow body louse *Menacanthus cornutus* on light microscopy (100x). E) clusters of lice seen infesting the vent area of a hen. F) feather and skin damage typical of lice infestation.



Heavy infestation with certain species, such as *Menopon gallinae*, the wing louse, and several species of *Menacanthus* body lice (Figure 21 D) and can cause irritation, reduced productivity and occasionally anemia. Infested birds may appear restless, preening and scratching excessively, resulting in visible damage to feathers and skin (Figure 21 F)

Birds may tolerate mild or moderate louse infestation without apparent disease. However, this burden could contribute to reduced productivity in the event of concurrent disease, or act as a source of infection for more susceptible birds, such as young chicks.

Strict sanitation, avoiding overcrowded housing, providing dust or ash baths for the birds can help to treat lice, as will keeping roosting areas, nests, bedding and litter clean. Insecticidal treatments and powders licensed for the treatment of mites can be used under the guidance of a veterinary or poultry specialist.

Skin mites

There are a number of species of skin mite that infest chicken. Mites are generally very small, just visible to the naked eye, and fast moving on the skin of the bird. Species that can cause significant disease include *Ornithonyssus sylviarum*, *Ornithonyssus bursa*, which spend their entire life on the bird, and *Dermanyssus gallinae*, the red poultry mite, which lives in the housing environment and largely feeds on birds at night. All species are bloodsucking, and heavy infestation can lead to irritation, loss of condition, poor productivity, and paleness of the skin, comb and wattles due to blood loss.

Insecticidal treatments designed for the housing environment can be used in accordance with the manufacturers' instructions. Such treatments should be repeated after one week, to ensure that newly-hatched mites are also killed. Smoke can be used to fumigate roosts, nests and shelters regularly.

Ticks

Ticks are blood-sucking parasites that can be found on the skin, particularly areas with little or no feather cover, such as the face and under wings. Although small, all life stages are typically visible on the bird, and are usually a blue-brown colour.

Infested animals may lose condition and show reduced productivity. The skin, comb and wattles may become pale due to blood loss, and red spots may be seen on the skin where the ticks have fed. Birds may seem restless and irritated when roosting, as this is a time when the ticks will typically feed.

Important species include the fowl tick *Argas persicus*, a soft, brown tick which may live for up to four years without a blood meal. Adult ticks will usually blood feed at night, preferring to live in cracks and crevices in housing during the day. Nymph stages will feed continuously for a period of 2–7 days on the bird. Fowl ticks can also act as vectors for important blood parasites such as *Borrelia anserina* and *Aegyptianella pullorum*.

Poultry can also act as a transient host for nymph stages of ticks of mammalian species, such as *Amblyomma variegatum*, typically seen on cattle.

Treatment of the environment is important in tick control. Removing the bark from any timber used to construct poultry shelters and covering structures and perches with agricultural lime can help. Insecticidal treatments designed for the housing environment can be used in accordance with the manufacturers' instructions.

Fleas

The stick-tight or stick-fast flea (*Echidnophaga gallinacea*) is commonly found in warm tropical and sub-tropical climates. These small brown-black parasites are visible in clusters firmly attached to the skin, typically around the eyes, on the face, comb and wattles (Figure 22). Adult fleas feed on blood and stay firmly attached to the bird, while eggs and nymphs remain in the surrounding environment.

Figure 22: Heavy infestation with the stick-tight flea, *E. gallinacea*. Clusters of fleas can be seen attached to the featherless skin around the eyes, wattle and face.

Infested birds may be irritated and scratch at sites where fleas are attached. The skin, comb and wattles may be pale due to blood loss, and red, crusted lesions are found where fleas have previously attached. Large clusters of fleas around the eyes and nostrils may affect sight and ability to breathe. A heavy flea burden may be sufficient to kill young chicks and debilitated birds.

Birds can be treated by regular direct application of Vaseline, paraffin or petroleum jelly onto the areas where fleas are attached. Note that dead fleas may remain attached for days or weeks following treatment. Attempts to remove the firmly attached fleas without treatment is painful to the bird and could cause further damage. Hence, this should be avoided.

