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PRO-POOR HPAI RISK REDUCTION

Qualitative Risk Assessments (Release and Exposure Assessments) for the Risk of introduction of Highly Pathogenic Avian Influenza (H5N1) Virus into Ethiopia Via Wild Birds Trade Transiting in the Country and for the Risk of Transmission of Highly Pathogenic Avian Influenza (H5N1) Virus between Large Scale Commercial and Small Scale Commercial Poultry Farms in Ethiopia

Bewket Siraw

Hassen Chaka

With contributions from:

Bernard Bett
Raphaëlle Métras
Solenne Costard

Africa/Indonesia Team Working Paper No.21

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Authors

Bewket Siraw works for Gafat Endowment, Amhara Region, Ethiopia; Hassen Chaka works for National Animal Health Diagnostic and Investigation Centre, Sebeta, Ethiopia; Bett Bernard works for ILRI, Nairobi, Kenya, and Solenne Costard and Raphaëlle Métras work jointly for the Royal Veterinary College, London, UK and ILRI, Nairobi, Kenya.

Disclaimer

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More information

For more information about the project please refer to www.hpai-research.net.

1 Abbreviations

AI	Avian Influenza
BIP	Border Inspection Point
CIRAD	Agricultural Research Centre for International Development
DFID	Department For International Development
DOC	Day Old Chick
EFSA	European Food Safety Authority
HPAI	Highly Pathogenic Avian Influenza
ILRI	International Livestock Research Institute
LSCF	Large scale Commercial Farm
OIE	Office International De Epizootics
SSCF	Small Scale Commercial Farm

2 Glossary and Definitions

Poultry production systems in Ethiopia and their major features (adapted from Dawit et al., 2008):

Backyard poultry production
This system is a low input (scavenging is almost the only source of diet, low input of veterinary services), low output system with minimal level of bio-security, high off-take rates and high levels of mortality. Here, there is little or no input for housing, feeding or health care. As such it does not involve investments beyond the cost of the foundation stock, a few handfuls of local grains, and possibly simple night shades, mostly night time housing in the family dwellings. Poultry are kept in close proximity to the human population. Mostly indigenous chickens are kept although some hybrid and exotic breeds may be kept under this system. The few exotic breeds kept under this system have mainly been acquired through government extension programs.

Small-scale commercial poultry production
In this system, modest flock sizes usually range between 50 and 500. Exotic breeds are mainly kept for commercial purposes. Most small-scale poultry farms are located around Debre Zeit town in Oromia region and Addis Ababa. This production system is characterized by medium level of feed, water and veterinary service inputs and minimal to low bio-security. Most small-scale poultry farms obtain their feed and foundation stock from large-scale commercial farms (Genesis or Alema).

Large-scale commercial poultry production
It is a highly intensive production system that involves, on average, greater or equal to 10,000 birds kept under indoor conditions with a medium to high bio-security level. This system heavily depends on imported exotic breeds that require intensive inputs such as feed, housing, health, and modern management system. It is estimated that this sector accounts for nearly 2% of the national poultry population. This system is characterized by higher level of productivity where poultry production is entirely market-oriented to meet the large poultry demand in major cities. According to Bush (2006) the existence of better bio-security practices has possibly reduced chick mortality rates to merely 5%. In Ethiopia, the commercial poultry farms are found mostly in Debre Zeit areas. The main ones located there include ELFORA, Alema, and Genesis farms.

Border Inspection point/post (BIP): means any airport, or any port, railway station or road check-point open to international trade of commodities, where import veterinary inspections can be performed.

Transit country: any country through which commodities destined for an importing country are transported or in which a stopover is made at a border post.

International veterinary certificate: certificate, describing the animal health and/or public health requirements which are fulfilled by the exported commodities.

Live poultry: domestic poultry including Day old chicks, pullets and cockerels

Resident birds: wild birds resident in Ethiopia which may move across the country

Compost/manure: poultry faeces and bedding collected from either the layer or broiler farms and have undergone fermentative processes either in a pit or pile.

Wild bird: Free-living bird which is not kept on any holding

Release assessment: The process of describing the biological pathway(s) necessary for an importation activity to “release” (that is, introduce) pathogenic agents into a particular environment, and estimating the probability either qualitatively or quantitatively, of that complete process occurring (OIE, 2004). Release in the context of this study assesses all the biological pathways that will lead to the "importation" of H5N1 HPAIV to BIP (Air) of Ethiopia through traded transiting wild birds. This assessment will give an overall probability (measured qualitatively) of the disease being introduced into the country.

Exposure Assessment: The process of describing the biological pathway(s) necessary for exposure of animals and humans in the importing country to the hazard (in this case the pathogenic agent) released from a given risk source, and estimating the probability of the exposure(s) occurring, either qualitatively or quantitatively (OIE, 2004). Exposure in the context of this study assesses biological pathways that will lead to the exposure of poultry in Ethiopia to H5N1 HPAI virus released from wild birds traded transiting at the airport or other BIP of Ethiopia. This assessment will estimate the probability of domestic poultry population being exposed to the disease once the disease has been introduced to the BIP.

Consequence /transmission assessment: The process of describing the relationship between specified exposures to a biological agent and the consequences of these exposures. The consequence assessment describes the consequences of a given exposure and estimates the probability of them occurring (OIE, 2004). Consequence in the context of this study determines the risk of transmission of H5N1 HPAI virus between large scale and small scale commercial poultry farms following the exposure of either of these sectors to the disease.

3 Executive Summary

As part of the DFID funded Pro-poor HPAI Risk Reduction Project, a qualitative risk assessment was conducted for risk questions, agreed during stakeholders workshop in September, 2008, related to introduction of highly pathogenic avian influenza (H5N1) virus into Ethiopia via wild birds trade transiting in the country and the transmission of the virus between large scale commercial and small scale commercial poultry farms.

The principal risk questions were:

> ***Risk question 1: Release assessment****: What is the risk of introduction of HPAI (H5N1) via legal and illegal trade of wild birds transiting in Ethiopia?*
>
> ***Risk question 2: Exposure assessment:*** *What is the probability that domestic poultry in Ethiopia become infected by H5N1 HPAIV after the release of the virus by an infected traded wild bird transiting in Ethiopia?*
>
> ***Risk question 3: Consequence/transmission assessment:*** *What is the risk of transmission of HPAI (H5N1) between large commercial poultry farms and small scale commercial poultry farms?*

Methodology

For this qualitative risk assessment, the OIE framework was followed. With respect to the identified risk questions, the risk assessment team together with the workshop participants identified the risk pathways and data needs and sources for each step of the pathways.

Data for the parameters was obtained from different sources of information: interview with cargo supervisor, representing persons involved in handling wild bird trade transits at the airport; information from custom posts; expert opinions and scientific literature. Expert opinion was collected through questionnaire distributed to key professionals working in poultry farms, research centers and international institutions (ILRI). All locally available data and published papers accessed on the subject were reviewed by the authors.

To qualitatively estimate the risks associated with each pathway, the risk assessment team applied six probability categories, adapted from the EFSA HPAI risk assessment report 2006: Negligible, Very Low, Low, Medium, High and Very High. The level of uncertainty was also indicated in each step of a pathway using the following three categories: Low, Medium and High. For each biological pathway, a risk estimate was obtained by combining risk categories according to a pre-defined combination matrix.

Result and discussion

For risk questions 1 and 2, the relevant conclusions drawn from this assessment are that the probability of release of H5N1 HPAIV into Ethiopia through transiting wild birds (via air) is very low (medium uncertainty) and the risk of domestic poultry in Ethiopia becoming infected by H5N1 HPAIV after the release of the virus by an infected wild bird on trade transit is medium with high uncertainty. The global risk estimate for the introduction of H5N1 HPAI in the poultry population in Ethiopia as a result of the introduction of the hazard through trade transiting wild birds (via air) is

therefore assessed to be **very low with high uncertainty** , which means that this occurrence is very rare but cannot be excluded.

It is evident that the overall risk is very low as a result of the very low risk of introduction of the pathogen to Ethiopia through the BIPs. The assessment revealed that about 11 different species of wild birds from five different African countries (Republic of South Africa, Democratic Republic of Congo, Senegal, Tanzania and Ivory Coast), among which Ivory Coast was reported to have been infected. Nevertheless, all the consignments carry health certificate. It is, however, important to note that if an infected wild bird on trade transit happens to reach at BIP, it can pass undetected for there is no reliable veterinary check at the airport and the virus can escape out of BIP easily for there are no appropriate holding facilities that can assure biocontainment of the virus. These steps in the release risk pathways should be considered as being critical control points where appropriate intervention measures can be applied. For the exposure risk pathways, resident wild birds and staff handling transiting birds contaminated with H5N1 HPAI and rearing poultry are important risk factors for the spread to the disease to the poultry population.

As described in the glossary and definitions section, consequence assessment in the context of this study determines the risk of transmission of H5N1 HPAI virus between large scale and small scale commercial poultry farms following the exposure of either of these sectors to the disease. In this assessment it was revealed that the most important risk factors in the transmission of HPAI (H5N1) from LSCF to SSCF are staff movement, sales of live poultry, equipment exchange and to lesser extent visitors. For the transmission of HPAI (H5N1) from small scale to large scale poultry farms, the most important risk factors are staff movement, equipment exchange and visitors.

Recommendations

Critical control points were identified, for which actions to be taken in order to reduce the risks of introduction, subsequent exposure of poultry population and transmission of HPAIV H5N1 between LSCF and SSCF are suggested below:

A. To reduce the risk of introduction of H5N1 HPAI and subsequent exposure of the poultry population through transiting wild birds, enforcement of the following measures would make a large contribution:

- ♠ Ethiopia should require transit permit from wild bird exporting countries. The permit should ensure that the exporting country must be a member of the OIE and the consignment is accompanied by an animal health certificate (valid for 5 days only), signed by an official veterinarian. This certificate should guarantee adequate holding and examination procedures for birds of the consignment.