CH4D findings: Ecto- and endoparasites in Ethiopia

- We identified a large selection of ectoparasites in Ethiopian village poultry, in particular, chewing lice and Scaly leg mite, with 60% of birds examined infested with one or both.
- Thirteen species of ectoparasite were identified, with many known to cause morbidity and mortality in flocks, particularly in young birds.
- Stick tight fleas were common in lowland areas with warmer climates, and body lice and scaly leg mites common to all regions.
- Farmers in all the regions studied reported ectoparasites to be a significant disease concern.
- Some important nocturnal ectoparasites, such as ticks and skin mites may be a significant cause of disease, though will not be commonly seen on the bird during the daytime. These require control measures directed at the housing environment of the birds.
- Both ascarid worm and tapeworm eggs were identified on faecal examination, with ascarid eggs detected in 17% and tapeworm eggs detected in 23% of the birds sampled.

Many of the environmental treatment options for poultry housing described here will benefit the control of a number of these parasites simultaneously and should be adopted alongside treatment of affected birds where necessary. With all parasites mentioned here is important to treat all affected birds at once, as re-infection can easily occur.

Zoonotic diseases

Whilst most infectious diseases of poultry are only a problem for birds, a number of infections can be passed from the animal to people. Such diseases are called zoonoses. Avian influenza serotypes A(H5N1), A(H7N9) and A(H9N2) can be occasionally passed from chickens to people, usually through contact with live or dead poultry or their feces. Whilst these are less likely to be transmitted than human influenza serotypes, they can lead to (sometimes fatal) respiratory disease. Influenza is not transmitted via cooked chicken meat.

Salmonella, *E. coli* and another bacterial infection called *Campylobacter* (which lives in chickens but causes little disease) can all be transmitted to people via chicken droppings or can contaminate chicken meat and, in the case of *Salmonella*, eggs. All three may cause diarrhea, especially in children, and can cause invasive disease, especially in people with HIV or malaria where infection can be fatal. We call these diseases food borne zoonoses.

Reducing the risk of zoonotic infection

Most zoonotic infection is caused by handling infected birds, through their droppings or eating contaminated meat or eggs. The following steps can reduce the risk of people becoming infected:

1. Always wash hands after handling poultry, their droppings and raw poultry meat
2. Incinerate the carcasses and droppings of diseased animals
3. Avoid birds entering kitchen or food preparation areas
4. Ideally, house birds outside the house where people live, in separate accommodation
5. Make sure chicken meat and eggs are cooked thoroughly before eating.

Disease prevention

Prevention of disease in chickens should be the priority in order to minimize unnecessary costs related with both loss and treatment. The two most important aspects in the control of disease in the flock are maintaining high levels of the biosecurity and management, and, where possible and appropriate, administration of suitable vaccines for populations at risk. However, even where these measures (and others) are used, it is not possible to guarantee the health of chickens and prevent disease related losses. For example, Newcastle disease virus is endemic to Ethiopia and prevention of this disease using only biosecurity and management measures often is not effective because the disease can occur in any farm if there is even a slight biosecurity breach, including via wild birds. Similarly, vaccination may not always successfully prevent Newcastle disease due to the risk of vaccination failure, which can happen due to several different reasons. For this reason it is important to always apply vaccines as part of a broader control strategy. Successful control of disease in poultry needs to bring together vaccination with improved biosecurity, hygiene, management and animal welfare, rather than control through a single measure.

Vaccination

A vaccination program for a given area should be tailored to local conditions including the type of production, vaccine availability, vaccine cost, the burden of disease, the presence of other infections that may interfere with vaccination, and the resources available to deliver the vaccine itself.

There are three vaccination strategies that may be appropriate in different situations (Marangon et al. 2006):

a. A routine vaccination program which may take place in areas where the disease is endemic. The aim should be to reduce the effects of the disease (including mortality) and may also contribute to eradication campaigns.

b. An emergency vaccination program is an option during introduction of an infection in previously unaffected area. This may be used to reduce the impact of the disease in that area and help prevent spread to other areas.

c. A preventive vaccination program may be applied wherever a high risk of introduction and further spread of a contagious poultry disease has been identified. Prophylactic vaccination should be applied while the risk of infection exists.

Even if vaccination is an effective means of disease prevention method, its failure may happen due to a range of different factors. These factors relate both to the vaccine itself and with other related components of the vaccine and the vaccination program. These factors may be inter-related; for example, a vaccine of moderate-to-poor immunogenicity (the ability to produce and immune response) may give satisfactory results if very carefully applied, while it may have little or no effect if poorly applied.

Vaccination is said to be good if the immune response to the vaccine is protective and stable for the targeted period of time. This may be affected by the vaccine itself, the way it is stored (including the cold chain), the duration of storage, the efficacy of administration and the health of the recipient birds.

Vaccination of chickens can fail to result in protective immunity if the vaccine is not administered correctly. Routes of vaccination affect the outcome of the vaccines. For example, sometimes when mass vaccination strategies using drinking water or feed are implemented, some birds may remain unvaccinated if they fail to consume adequate water/food, and these unvaccinated individuals may cause of vaccination failure in the flock. Therefore, it is important to consider uniformity of the flock before starting a mass vaccination program. Live vaccines, which allow some lateral spread of the immunizing virus among birds, reduce the necessity for uniformity at time of application. The diluents used for live virus vaccines are very important to ensure that an adequate vaccine dose reaches the birds.

The previous exposure status of the bird to a pathogen, and passive protection, may affect the response to vaccination. Passive immunity results from passage of maternal immunity to chicks and this can influence the response to vaccination. If the breeder flock has high levels of circulating antibodies which pass to the progeny through the egg, this may interfere with the replication of live vaccines. This will decrease the immune response to the vaccine because it is not stimulating the immune system for the necessary duration or extent. Therefore, to induce higher protection levels it is necessary to accurately follow vaccination program designed for each particular area.

A vaccine may appear to fail to fully protect against a disease if the birds were infected prior to, or soon after, vaccination; however, this is considered to only be an apparent (rather than true) vaccine failure. Stress of any sort is well known to reduce disease resistance and can also be expected to affect response to vaccination.

Table: 5. Vaccination schedule

Type of vaccine	Age of bird	Route of administration
Marek's vaccine	Day 1	Subcutaneous
Newcastle disease HB1 vaccine	Day 3	Eye drop
Gumboro vaccine	Day 7 and 21	Eye drop/water
LaSota Newcastle disease vaccine	At day 27, 63, 112 and every 3 month	Eye drop/water
Fowl typhoid vaccine	At 6 and 12 weeks of age	Subcutaneous
Fowl pox vaccine	From day 70-90	Wing web

Source: DZARC, vaccination schedule

Improper vaccine administration is the most common cause of vaccine failure. Prior to application of the vaccine, the details of the whole process must be well planned. This includes ensuring that the vaccination team is correctly trained in handling and applying the vaccine. Relying on replication of a live vaccine in chickens and then horizontal transmission of the vaccine from bird to bird is not a good practice as it cannot guarantee vaccination of every bird and may also lead to the differential onset of immunity within a flock which may still lead to transmission during disease challenge. It is also a good idea to monitor vaccine efficacy in a few random birds within a flock to ensure the vaccine is working and is being administered properly.

Another reason for vaccination failure occurs when the bird is under stress during the time of vaccination. A bird being inoculated with a live vaccine is actually becoming infected with a mild form of the disease. Stress may reduce the chicken's ability to mount an effective immune response. Stress can be caused by environmental extremes (temperature, relative humidity), inadequate nutrition, parasitism and other diseases.

It is also important not to vaccinate diseased birds because the existing disease may affect their immune response. Hence, the basic principle of vaccination is to delay vaccination until the birds are healthy. This is also related with time of vaccine administration; if chickens are already incubating the disease at the time of vaccination they may still develop the disease because there may be inadequate time for antibody production to reach protective levels.

Vaccination failure can also happen when poultry farms are trying to reduce cost of vaccination by eliminating vaccines or administering partial doses. When partial doses are given, birds will not get enough vaccine to properly stimulate their immune system. The result will be decreased resistance to disease. The proper vaccine must be selected based on local conditions.

In general, vaccination failure is a major problem in many part of the world, including Ethiopia. It should be recognized that vaccines cannot reasonably be expected to protect 100% of the flock under commercial poultry conditions. The actual protection obtained will be determined by the sum of all the factors which can affect vaccine efficacy (Paul 1985; www.ncf.org.np).

Furthermore, incorrect use of vaccines can induce disease. For instance, fowl pox vaccine has mistakenly been confused with Newcastle disease vaccine and given by eye drop route, which resulted in pox lesions in the eyes with substantial losses.

Examination of chickens

It is important to observe chickens regularly to determine their health status. Observation is very important because if any disease situation is detected early it is possible to take precautionary measures in other flocks and in healthy chickens for the flock in which individual chickens are sick. Some poultry diseases are treatable if detected early. But early detection of disease problems in chickens needs a good knowledge of their phenotypic, anatomical and physiological behaviours.