- ♠ Ethiopia should establish a unit responsible for the checking and inspection of wild birds transiting the BIP. Alternatively, the Bole International Airport Animal and Animal Products Quarantine and Inspection Units could be mandated to carry out this inspection in addition to the other responsibilities they have.

- ♠ The holding facility for keeping the transiting wild birds in the airport should be refurbished: resident wild birds and rodents should not have access the waiting ground, adequate sick bay and disposal pits should be built.

- ♠ Wild bird transit attendants should be trained on safe handling of transit birds and provided with sufficient protective clothing that should always be used within the facility. The facility should also introduce biosecurity practices such as discouraging the use of street clothes while handling birds, washing hands before and after work and disinfecting equipment used in the facility periodically.

B. Results of the risk assessment revealed that movement of staff; sales of live poultry, equipment exchange and visitors are important risk factors in the transmission of the virus. To reduce the risk of transmission of H5N1 HPAI from LSCF to SSCF and vice versa, maintaining good level of biosecurity and sanitary measures with particular emphasis to the risk factors identified are important.

Finally, the study team would like to bring to the attention of the reader that many of the risk estimates are associated with medium and high levels of uncertainties. This indicates that there are significant knowledge gaps. Therefore the risk estimates need to be interpreted with caution and targeted studies to fill some of the relevant knowledge gaps are required. The areas in particular need of data are: susceptibility information for the eight out of eleven species involved in trade transit; surveillance and certification procedures in the exporting countries; species, number and susceptibility of resident wild birds and contact rate with poultry. Regarding transmission between large scale and small scale commercial farms, investigations are required to understand the reasons for not reporting and complying with regulations, and factors discouraging commercial poultry farms from maintaining the required biosecurity standards in the farms.

4 Introduction

4.1. Context

Since the panzootic of highly pathogenic avian influenza (HPAI) caused by viruses of the H5N1 sub-type occurred in Asia in 2003 and early 2004, the disease has spread to Europe and North and West Africa. It has caused high mortalities in affected poultry flocks, with additional losses due to culling. Farmers and traders have suffered loss of income as a result of market disruption caused by control activities and also market shocks due to consumer concerns for human health. A further concern is that the widespread circulation of the avian influenza virus increases the chances of mutation into a form that could pass from human to human, which could result in a new human flue pandemic of unknown magnitude (Ferguson et al., 2004)

The number of countries having been affected by the disease in Africa by March 2009 has reached eleven. These countries include Benin, Burkina Faso, Cameroon, Djibouti, Egypt, Ghana, Ivory Coast, Niger, Nigeria, Sudan and Togo (CIRAD, 2009). So far, there has not been an outbreak of the disease in Ethiopia, either in wild or domestic bird populations. Ethiopia, along with other east African Rift Valley nations, such as Kenya, Tanzania and Uganda are, however, considered at risk of being infected because millions of migratory birds flock into these countries during the European winter season (Goutard and Magalhaes, 2006). Moreover two of Ethiopia's neighboring countries (Sudan and Djibouti) reported outbreaks of HPAI H5N1 in April and May 2006 respectively (OIE, 2009).

HPAI control measures have so far included prevention and eradication measures in poultry populations. More than 175 million birds have been culled in Southeast Asia alone (Dawit Alemu et al., 2008). Until now, little emphasis has been placed on assessing the efficacy of risk reduction measures, including their effects on the livelihoods of smallholder farmers and their families. In order to improve local and global capacity for evidence-based decision making on the control of HPAI (and other diseases with epidemic potential), which inevitably has major social and economic impacts, the UK Department for International Development (DFID) has agreed to fund a collaborative, multidisciplinary HPAI research project in Southeast Asia and Africa. This objective is being addressed through a number of interrelated research activities, including qualitative risk assessments.

The definition of the risk questions that were addressed in the qualitative risk assessment of the introduction and spread of HPAI H5N1 in Ethiopia were defined in a consultative workshop that was held at ILRI, Addis Ababa in September 28-29, 20008. The workshop brought together different stakeholders, both in public and private sectors. A review of the previous risk assessment studies indicated that the following topics had been addressed:

1. qualitative risk assessment of introduction and dissemination of the HPAI H_5N_1 virus in Ethiopia by migratory wild birds to backyard poultry production system (Goutard, et al., 2007);

2. quantitative and qualitative risk assessment of introduction of the virus via commercial imports of DOC and commercial trades of poultry (Magalhaes et al., 2007; Olive et al, 2007).

These studies mainly dealt with the introduction/release and exposure aspects of risk assessment. The risk of spread of the disease via government multiplication centers, within and between villages and via movement of trades between markets and villages were also assessed qualitatively. This had substantial influence on the definition of the risk question and pathways during the workshop.

After reviewing what had been done so far, the workshop stakeholders agreed on three risk questions for this activity (see section 5 of this report).

4.2. Approach

This study used the framework that has been recommended by the World Organization for Animal Health (OIE, 2004) for risk analysis. The framework outlines four key steps that should be covered systematically. These are:

- Release assessment (probability of release from the source)
- Exposure assessment (probability of exposure to the hazard)
- Consequence assessment (biological consequences such as incidence and severity, economic consequences, etc.)
- Risk estimation (which consists of combining the release, exposure and consequence probabilities).

In this analysis, the events that were considered as contributing to the release, exposure and the consequence pathways were specified and broken down into several stages, with each stage being assigned a conditional probability. The overall probability of a given pathway was then arrived at by combining the probabilities of the various stages defined as indicated in Fig 4- 1.

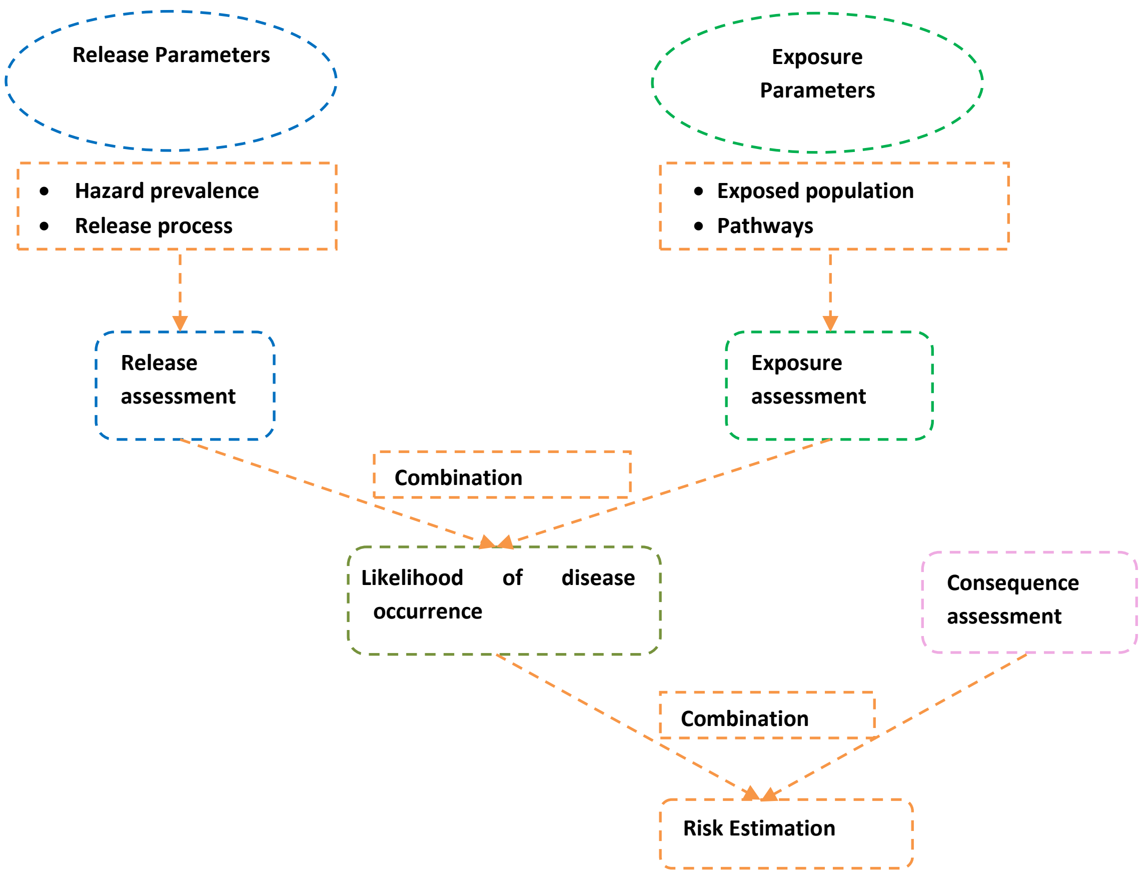

Figure 4-1 General scheme of the assessment (OIE method)

A qualitative risk assessment was conducted because there was not sufficient time and resources to collect data that would have been required for quantitative risk analysis. Three different approaches were used to collect the data. The first one utilized a simple questionnaire which was administered to the airport cargo supervisor representing the staff handling wild bird transit. The second involved the use of a checklist of questions for interviewing staff working at the border inspection posts, while the third involved the use of an expert opinion questionnaire that was distributed to key professionals working in poultry farms, research centers and international institutions (ILRI). These professionals were expected to fill out the questionnaire and post it back to the first author. Responses were, however, obtained only from the commercial poultry farms.

In qualitative risk assessment the probabilities are assessed and described textually. The categories of risk used in this study ranged from negligible through to very high (Table 4.1).

Table 4-1: Interpretation of probability categories used in this risk assessment (adapted from EFSA, 2006)

Probability category	Interpretation
Negligible	Event is so rare that does not merit to be considered
Very low	Event is very rare but cannot be excluded
Low	Event is rare but does occur
Medium	Event occurs regularly
High	Event occurs very often
Very high	Even occurs almost at certainly

Each risk estimate is associated with some level of uncertainty. This is indicated in the results of this risk assessment. It was not always possible to differentiate variability from uncertainty; both of these parameters were therefore captured as uncertainty. The terms and criteria for usage are listed in Table 4.2.

Table 4-2 Qualitative categories for expressing uncertainty in relation to qualitative risk estimates.

Uncertainty category	Interpretation
Low	There are solid and complete data available; strong evidence is provided in multiple references; authors report similar conclusions.
Medium	There are some but no complete data available; evidence is provided in small number of references; authors report conclusions that vary from one another. Facts that can be seen / touched, for instance the presence or absence of building, facility, etc
High	There are scarce or no data available; evidence is not provided in references but rather in unpublished reports or based on personal communication; authors report conclusions that vary considerably between them.

For each biological pathway, a risk estimate is obtained by combining parameters/ risk categories according to the combination matrix presented in Table 4.3

Table 4-3 Risk categories combination matrix

		Parameter 2 /Exposure risk category					
Parameter 1 / Release risk category		**Negligible**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Very High	N	VL	L	M	H	VH
	High	N	VL	L	M	H	H
	Medium	N	VL	VL	L	M	M
	Low	N	N	VL	VL	L	L
	Very Low	N	N	VL	VL	VL	VL
	Negligible	N	N	N	N	N	N

For combination of the combined release and exposure risk estimate with the consequence (transmission) risk estimate, we used the combination matrix shown in Table 4.4.

Table 4-4 Risk categories combination matrix

		Consequence/transmission risk category					
Combined release and exposure risk category		**Negligible**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Very High	N	VL	L	M	H	VH
	High	N	VL	L	M	H	VH
	Medium	N	VL	L	M	H	VH
	Low	N	VL	VL	L	M	H
	Very Low	N	N	VL	VL	L	M
	Negligible	N	N	N	N	N	N

Adapted from: Cristobal Zepeda (Centers for Epidemiology and Animal Health USDA-APHIS /Animal Population Health Institute, Colorado State University).

5 Risk questions

The risk questions were formulated on the basis of the conclusions of the stakeholders' meeting held in September 28-29, 2008; and they were made as specific as possible in order to focus the efforts of the Risk Assessment Team.

The following risk questions were defined:

5.1. Risk question 1: Release Assessment

What is the risk of introduction of HPAI (H5N1) via legal and illegal trade of wild birds transiting in Ethiopia?

5.2. Risk question 2: Exposure assessment

What is the probability that domestic poultry in Ethiopia become infected by H5N1 HPAIV after the release of the virus by an infected traded wild bird transiting in Ethiopia?

5.3. Risk question 3: Consequence/transmission assessment

What is the risk of transmission of HPAI (H5N1) between large commercial poultry farms and small scale commercial poultry farms?

6 Risk pathways

6.1. Overview

Risk pathways describe series of events that should occur so that the hazard under consideration results in the unwanted outcome specified. In this risk assessment, the hazard is defined as the pathogenic organism H5N1 HPAIV. The unwanted outcomes are defined in the risk questions. To assess the risk, the probability that each stage in the risk pathway will occur needs to be considered separately.

Release Pathways

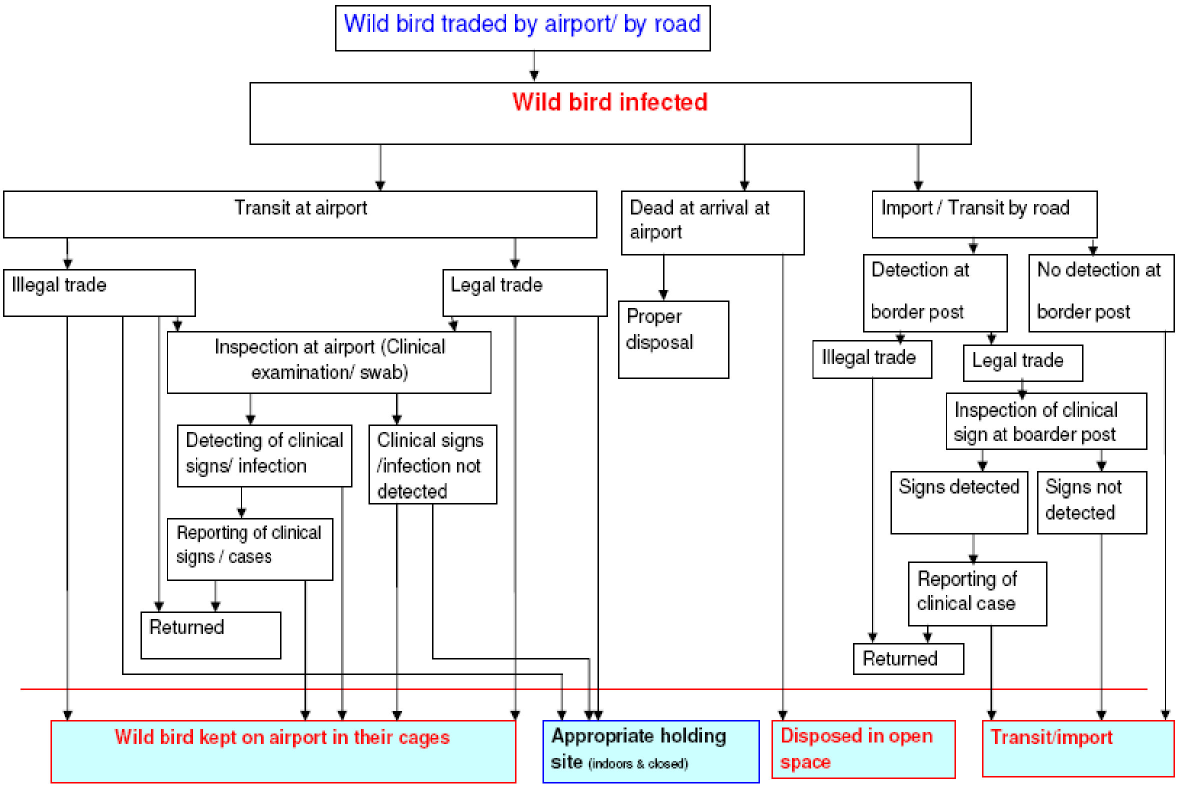

Figure 6-1 Diagram of release pathways of HPAI H5N1 into Ethiopia through wild bird trade transiting in Ethiopia

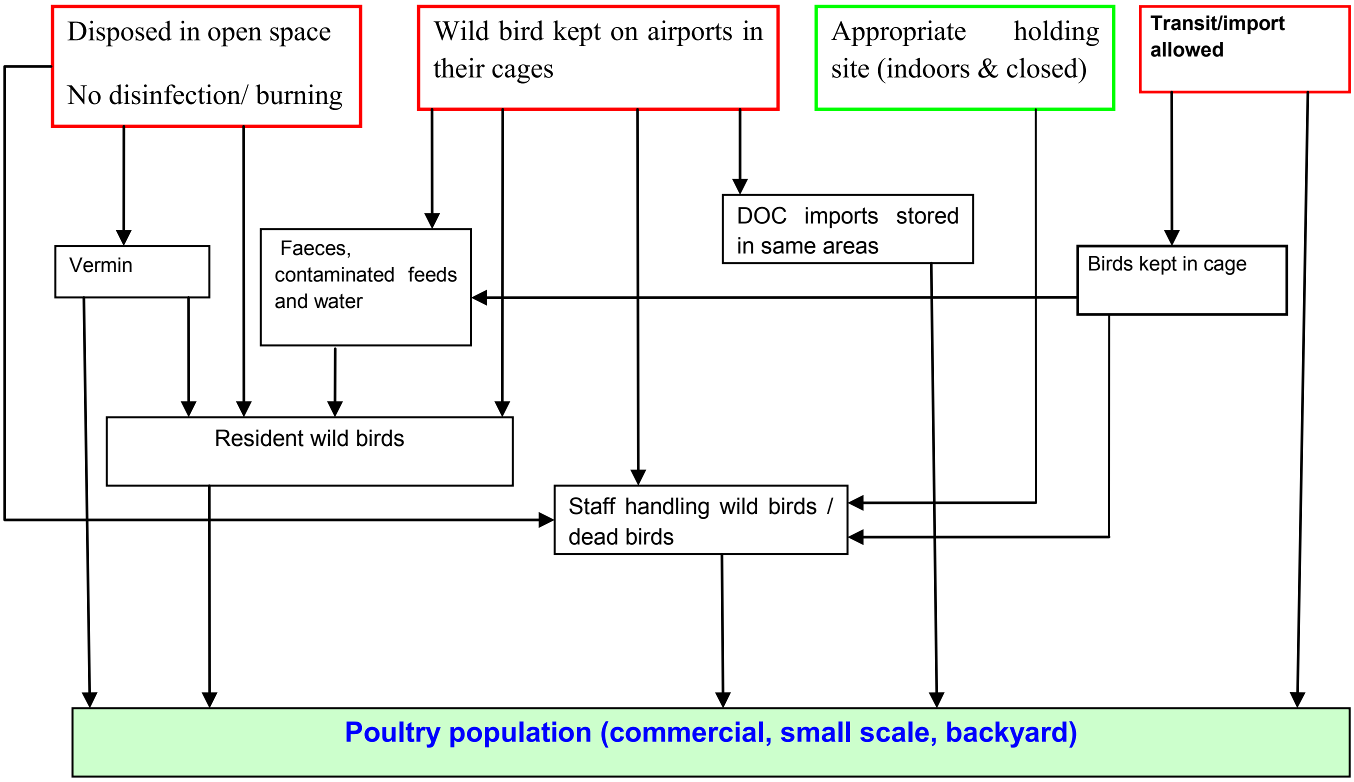

Figure 6-2 Diagram of exposure pathways of HPAI H5N1 to the poultry population after the release of the virus by an infected wild bird trade transiting in Ethiopia.