The first thing that a poultry producer should do is observe the areas where chickens are kept, as contaminated environments are the major sources of most pathogens. Contamination of chicken environments can be from vermin, wild birds, human interventions, contaminated feed, water, or equipment, and flies. Litter management can be especially important in the control of flies, since wet litter and droppings are potential fly breeding areas.

After observing the environment for contaminants and risk factors for disease, the second step should be to observe the nutritional status of the chicken. Nutritional status of the chickens relates to two aspects; the first is deficiency in the amount of feed delivered and the second one is deficiency of the nutrient content of the feed. If those poultry producers who have access to nutritionally-balanced feed are facing a problem of nutritional imbalance in their chickens, it might be related to the amount of feed that they are delivering to the chickens. They should supply their chickens with the standard amount of feed (see Table 4) and ensure that there are enough feeders and drinkers for each age group.

Poultry producers also should monitor the production parameters of the flock. Changes in parameters, such as egg production, weight gain, mortality, number of sick birds, fertility, and egg hatchability, can be early indicators of infectious diseases. Knowledge of the season at which certain diseases are more likely to occur can help to identify a disease in the early stages before it becomes spread throughout the flock.

It is important to observe chickens early in the morning and before entering the house (without trying to catch birds, as this will disturb them and mask characteristics that can suggest a problem to the observant stockperson). It is very important to observe the behaviour of the chicken, physiological and anatomical conditions and the interactions between birds. Many diseases cause a change in attitude or behaviour, which can be detected by close observation.

After observation, it is very important to examine birds which exhibit abnormal behaviour. Detailed clinical examination of chickens is done after catching and restraining the bird. Restraining of birds is done by placing the bird's legs between your fingers and supporting the keel in the palm of your hand.

Figure 23: A healthy cockerel.

Examination involves a detailed observation of various parts of the body. Examination of the bird should include checking the natural opening areas (nostril, eye, vent etc.) the skeletal system, respiratory and gastrointestinal systems, skin and feathers, and the weight of the chicken.

The eyes of healthy chickens are bright and shiny, but changes to the eye are often a sign of illness. Some diseases cause discolouration, scars, accumulations and discharges in and around the eye, and sick birds will often close or partly close their eyes. Therefore, it is important to record any change observed in the eye of birds and to seek expert advice. Birds whose eyes are affected such that they cannot see will have problems feeding, and should be isolated from other birds to allow them to access feed more easily. Treatment should be based on expert advice. If the problem is only affecting the eye, and the bird is otherwise healthy, an individual bird may be treated with Tetracycline ointment in the affected eye and birds supplemented with green leaves such as kale or spinach, which are rich in vitamin A content.

It is also important to examine the nostrils, beak and oral cavity for any kind of swelling, discharge, odour, discolouration and texture of the nostril and surrounding skin. When there is a problem in the respiratory tract, abnormal sounds such as rattles or wheezing may be heard as the bird breathes. Birds may also show open mouth breathing and tail bobbing (moving the tail feathers up and down). Birds which become overheated or stressed during catching may also show these signs, so birds should be allowed to rest in a cool place for 10 minutes after catching if respiratory problems are suspected, in order to differentiate disease from stress.

If several birds are showing signs of respiratory disease it is important to report this to veterinary clinics or another professional, as some respiratory diseases, such as avian influenza, are zoonotic and can cause human disease. It is not advisable to take treatment measures for such conditions without consulting poultry health professionals.

Examination of birds should also include the skeletal system, especially if nutritional problems are suspected. Wings should be examined for swelling, fractures, discolouration of feathers or skin, bone deformation, plumage quality, wing paralysis and skin changes. The legs are examined similarly to the wings except that, in most birds, no feathers are present on the lower leg. Plumage also can be examined for damage, colour changes, condition, evidence of soiling, frayed feathers, new feathers and parasite damage.

The vent should be examined last during examination of the bird. This is the area in which most evidence of gastrointestinal problems can be seen, including a vent heavily soiled by fecal material, which may indicate gastrointestinal disease. It is important to check for parasites, soiling of the feathers, evidence of laying eggs, diarrhoea, swelling, reddening, blood from the vent, prolapse, or other abnormalities. It is very important to take information on dropping colour, its consistency and odor, as some infections cause distinctive changes in droppings, which can help experts in the diagnosis process (see disease section for further information).