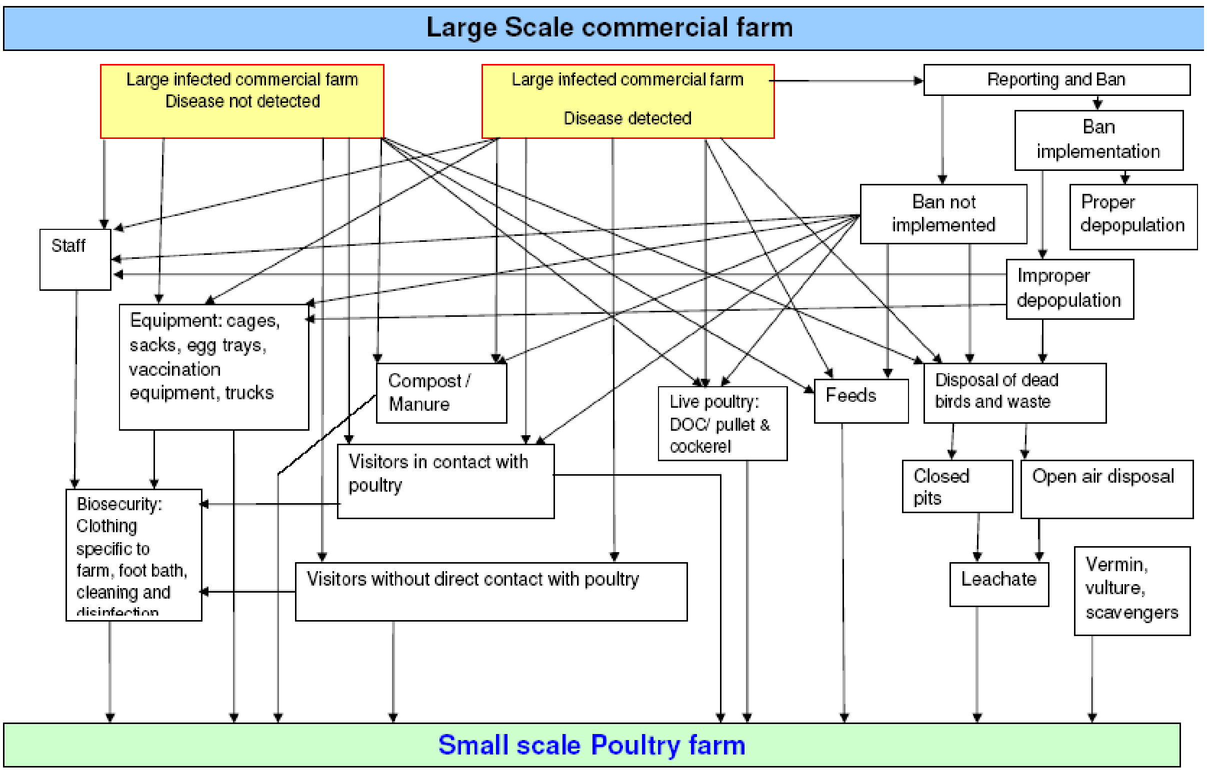

Figure 6-3 Diagram of the risk pathways for the transmission of HPAI (H5N1) from large commercial poultry farms to small scale poultry farm.

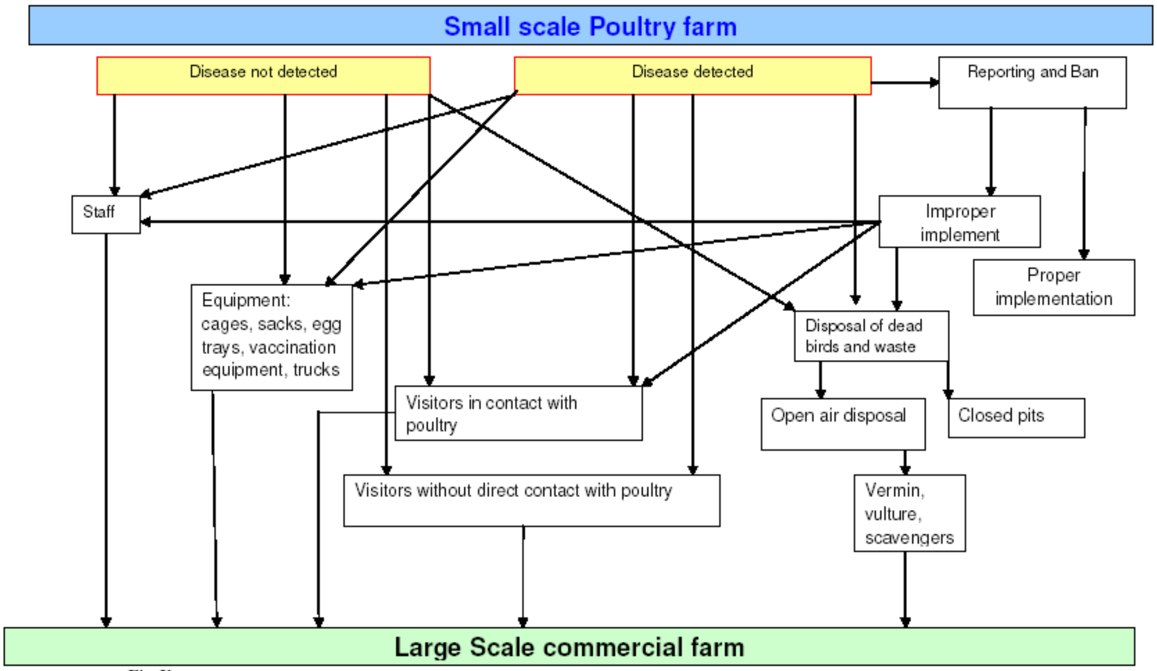

Figure 6-4 Diagram of the risk pathways for the transmission of HPAI (H5N1) from small scale poultry farm to large commercial poultry farm.

6.2. Risk question 1- Release pathway

What is the risk of introduction of HPAI (H5N1) via legal and illegal trade of wild birds transiting in Ethiopia?

The release pathway describes biological events necessary for a wild bird on trade transit, to introduce HPAI (H5N1) virus into Ethiopia (via air and via road). The release of H5N1 HPAI virus to Ethiopia through infected wild birds transiting in the country is a function of the probability of a wild bird on trade transit being infected, the probability of detection given that it is infected and the probability of biocontainment of the virus within the facility of the Border Inspection Point should undetected infection from the transiting wild birds be present.

Factors influencing the release are:
- H5N1 HPAI status of the source/exporting countries
- Susceptibility of wild birds under consideration to H5N1 HPAI virus
- Frequency and volume of wild birds on trade transit to Ethiopia
- Time spent on transportation to reach to Ethiopia
- Compliance to veterinary checks at BIP
- Legality of the trade
- Number / Frequency / Proportion of wild birds inspected (clinically and /or swab)
- Time to examination / Description of clinical examination
- Incubation period
- Actions taken on the detected (on the dead at arrival, sick, etc.)
- Presence of appropriate holding facilities and disposal pit
- Survival of the agent

The release assessment considers two possible routes via which infected wild bird on transit could reach Ethiopia: air or road. It also takes into account legal and illegal ways of introduction of infected bird as indicated in figure 5.1.

6.3. Risk question 2: Exposure pathways

What is the probability that domestic poultry in Ethiopia become infected by H5N1 HPAIV after the release of the virus by an infected traded wild bird transiting in Ethiopia?

This exposure pathway describes the direct and indirect transmission pathways by which the infected wild birds on transit via Ethiopia transmit the disease to the domestic poultry population.

Assuming that the disease has been introduced into the country through infected wild birds on trade transit, the local poultry population could get infected via direct or indirect ways. The probability of exposure of the poultry population depends on the probability of the resident wild birds contracting the infection directly (birds in cage, disposed materials) or indirectly (fomites, vermin) and/or transmitting the disease to poultry, probability of the staff handling the birds getting contaminated and having effective contact with the poultry, probability that infected wild birds on transit transmit the virus to imported DOC while they are at the airport on their way to their farms of destination, probability of transmission through vermin, and probability of direct contact of the infected wild bird with poultry as it enters through illegal routes.

The exposure is affected by:

- Presence, abundance and susceptibility of the resident birds and vermin around BIP
- Access of birds and vermin to the holding site
- Volume/frequency of wild birds traded
- Duration wild birds kept in the air port in their cages
- Presence of appropriate holding sites for birds on transit
- Survival of the virus in the environment
- Presence of poultry population around BIP
- Possibility of contact between resident wild birds and poultry population
- Survival of the virus in contaminated environment
- Safety procedures followed by the people handling live transit birds in their cages and dead birds
- Contact with DOC importation process

6.4. Risk question 3: Consequence (transmission) pathways

What is the risk of transmission of HPAI (H5N1) between large commercial poultry farms and small scale poultry farms?

The risk factors identified for the transmission of H5N1 HPAIV between LSCF and SSCFs are movement of staff, visitors, equipment, vehicles, feed, live poultry, resident birds, vermin, compost/manure sales etc. Generally the biosecurity level of farms is an important determinant in the transmission process.
Factors affecting transmission are:

- Number of staff working in LSCF having access to SSCF

- Frequency of movement of staff from LSCF to SSCF
- Vehicle sharing between farms
- Biosecurity level of both the LSCF and the SSCF
- Survival of the virus in faeces and Existence of equipment exchange system and type of equipment exchanged
- Frequency of exchange of equipment
- Number and type of visitors
- Practice of moving compost/manure from LSCF to SSCFs
- Volume and frequency of compost/manure to SSCF
- Number and frequency of sales of live poultry by LSCF to SSCF
- Practice of selling feed to SSCF and volume and frequency of selling
- Number of SSCF buying feed
- Species, number and susceptibility of the resident birds around the LSCF
- Possibility of contact between resident wild birds and poultry population
- Disposal practice of dead birds in LSCF
- Probability of detection of diseases
- Reporting and implementing ban behavior

7 Risk Assessment for Release

The risk question for release (described in Section 5) was defined as:

What is the risk of introduction of HPAI (H5N1) via legal and illegal trade of wild birds transiting in Ethiopia?

This risk question takes into account the infection status of source (exporting) countries, susceptibility of the wild bird species involved in the trade, incubation period of the disease in the bird species, and the presence of veterinary checks, appropriate holding facilities and disposal practice in the border inspection points (BIP) of Ethiopia and their abilities to detect and contain the hazard upon release.

Two types of border inspection points were considered for release assessment: the first one is the inspection unit located at the Bole International airport while the other includes all the border road-checkpoints found along international borders. Risk pathways involving each of these types of BIP were expected to have different structures and data needs. Two independent risk assessments by type of BIPs were therefore conducted. Data regarding the airport transit was collected from cargo supervisor using structured questionnaire in face to face interview while data on road-check points was obtained from boarder customs posts through Wild Life Authority. Information obtained from all the six customs posts bordering the neighboring countries, including Humera, Metema and Almahal (on the border with Sudan), Moyale (border with Kenya), Togochale (border with Somalia), and Mille (border with Djibouti) showed that there is no legal or illegal trade of wild birds by road. Similar reports were obtained from the Wild Life Authority, Ministry of Agriculture and Rural Development. The authority further clarified that the items that are mostly traded (both legal and illegal) at the border posts include products of wild animals like ivory, tusks and horns, and not wild birds. It was reported that no bird had ever been seized at the border checkpoints. The risk of introduction of the disease via legal and illegal trade of birds at the border road-checkpoints was therefore considered negligible, hence not considered further. The release and exposure risk pathways described in this study then only considers Bole International airport, since it is the only airport in Ethiopia where wild birds from exporting countries transit on their way to importing countries.

7.1. Overview of information required

Table 7-1 Data required for the assessment of risk of release of H5N1 HPAIV via trade in wild birds transiting Ethiopia

Section of release assessment pathway	Data required
Probability that a wild bird transiting Ethiopia is infected with H5N1 HPAI virus	H5N1 HPAI infection/outbreak status of the country of origin.
	Species and susceptibility of the wild birds on trade transit to H5N1 HPAI virus
	Frequency and volume of wild birds on trade transit in Ethiopia
	Time spent on transportation to reach to Ethiopia
Probability that an infected wild bird is not detected at the BIP	Compliance with veterinary checks at the BIP
	Legality of the trade
	Number/frequency/proportion of wild birds inspected (clinically and /or swab)
	Time to examination/description of clinical examination
	Susceptibility of species/potential as carrier
	Incubation period
	Actions taken on infected cases or those found sick or dead on arrival
Probability of lack of biocontainment of the virus within the facility of the border inspection point should undetected infection from wild birds on transit be present.	Presence of appropriate holding facilities for wild birds on transit
	Presence of disposal pit
	Safety procedures for handling fomites, live and dead birds
	Presence of isolation room

7.2. Probability of a wild bird transiting in Ethiopia being infected with H5N1 HPAI virus

The probability of a wild bird on trade transit in Ethiopia being infected depends on the infection status of the country of origin, the susceptibility of the bird species involved, the likelihood of contracting the disease during transportation, whether the consignment went through veterinary checks in the exporting country before shipment (legal/illegal) and number and frequency of transits.

Information available

Eleven different species of wild birds are involved in the trade transit via Ethiopia. They are : African Grey Parrot (*Psittacus erithacus*), Violet Turaco (*Musophaga violacea*), Green Crested Turaco (*Tauraco persa*), Zebra Finch (*Taeniopygia guttata*), Cockatiel (*Nymphicus hollandicus*), Budgerigar (*Melopsittacus undulates*), Diamond Dove (*Geoplia cuneata*), Chest Nut Bellied Sandgrous (*Pterocles exustus*), Blue Naped Mouse Bird (*Urocolius macrourus*), Red Billed Horn Bill (*Tockus erythynchus*) and White headed Buffalo Weaver (*Dinemellia dineelli*) (Ethiopian Airlines Cargo Transit Supervisor, and official report of Ethiopian Wild Life Authority).

The Republic of South Africa, Democratic Republic of Congo, Senegal, Ivory Coast and Tanzania are the source countries for these birds. Except the Republic of South Africa which exports mixes of all the eleven different species, others export only parrots. Regarding the volume and frequency of trade transit, the highest number of consignment comes from Democratic Republic of Congo (120-150 birds/week) followed by Republic of South Africa (150-160/three months), Ivory Coast (100/two months), Senegal (75/three months) and Tanzania with irregular size and frequency (Ethiopian Airlines Cargo Transit Supervisor).

According to our source of information, all the wild bird consignments on transit are legal (hold international veterinary certificate) except one incident noted in January, 2009 where a person was found carrying a wild bird which was later confiscated by wildlife authority (information from wild bird Authority). However, illegal trade is another mode of import of captive birds into countries, which constitutes a possible risk for the importation of disease agents that may affect the importing as well as the transit countries. This risk is heightened by the fact that by the very nature of illegal trade, no inspection or quarantine of imported birds is applied by the responsible state authorities.

Time spent on transportation from the exporting country to Ethiopia ranges from 3-12 hours (Ethiopian Airlines Cargo Transit Supervisor). The probability that an infected but apparently healthy bird at the point of export develop symptoms or uninfected bird becomes infected and develop symptom during transport to BIP Ethiopia is dependent on a number of factors: the species of birds (different susceptibilities), the time since infection (incubation period), the transportation process and whether it allows for mixing of species and inspection procedure and its sensitivity. Data for this stage of the pathway are sparse, but transport conditions provide opportunities for mixing. Transmission of AI between birds can therefore occur as a result of direct or indirect contact via surfaces or objects contaminated with fecal material, or a mixture of the two due to confinement within transportation facilities.

According to the OIE Terrestrial Animal Health Code (2007), countries that identify HPAI should report the occurrence to OIE within 24 hours. From the above five countries involved in the wild birds trade transiting in Ethiopia, it is only Ivory Coast/Cote d'Ivoire which is reported to have had H5N1 HPAI outbreaks at the end of April 2006 (OIE 2009). Five outbreaks were registered in the period between April 2006 and March 2007. Following the outbreak, the government culled birds in the outbreak area, banned importation of poultry from countries that had reported outbreaks, and established a surveillance system. The outbreaks were contained and no further outbreaks were reported (OIE, 2009). However, given low sensitivity of the surveillance system in most African countries, including Ivory Coast/Cote d'Ivoire, the possibility of underreporting could exist especially with the involvement of wild life/birds. At the time of the outbreaks importing countries instituted some preventive measures to protect their countries from introduction of the disease (e.g. banning imports). In early 2006, when avian influenza was considered a threat, the government of Ethiopia had imposed ban on transiting wild birds which lasted for the period of about six months irrespective of the country of origin (Dr Yohannes, veterinary quarantine check post staff at Bole international airport)

Very limited data is available regarding the susceptibility of wild birds involved in trade transit in via Ethiopia. Out of the 11 species listed earlier, only three (Zebra finches, Budgerigars and parrots) have some fragmented data on their susceptibility to the virus.

An investigation to ascertain the susceptibility of zebra finches, house finches, budgerigars, house sparrows and European starlings to intranasal inoculation with H5N1 HPAI virus was conducted by Perkins and Swayne (2003). Intranasal administration of the chicken/Hong Kong virus resulted in high morbidity and mortality in zebra finches, house finches, and budgerigars within 10 days of inoculation. Clinically, the affected birds suffered a sudden onset of mortality, severe depression, and/or neurologic dysfunction. Clinical results of inoculation of these non-gallinaceous species with the chicken/Hong Kong virus were comparable with those previously reported for this and other HPAI viruses in chickens and turkeys, indicating that the chicken/Hong Kong virus is highly pathogenic for these avian species as well. Furthermore, using immuno-histochemistry, viral antigen was demonstrated in multiple tissues, indicating that disseminated infection, again typical of HPAI viruses in domestic poultry, occurred in finches and budgerigars. This is the first investigation to detail the clinical disease, gross and histological lesions, and distribution of viral antigen after infection of passerine and Psittacine species with an H5N1 HPAI virus.

In contrast to finches and budgerigars, inoculation of sparrows and starlings with the chicken/Hong Kong virus did not result in mortality, and only transient morbidity was observed in a few of the sparrows. Infected sparrows shed larges amount of virus (Boon, ACM et al., 2007)

With regard to parrots, there have been limited systematic direct studies investigating the susceptibility and prevalence of HPAI in this species. Alexander DJ (2000) indicated that avian influenza was rare in imported pet birds and surveillance for H5N1 that was carried out at live bird markets in Hong Kong indicated that parrots were not infected even though chickens, ducks and geese had high prevalence. Since 1975 when the first isolates from aged birds were recorded, the viruses were of H4 and H3 (not H5) subtypes, and mostly occurred in passerine species but only rarely in parrots. According to Ritchie et al. (1994) cited by Jackson et al., (2000) a range of parrot species are known to be susceptible to HPAI in captivity. These include sulphur-crested cockatoos, yellow crowned Amazons, plum-headed parakeets, rose-ringed parakeets and African grey parrots. Mortality rates may reach 30% with virulent strains and affected birds show lethargy and central nervous system signs and the course of the disease takes about two weeks. Generally the existing data suggest that parrots may have relative resistance to H5N1 HPAI, and when they contract the disease they show clinical signs indicated above (Stewart Metz, 2005).

Interpretation

Of the countries identified as being involved in the trade of wild birds that transit in Ethiopia, it is only Ivory Coast which is reported to have had outbreaks of HPAI H5N1 in the recent past. The outbreaks were immediately contained and no fresh outbreaks were reported in 2008 and 2009. Nearly all the consignments are also said to be legal, holding international veterinary certificates from authorized bodies. This indicates that these birds often pass legal inspections in the exporting countries. **T**he probability that an infected bird is detected at the point of export is, however, highly variable and heavily dependent on testing capabilities of the exporting country. In addition, parrots are often imported from Ivory Coast. This species is relatively resistant to the virus but show clinical signs when infected. Taking all these into account, the likelihood of a wild bird on trade transit to Ethiopia being infected is considered to be **very low with medium uncertainty,** the uncertainty being attached mainly to the possibility of under reporting as the surveillance systems in most African countries are not very sensitive, and to the lack of knowledge on parrots virus shedding behavior.