Basic clinical measurements:

- Normal heart rate: 250 to 300 beats per minute
- Normal body temperature: 40.6 to 43.0 ^{o}C

8. Biosecurity

(adapted from: www.ncf.org.np; www.aitoolkit.org; www.outbreak.gov.au)

Biosecurity consists of a set of management practices which, when followed, collectively reduce the potential for the transmission and spread of disease-causing organisms onto and between farms, animals and humans. Biosecurity is the normal way to avoid unnecessary contact between animals and microbes, and between infected animals and healthy ones. Biosecurity also applies to public health measures that will reduce contact between animals and humans.

Biosecurity plays an essential role in prevention of transmission of pathogens causing clinical and subclinical infection in a flock.

Biosecurity measures can be designed for, and implemented, on small-scale production systems in rural areas. Ideally, bio-security requires periodic risk assessment and the measures used in an area may need to be modified as local circumstances change. Many risk factors for infection are related to the farm, movement of animals on and off the farm, and general management practices.

Isolation, traffic control and sanitation are the three biosecurity measures which should be implemented in all production system to minimize the risk of introduction of disease to a flock. For this to be effective, training is needed to provide knowledge to poultry producers about the range of measures that should be undertaken for proper biosecurity implementation on the farms. On-farm biosecurity training is an on-going requirement with the need to update farm personnel and train new personnel at regular intervals.

Traffic control in poultry production

Controlling the 'traffic' of people and animals in and around poultry production areas can help limit disease and improve biosecurity. This can be achieved by ensuring:

- Increased standards of the facilities which allow farmers to limit and control access to poultry production areas by people, livestock, wild birds and other animals.
- The production area has a perimeter fence or otherwise well-defined boundary, establishing a clearly defined biosecurity zone.
- The main entrance to the production area is capable of being closed to traffic and displaying appropriate signage including Biosecure Area, no entry unless authorized or similar wording.
- Entry to the sheds is only be made through entrances with a foot bath containing a suitable disinfectant (see disinfectants in foot bath).
- Dead bird disposal methods conform to appropriate procedures and standards.
- Trees and shrubs are selected to minimize wild bird attraction.
- The area around sheds are kept free from debris and vegetation and mown regularly to prevent rodents from hiding in it.

- The production area is adequately drained to prevent accumulation and stagnation of water likely to attract water fowl, especially in the areas around sheds.
- An appropriate vermin control plan is developed and implemented in consultation with people experienced in vermin control.
- People entering the farm wear appropriate protective clothing and, boots/spare shoes. Where appropriate, these should be changed between sheds. These clothes/boots should only be worn within designated areas and should never be worn off-site.

Isolation includes:

- Quarantine of imported birds for three weeks (or at least two weeks if in a low risk situation). During this time, it is very important to observe for any signs of illness.
- Sick birds (or groups of birds which include some sick individuals) being kept in isolation. It is important to avoid placing new birds, including baby chicks, in contact with droppings, feathers, dust and debris left over from previous flocks. Some disease-causing organisms die quickly; others may survive for long periods. Hence, thorough cleaning and disinfection of production areas between flocks is important.
- Different age and sex groups being kept separately to minimize the risk of disease spread.

New birds represent a great risk to biosecurity because their disease status is usually unknown. These birds may have an infection or be susceptible to an infection that is already present in birds that appear normal (healthy carriers) in a farm. While an all-in/all-out management system is not feasible for many farms, it is often possible to maintain a separate pen or place to isolate and quarantine all new, in-coming stock from the resident population.

Sanitation measures:

- Disinfecting footwear at each site to reduce the dose of organisms on boots is an important part of biosecurity. Farmers can use different disinfectants in this process, the most common ones are 'formaldehyde' (which is expensive in Ethiopia and can damage people's health), 'biosafe' which is relatively cheaper but still not affordable in small-scale production system and 'Berekina' which is cheap and easily available in small shops in small towns
- Footbaths must be inspected daily (e.g. for excessive organic matter) and the contents replaced as required to achieve an adequate concentration of suitable disinfectant following the manufacturer's recommendations.
- It is advisable to always wash hands using soap and water after handling birds in isolation or birds of different groups.
- It is mandatory to disinfect drinkers and feeders on a daily basis. Plan periodic clean-out, clean-up and disinfection of houses and equipment, at least once in each production cycle. For this soaps like 'Ajax' and 'Berekina' or other disinfectants can be used.
- Drying and sunlight (UV light) are very effective in killing many disease-causing organisms.
- Feed spills must be cleaned up as soon as practicable. Feed attracts birds and rodents to the production area.
- Grass on and around the production area must be kept cut; long grass attracts rodents and favours the survival of viruses and bacteria.
- Routine maintenance should be conducted, where possible, between batches and prior to final disinfection, where a batch system is practiced.
- Tools taken into the production area must be cleaned before entry into sheds and must be free of dust and organic matter.
- In large poultry operations, all-in/all-out management styles allow simultaneous depopulation of facilities between flocks and allow time for periodic clean-up and disinfection to break the cycle of disease.