7.3. Probability an infected wild bird is not detected at BIP

The probability of detection of an infected wild bird on transit depends on the presence of veterinary checks, the efficiency of the inspection process, the stage of the disease in the infection process (if the disease is in the incubation period) and the legality of the trade. The inspection procedure for AI at the border inspection points primarily involves clinical examination which may include sampling (swab) and laboratory testing. Infected birds that are still incubating the disease provide major challenges to the diagnostic process because they do not show clinical signs.

Information available

Upon arrival in Ethiopia, the transiting wild birds (confined in their cages) are taken to a shaded open space specifically meant for birds waiting for a flight connection. They are kept here for an average of 12-24 hours under the care of transit attendants. The transit attendants check for international veterinary certificate and have a quick look on the birds to see if there is any sick looking or dead animals (Information obtained from the Transit supervisor and Animal and Animal Products Quarantine and Inspection Unit at Bole International Airport). There is not any other check or follow up by authorized veterinarians.

The transit attendants transfer any sick or dead birds identified on arrival to the waiting ground, along with others, and prepare a report. These birds are kept in their cages in the waiting ground (with the sick ones receiving some nursing care) until they are shipped to their destination.

The incubation period of the disease ranges from 3 days in naturally-infected individual birds to 14 days for a flock (Swayne and Halvorson 2003). The Code gives the incubation period for the purpose of international trade as being 21 days (OIE, 2007). Therefore, this risk assessment considers that susceptible birds may be viraemic up to 21 days following exposure. They may therefore, act as reservoirs of the virus with a potential of exposing other susceptible birds to the infection before showing clinical signs of the disease.

Interpretation

Wild birds on trade transit at Bole International Airport are not usually examined by veterinarians. It is only the transit attendants who have the responsibility of inspecting and taking care of the transiting birds while confined in their cages. The attendants are also expected to nurse sick and apparently healthy birds (without any facilities for isolating those found sick from the apparently healthy ones) even though they do not have the necessary veterinary skills and knowledge. In addition, they also expose themselves to a great risk of being contaminated or even acquiring the disease should an infected bird or carcass arrives at the BIP. The probability of not detecting the infected bird under the specified conditions is therefore assessed to be **very high with medium uncertainty**.

7.4. Probability of lack of biocontainment of the virus within the facility at the border inspection point

The biocontainment of the virus given undetected infection can be achieved at BIP depends on the presence of appropriate holding facilities and handling practices.

Information available

As described above, the airport has an open space with a shed specifically meant for holding transiting wild birds. The facility is not shared with other live birds such as DOCs. Apart from the airport staff, nobody is allowed to get into the facility. The suitability of the facility to contain the virus was not assessed because its access was forbidden for security reason. However, from the discussion held with the transit supervisor, it was made clear that vermin, rodents, cats, pigeons, vultures and resident wild birds can access it. We were also informed that the facility does not have a specific space or room for keeping sick birds before they are shipped to the country they are destined for. The facility does not also have disposal pits for disposing carcasses. The airport staff also informed us that the facility is not under the control of the veterinary inspection post of the airport, therefore no regular inspection of the facility is carried out by this department. The transit staffs handling the consignments do not have personal protective equipment.

Interpretation

At the BIP (airport) there is no appropriate facility for holding birds on transit. Resident birds, vermin and cats have free access to the holding area. There is no isolation room or disposal pits. The cargo staffs do not use protective cloths while handling the birds and also do not use sanitary and disinfection facilities to avoid contamination. Generally, should there be an introduction of unobservable infection via transit birds, the facility would not be able to contain it within the BIP. The probability of lack of biocontainment of the virus within the facility of the border inspection point should undetected infection from the transiting wild birds be present is therefore considered **high** posing high risk of introduction of the disease **with medium uncertainty**.

Table 7-2 Summary

Step of pathway	Information obtained	Source	Risk Category	Uncertainty
Probability that a wild bird transiting Ethiopia is infected with H5N1 HPAI virus	H5N1 HPAI infection/outbreak status in the country of origin. Species and susceptibility (partially) of the wild birds on trade transit to H5N1 HPAI virus	Bole International Airport Transit Supervisor Ethiopian Wild life authority OIE reports Bole International Airport Transit Supervisor & Ethiopian wild life authority	Very low	Medium uncertainty

		Perkins and Swayne (2003), R. Jackson et al. (2000), Alexander DJ (2000)		
	Frequency and volume of wild birds on trade transit to Ethiopia	Bole International Airport Transit Supervisor		
	Time spent on transportation to reach to Ethiopia	Bole International Airport Transit Supervisor		
Probability of an infected wild bird is not detected at the BIP	Compliance to veterinary checks at BIP Legality of the trade	Bole International Airport Transit Supervisor & Animal and Animal Products Quarantine and Inspection Unit at Bole International Airport	Very high	Medium uncertainty
	Number/frequency/proportion of wild birds inspected (clinically and/or swab	Bole International Airport Transit Supervisor		
	Time-to-examination / Description of clinical examination	No data for there is no veterinary check on the transit birds		
	Susceptibility of species/ Potential as carrier (Partially obtained for three spp.)	Perkins and Swayne (2003) Swayne and Halvorson (2003)		
	Incubation period	OIE, (2007)		

	Actions taken on the detected (on the dead at arrival, sick, etc.)	Bole International Airport Transit Supervisor		
Probability of lack of biocontainment of the virus within the facility of the border inspection point should undetected infection get introduced by transiting wild birds.	Presence of appropriate holding facilities for the wild bird on transit Presence of disposal pit Safety procedures followed in handling fomites, live and dead birds Presence of isolation room	Bole International Airport Transit Supervisor & Animal and Animal Products Quarantine and Inspection Unit at Bole International Airport Bole International Airport Transit Supervisor Bole International Airport Transit Supervisor	High	medium uncertainty
Summary: *The probability of introduction of HPAI (H5N1) virus to Ethiopia via legal and illegal trade of wild birds transiting the country (Via air)*			Very Low	Medium

7.5. Overall risk estimate and conclusion for the release of HPAI (H5N1) virus to Ethiopia via legal and illegal trade of wild birds transiting the country- Via air

Release assessment analyses all biological pathways that would lead to the "importation" of the virus to Ethiopia. This definition is adapted from the OIE framework for risk estimation (OIE 2004). The analysis revealed that the probability of H5N1 HPAIV being released into Ethiopia through transiting wild birds (via air) is **Very low with medium uncertainty** (Table 7.2). Using the interpretation given in Table 4.1, this risk estimate means that the probability of H5N1 HPAIV release into Ethiopia by trade transiting wild birds (via air) is very rare but cannot be excluded

It can be concluded that the overall risk for the release of H5N1 HPAIV to BIP in Ethiopia is very low because of the risk of infection in the source countries is considered to be very low. However, it is important to note that should an infected wild bird on trade transit reaches BIP, it will be very possible for it not to be detected for there is no veterinary check for transiting wild birds at the airport. It is also possible that the virus would not be contained at the BIP if it is introduced because there are no appropriate holding facilities for keeping sick birds or disposal pit for dead birds. The lack of veterinary checks and appropriate biocontainment facilities at the BIP are the two "high risk" steps in the release pathway that would promote the introduction of the virus into the country. The probability of detecting an infected bird could be improved by instituting veterinary inspection at the BIP. Biocontainment of the virus could be improved by establishing appropriate holding facilities for keeping transiting wild birds, isolation room for keeping sick ones and disposal pit for proper clearance of dead birds.

It should be noted also that this qualitative probability estimate is associated with a medium level of uncertainty. This level of uncertainty is due to lack of information on the pre-export activities (quarantine practices, type of tests applied, etc.) and degree of susceptibility, virus shading behaviour and carrier status of the birds involved in trade transit.

Data gaps and recommendation for future research

- An assessment of the reliability of surveillance and certification procedures applied in the exporting countries would provide very valuable information.
- As described previously, limited information on the susceptibility to the virus of only 3 (Zebra finches, Budgerigars and parrots) out of the 11 species of wild birds involved in trade transit in Ethiopia has been published. This implies that there is a need to:
    - Virological studies to determine the virus shedding behavior and carrier status of these three species of birds would need to be conducted, and
    - Establish the degree of susceptibility, virus shading behaviour and carrier status for the remaining eight species (Violet Turaco (*Musophaga violacea*) , Green Crested Turaco (*Tauraco persa*), Cockatiel (*Nymphicus hollandicus*), Diamond Dove (*Geoplia cuneata*) , Chest Nut Bellied Sandgrous (*Pterocles exustus*), Blue Naped Mouse Bird (*Urocolius macrourus*) , Red Billed Horn Bill (*Tockus erythynchus*) and White headed Buffalo Weaver (*Dinemellia dineelli*) should be investigated.

8 Risk assessment for the exposure

In section 5 of this document the risk question is defined as

What is the probability that domestic poultry in Ethiopia become infected by H5N1 HPAIV after the release of the virus by an infected traded wild bird transiting in Ethiopia?

Conditional on the likelihood of introduction of H5N1 HPAIV through infected wild birds on trade transit, poultry population in Ethiopia could be exposed to H5N1 HPAIV after its release through the following 5 different routes (Figure 6-2):

- via resident wild birds contracting the infection directly (imported wild birds in cage) or indirectly (faeces, contaminated feeds and water, vermin), or via resident wild birds getting contaminated and having effective contact with poultry;
- via airport staff getting contaminated by handling imported wild birds and having effective contact with the poultry;
- via DOC getting infected from imported infected wild birds kept at airport in their cages or while they are on their way to the farms.
- via vermins getting contaminated from open space disposal at BIP, and
- by direct contact between imported wild bird on transit by road and poultry population. As described in section 6 of this report this route in the risk pathway is considered negligible and therefore will not be discussed further.

8.1. Overview of Information Required

Table 8-1 Data required for the exposure assessment of domestic poultry to H5N1 HPAIV

Sections of the exposure assessment pathways	**Data required**
• **<u>Exposure pathway 1: Probability of infection of resident wild birds after exposure to H5N1 HPAI from wild birds on trade transit and transmitting the virus to poultry population</u>**	
Step 1: Probability of infection of resident wild birds after exposure to H5N1 HPAI from wild birds on trade transit	• Species, number & susceptibility of the resident wild birds around BIP • Access to the holding site • Volume/frequency of wild birds traded • Duration wild birds kept in the airport in their cages • Disposal practice of dead birds and fomites • Presence of appropriate holding sites for birds on transit • Survival of the virus in contaminated material
Step 2: Probability of transmitting the virus to the poultry population	• Presence of poultry population around BIP • Possibility of contact between resident wild birds and poultry population (bio-security) • Survival of the virus in the environment
• **<u>Exposure pathway 2: Probability that staff handling live and dead wild birds on trade transit get contaminated with H5N1 HPAI and transmit to poultry population</u>**	
Step 1: The probability that staff handling live	• Number of people involved in handling live and dead wild birds in transit

and dead wild birds on trade transit get contaminated with H5N1 HPAI virus	• live bird handling and disposal practices (use of protective clothing and disinfectants) • Survival of the virus in contaminated material
Step 2: probability of transmitting the virus to the poultry population	• Number of people involved in handling live and dead wild birds in transit • Proportion of staff handling transit birds owning poultry • Presence of poultry farms on the way to staffs homes • Survival of the virus in contaminated material
• **Exposure pathway 3: Probability that vermin (rodents) get contaminated with H5N1 HPAI and transmit the virus to poultry population**	
Step 1: The probability that vermin (rodents) get contaminated with H5N1 HPAI Virus from faces, contaminated feeds and dead bodies from open space disposal.	• Presence and abundance of vermin around the holding premises and disposal pits. • Access to the holding site • Duration wild birds kept in the air port in their cages • Disposal practice of dead birds and fomites
Step 2: probability of transmitting the virus to the poultry population	• Survival of the virus in contaminated environment • Distance covered by rodents/day from their hole in search of their feed requirements • Presence of poultry around BIP • Biosecurity
• **Exposure pathway 4: Probability that wild birds on transit kept at airport infect DOC imports stored in the airport and the DOCs transmit H5N1 HPAIV to the poultry population.**	
Step 1: Probability that wild birds on transit kept at the airport infect DOC imports stored in the airport	• Number and frequency of DOC imports • Place of storage of DOC and possibility of contact with wild birds on transit • Duration of stay in the air port • Susceptibility • Survival of the virus in the environment
Step 2: probability of transmitting the virus to the poultry population	• Incubation period • Virus shedding behavior • Quarantine procedures followed • Duration of transport

8.2. Exposure Pathway 1: Probability of infection of resident wild birds after exposure to H5N1 HPAIV from wild birds on trade transit and transmitting the virus to poultry population

8.2.1 Probability of infection of resident wild birds after exposure to H5N1 HPAI from wild birds on trade transit

The probability of infection of resident wild birds after exposure to H5N1 HPAIV is a function of the presence and abundance of susceptible resident wild birds in the airport area, access of resident wild birds to the holding site, number and frequency of wild birds on trade transit to Ethiopia, duration of stay in the airport, disposal practice of dead birds and fomites and survival of the virus in the environment.

Information available

There are no systematic studies on the species and number of resident wild birds present around Bole International Airport. According to the information obtained from the transit supervisor of the airport, the most common types of birds available around the airport are house sparrows, pigeons, crows and kites.

As there is no appropriate holding facility for the wild birds on trade transit to Ethiopia, the resident wild birds have access to the holding site, and often share water and feed with the transiting wild birds in their cages (transit supervisor of the airport). **<u>This is one of the critical point that gives the possibility of both direct and indirect transmission of the virus to the resident wild birds</u>.**

Regarding their susceptibility to H5N1 HPAIV, Perkins and Swayne (2003) reported that sparrows have some degree of susceptibility and pigeons are resistant to the virus. Results of H5N1 HPAIV inoculation experiments in wild bird species by these researchers revealed that out of the 10 house sparrows inoculated with the virus, 3 contracted the infection and showed mild clinical signs but no mortality. In pigeons however, establishing the disease was hardly possible. Even direct inoculation of the virus into nasal cavity caused limited infections with between 60-80% of the pigeons not becoming infected. In some asymptomatic courses hardly any sign of viral replication can be detected. Re-isolation of the virus is only exceptionally possible. There are, however, reports that also indicate that pigeons can be susceptible (EFSA 2006). Boon, ACM et al. (2007) also reported that when infected, house sparrows would shed the largest amount of the virus. In addition, crows in Japan were found to harbor and excrete H5N1 HPAIV of different genotypes. These viruses were highly pathogenic for chicken but not for domestic ducks and mice (Kwon et al. 2005).

One of the determinants in the transmission of the virus from transiting birds to locally resident wild birds is the number and frequency of wild birds on trade transit to Ethiopia. As indicated in section 6 of this report significant volume of wild birds are transiting in the country. In the air port, transiting wild birds stay 12-24 hours in an open space that is freely accessible to the resident wild birds.

In the BIP (airport) there is no disposal pit to get rid of the carcasses or isolation room for handling sick birds. Except one incident from Democratic Republic of Congo where over 90% of the birds in a consignment were found dead on arrival, from which Paramyxovirus type3 (PMV-3) and Herpes virus (Pacheco's disease) were isolated, there has not been any time when the airport has buried carcasses of wild birds on transit within its compound. They usually keep the dead birds in their cages until they are shipped to countries they were destined for (Airport Transit supervisor).

Interpretation

The number of wild birds transiting in Ethiopia is significant. The length of time at which they stay in the airport is sufficient to transmit the disease to susceptible animals. Resident wild birds can readily access the waiting ground where birds on transit are kept for there is no appropriate holding site at the airport. Some of the birds, for example house sparrow and crow that are found around the airport have some degree of susceptibility to H5N1 HPAI. If the wild birds on trade transit in Ethiopia are infected, there is a high likelihood of the resident wild birds getting infected by H5N1 through direct contact or contaminated feed and water. This probability is considered as being **medium with high uncertainty** as there is some degree of resistance to infection by house sparrows and the contact rate between resident wild birds and transiting wild birds is not well known.

8.2.2. Probability of transmitting the virus to the poultry population

Once the resident wild bird contracts the infection, transmission to poultry population depends on the presence of susceptible poultry around the airport, the possibility of contact between resident wild birds and poultry population and survival of the virus in the environment.

Information available

In the nearby villages at the furthest end of the airport, there are a number of backyard and small scale commercial poultry farms. Given that the levels of biosecurity in these production systems are very low to inexistent (Abebe Wossene, 2006), resident wild birds can have free access to the facilities where poultry are kept. There is therefore a high possibility of the wild birds transmitting the virus if they are infected.

The indirect transmission of H5N1 HPAIV is strongly influenced by the ability of the virus to survive in different environments. Inactivation of extracellular viral infectivity is a function of temperature, time of exposure and the existence of UV radiation. Presence of stabilizing agents, in particular proteins, may prolong survival times (EFSA, 2006). Data from published studies on survival of the virus in the environmental material are presented by different researchers (Table 8.2)

Table 8-2 Stability of H5N1 HPAI virus in faeces and water

Material	Parameter	Time	Result	Reference
Chicken faeces (H5N1 HPAIV)	25-32^{0}c	4 days	No infectivity retained	Soengsrm et al 2005
Surface water (H5N1 HPAIV)	Not specified	3 days	No infectivity retained	Soegsrm et al 2005

Virus survival is highest in moist faeces, significantly high in water especially if it is cold and little survival occurs in dry and sunny conditions. The period of infectivity will increase with decreasing temperature, from 4 days in 25-32^{o}C to more than 3 weeks at 4^{o}C. The role of aerosol in the transmission of Asian lineage H5N1 HPAIV is unclear, but it may be less important than faecal-oral transmission. This contrasts with human influenza viruses which are considered to be mainly transmitted via aerosol (EFSA, 2006).

Bird faeces comprise a complex and often chemically aggressive matrix. The presence of uric acids leads to low pH values. Masses of the intestinal bacterial flora provide potentially hazardous enzymes (proteases, neuraminidases, nucleases). Nevertheless, values given in Table 8.2 indicate a **remarkable resistance of avian influenza viruses in faeces.** This includes H5N1 HPAIV which required at least four days at ambient temperatures of 25-32°C in the shade in Thailand for its reduction beyond detection level. Other studies, which examined different AI strains, demonstrated longer survival times in droppings and chicken manure. Frequently, the infectivity was retained after more than three weeks, especially when stored at temperatures as low as 4°C. The data indicates that contaminated faeces are likely to represent a significant mechanism for exposure of other birds (EFSA 2006).

The only data available on the stability of H5N1 HPAIV in water indicates that it was inactivated after 3 days in surface water coming from rice fields in Thailand. It is likely that the duration of stability will increase with reduced temperature. This suggests that indirect transmission via water is possible, to other water birds using or drinking contaminated water or through domestic poultry drinking unprocessed water from contaminated reservoirs (EFSA 2006).

Interpretation

These resident wild birds live in close proximity to backyard and small scale commercial farms. As biosecurity in these types of poultry production systems is so poor or non existent, the resident wild birds have free access to poultry (Abebe Wossene, 2006). If they get exposed to the H5N1 HPAIV at the airport, these birds have a high potential of transmitting the virus to the local poultry population as the dominant bird species, the house sparrows, shade large quantity of virus. They can either transmit the virus through direct contact with poultry or indirectly via faeces, contaminated water and feed. The probability of transmission of H5N1 HPAI from infected resident birds to poultry population is therefore assessed to be **high with high uncertainty** as we lack information on contact rate of resident wild birds to transiting wild birds as well as frequency of contact with domestic poultry population.

8.2.3 Overall risk estimate for exposure pathway 1

The risk for the exposure and transmission of H5N1 HPAI to the poultry population through resident wild birds which happen to be infected by transiting wild birds is therefore estimated as **medium with high uncertainty.** The uncertainty is high as there is some degree of resistance to infection by house sparrows and we lack information on contact rate of resident wild birds to transiting wild birds as well as contact with domestic poultry population.