Biosecurity measures for high disease risk (high risk biosecurity)

Different types of biosecurity measures can be implemented depending on the level of risk associated with the production system. In this section, levels of biosecurity are briefly reviewed.

High-risk biosecurity measures are measures which are implemented during an outbreak of an emergency disease or serious endemic disease. During conditions like this, ideally every farm should cease movement of birds immediately. But this kind of measure might not be implemented in Ethiopia due to the economics of production. Therefore, it is important to consult a veterinarian prior to implementation of any measures in diseased flocks. In addition, all gates should be locked to limit movement of people and equipment on and off the farms, and materials for cleaning and disinfection of equipment, vehicles and people should be made available where movement on and off the production area is unavoidable.

No visitors should enter the production area unless absolutely essential. Routine repairs and maintenance should be avoided; only emergency work should be carried out. In the case of essential visits, a complete change of clothes, footwear, perhaps including hair covering and breathing protection, is required. It is also important to keep used clothing and other used personal protection equipment on the property. No birds or litter should be moved on or off properties until disease status is clarified.

Biosecurity in live-bird open markets

Poultry markets in Ethiopia are mainly open markets. Open markets provide conditions for the disease transmission between birds and from birds to people. There is often poor hygiene at live markets, with a lack of cleaning and disinfection of facilities, equipment and personal protective garments.

Open markets are biosecurity risk areas, as sick or disease-incubating birds can transmit infection to other birds and/or humans.

Figure 24: Local poultry marketing system.

The following biosecurity measures should be undertaken at live-bird markets:

- Educate live market workers on personal hygiene improvement through cleaning and disinfection.
- Chickens should be in a good condition before transporting to an open market.
- Purchasing of chickens door to door should be avoided.
- A separation strategy must be followed for unsold chickens, especially if birds in the market are from different locations.

Annexes

Annex 1. Entry conditions for visitors to (semi-)intensive farms

- Visitors must not keep poultry, caged birds or pigs at home.
- Visitors must not have been in contact with any avian species or untreated poultry manure on the same day, unless a full head-to-toe shower and a change of protective clothing have been carried out.
- Visitors must wear protective clothing provided.
- Visitors must wear protective boots.
- Visitors must sanitize boots in the footbath provided on entering production area/shed, or change into a separate pair of shed boots.
- Visitors must sanitize hands before entering sheds.

Annex 2. Collection of dead birds

1. Dead birds must be collected regularly from the property. Frequency of collection will be determined by factors such as size of chicken and climatic conditions.
2. Collection area must be as far as practical away from the production area so that there is low risk of contamination of the farm.
3. All containers used for collecting dead birds must be washed and disinfected before returning them to the production area.

Annex 3 Record sheet for commercial layer farm

Breed ____________ Date of hatch ___________ Point of lay (date) ___________House number ____________ Pen number _______________________ Name of data collector __________________________Signature of data collector _______

Age in week (currently)	

				Feed		Egg production							
Monday up Sunday	Date	Female	Male	Total No of birds	Feed given	Feed refusal	Morning		Afternoon		Total	Mortality	Remark
							1st	2nd	1st	2nd			
					Total								

Av.wt/wk F_______ M________	

				Feed		Egg production							
Monday up Sunday	Date	Female	Male	Total No of birds	Feed given	Feed refusal	Morning		Afternoon		Total	Mortality	Remark
							1st	2nd	1st	2nd			
Av.wt/wk F_______ Male________					Total								

Age in week (currently)	

Mo = Monday, Tu = Tuesday, We = Wednesday, Th = Thursday, Fr = Friday, Sa = Saturday and Su = Sunday.

Annex 4. Relevant contacts for poultry producers

1. National Veterinary Institute (NVI)

    Tel.: +251 114 33 84 11

    Email: nvi-rt@telecom.net.et

    Debre Zeit, Ethiopia

2. Debre Zeit Agricultural Research Centre

    Tel.: +251 114 33 85 55

    Email: DZARC@ethionet.et

    Debre Zeit, Ethiopia

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