8.3. Exposure Pathway 2: Probability that staff handling live and dead wild birds on trade transit get contaminated and transmit the disease to poultry

8.3.1. Probability that staff handling live and dead wild birds on trade transit get contaminated

The probability that staff handling transiting wild birds get contaminated with HPAI H1N5 from infected wild birds on trade transit depends on the number of people involved in handling live and dead wild birds in trade transit, live bird handling and disposal practices (protective clothing & disinfectant) and survival of the virus in contaminated material.

Information available
The number and proportion of staff working in the airline cargo section that deal directly, therefore come in contact, with transiting live and dead birds was assessed. The assessment revealed that from the point of unloading to reloading of the birds, including the feeding and watering works, about 18 cargo staffs are involved and the contact with birds lasts for two hours on average. When asked whether they use protective clothing while handling consignments and disinfectants after handling the birds, the transit supervisor reported that they don't.

Interpretation

Conditional on the likelihood of a wild bird on trade transit is infected, the cargo staff handling the birds can easily be contaminated with faeces and nasal discharges. Because the staff do not use protective cloths while handling consignments and disinfectant after handling the birds, H5N1 HPAIV would therefore remain viable. Therefore the probability that staff handling live and dead wild birds on trade transit get contaminated is **high with high uncertainty**.

8.3.2. Probability of transmitting the virus to the poultry population

The probability of transmitting the virus to the poultry population depends on number of people involved in handling live and dead wild birds in transit, the proportion of transit staff owning poultry and survival of the virus in contaminated environment.

Information available

There appears to be a consensus among scientists that mechanical transfer of faeces, plays a significant role in the spatial dissemination of the virus (various authors cited in Alexander, 2007). This mechanical transfer, among others, is usually attributed to movement of people. In experimental conditions, minimum infectious dose for susceptible poultry is considered to be greater than or equal to 10^1 infective doses for HPAI.

To what distance the virus may be mechanically transmitted from an infected bird population in a facility to another susceptible population outside the facility is considered relative and is primarily dependant on strict compliance to biosecurity measures and the type of movement involved. The ability of the virus to trigger an infection in a susceptible species will depend on the intensity of mechanical transmission to associated or other premises and the quantity and survivability of the virus in the contaminated environment within a certain period of time.

In the Redgrave HPAI outbreak in the UK in November 2007, the evidence suggested that poor biosecurity measures and movement of personnel resulted in the virus being spread to another associated premise (National Emergency Epidemiology Group, 2007a) which was approximately 11 km apart from the index premises. These data again demonstrated that the mechanical transmission could occur in local conditions and result in the transmission of the virus from several meters to several kilometers.

As described above about 18 people are involved in handling the transiting wild birds. From those staff working directly with transiting wild birds, only one is reported to keep poultry at home. The other risk that shall be considered with staffs is the possibility of contact with poultry in their way home. Though assessment was not made, as the staffs were assumed to live in the inner city (cargo supervisor) and the poultry population in this part of the city is very few, possibility of contact with poultry population in their way home was considered insignificant.

Interpretation

Given the capacity of the virus in the faeces to survive up to four days in 25-32 ^{o}C, it can be transported infective to the homes of the airport attendants handling transiting wild birds along with their boots and clothing and remains infective for some time. As one of the staff has poultry in his home a possibility that he/she would transmit the disease to his/her poultry exists, and could lead to the disease then being disseminated to other farms. However, as the number of staff possessing poultry in their home is low, and the poultry population on the way home to other staff may not be significant to be considered as a risk, the probability of contact with poultry is low and therefore the probability of transmitting the virus through contaminated staff is **low with high uncertainty**.

8.3.3. Overall risk estimate for exposure pathway 2

The overall probability that staff handling live and dead wild birds on trade transit get contaminated and transmit the disease to poultry is **low with high uncertainty**.

8.4. Exposure pathway 3: Probability that vermin (rodents) get contaminated and transmit H5N1 HPAI to poultry population

8.4.1 Probability that vermin (rodents) get contaminated with H5N1 HPAIV

Vermin considered in this assessment are rodents. The probability that rodents get contaminated with feaces from infected transiting wild birds and dead bodies in open disposal space at the airport depends on the number of rodents around the holding site, access to the holding site, duration of stay of the transit birds, and disposal practice of dead birds and contaminated materials.

Information available

There is no evidence to suggest that invertebrate vectors are involved in the interepizootic maintenance of transmission of HPAI (Easterday and Beard, 1984). However, there is a possibility of mechanical transmission by invertebrate or vertebrate vectors (Animal Health Australia, 2008). Vermin, particularly rodents, are present in the airport and have access to the 'holding site' of transiting wild birds (Airport Transit supervisor). As described under section 8.2.1 above, there is no disposal pit in the airport and the practice is to keep the dead birds on transit in their cages and send them to the countries which they are destined for (Airport Transit supervisor).

Interpretation

Given their free access to the holding site, rodents can get contaminated with the faeces and discharges of infected transiting wild birds. The airport usually keeps dead birds in their cages until shipped to importing countries. This implies that rodents have reduced chances of coming in contact with dead birds on transit. The probability that rodents get contaminated with H5N1 HPAIV from faeces and other infective discharges given the transiting wild birds are infected **was assessed as high with medium uncertainty**.

8.4.2 Probability of transmitting the virus to the poultry population

The probability that contaminated rodents at BIP transmit the virus to the poultry population depends on the presence of susceptible poultry around, biosecurity system in place and survival of the virus in contaminated environment.

Information available

According to the information from Bureau of Agriculture and Rural Development for Addis Ababa City Administration and Dr Yohannes, veterinary quarantine check post staff at Bole international airport, there are small scale and back yard poultry undertakings in the villages 3-4 kilometers from the airport. The biosecurity system under this two production systems generally is very poor (Abebe Wossene, 2006), and rodents can have access to the poultry if they happen to reach the farms.

Most rodents wonder not more than 2 kilometers per day from their living hole in search of feed (Opinion provided by Mr. Getachew Fentie, Rodent control expert in Bureau of Agriculture and Rural development, Bahir Dar, Ethiopia). As described above, the virus can remain viable in faces (contaminating rodents) up to 4 days under 25-32^{o}C.

Interpretation

The likelihood of rodents coming in contact with the backyard or small scale commercial poultry farms is very remote as the poultry farms are located beyond 3 kilometers from the holding site. The probability of transmitting the virus to the poultry population is therefore assessed to be **negligible with medium uncertainty**.

8.4.3 Overall risk estimate for exposure pathway 3

Given their free access to the holding site, rodents can get contaminated with the faeces and discharges of infected transiting wild birds (high with medium uncertainty). The likelihood of rodents coming in contact with the backyard or small scale commercial poultry farms, however, is very remote as the poultry farms are located beyond 3 kilometers from the holding site (negligible with low uncertainty). The overall risk estimate for rodents get contaminated and transmit H5N1 HPAI to poultry population is therefore assessed to be **negligible with medium uncertainty.**

8.5. Exposure pathway 4: Probability that wild birds on transit kept at airport infect DOC imports stored in the airport.

8.5.1 Probability that wild birds on transit kept at the airport infect DOC imports stored in the airport

Conditional on the likelihood of a wild bird on trade transit is infected, the probability that a wild bird on transit kept at the airport infect DOC imports depends on number and frequency of DOC imported, place of storage of DOC and possibility of contact with wild birds on transit, susceptibility of DOC to H5N1 HPAIV, duration of stay in the airport and survival of the virus in the environment.

Information available

Commercial poultry farming in Ethiopia is also dependant on importation of day old chicks from abroad. The main countries involved in the supply of DOC are Netherlands, Saudi Arabia, Egypt Great Britain, Kenya and France. The import volume is presented in table 8.3. The import volume ranges from 2000 – 35,000 chicks per consignment.

Table 8-3 Number of day old chicks and ducklings imported from abroad, 2005-2009

Exporting country	Day old chicks				Day old ducklings			
	2005/2006	**2006/2007**	**2007/2008**	**2008/2009**	**2005/2006**	**2006/2007**	**2007/2008**	**2008/2009**
Netherlands	133,820	96646	269,068	97,235				
Saudi Arabia	108,773							
Egypt	5000							
Great Britain	13206	8000						
Kenya	52500							
France					512	1164	1129	1230
Sum	**313, 299**	**104,646**	**269,068**	**97,235**	**512**	**1164**	**1129**	**1230**

Source: Bole International Airport Animal and Animal Products Quarantine and Inspection Unit

Currently the DOC import is limited to the Netherlands and KLM cargo flight. The average frequency of importation has been one consignment per month for the last two years. The DOC's are transported in a well prepared package that precludes any contamination to them. Upon entry into Ethiopia, day old chicks are taken directly to the inspection point, minimal role of cargo staff, where they will have random veterinary checks and then directly pass to the farms which they are destined for immediately (the quarantine and inspection unit is usually informed prior to the day of arrival). In some cases the staffs and vehicles from large farms (Like ELFORA) are allowed to enter into the cargo terminal to facilitate the unloading and transport process, directly from the plane. The cargo staff contacts with DOCs were assessed insignificant and were thus not considered as a potential mechanism of transmission from wild birds to poultry. In addition, there is no chance for the contact between the DOCs and wild birds on trade transit at the waiting ground under such arrangements (Airport Transit Supervisor and Airport Animal and Animal Products Quarantine and Inspection Unit Head)

Domestic chickens are very susceptible to severe and potentially fatal influenza caused by H5N1 HPAI strains with mortality reaching up to 100%.

Interpretation

It appears that the day old chicks have no contact with transiting wild birds and as well no appreciable contact with the staff at the airport, that would results in their contamination and/or infection. Probability that wild birds on transit kept at the airport infect DOC imports stored in the airport is therefore assessed to be **negligible with medium uncertainty** and the risk assessment involving DOC is concluded at this stage – no assessment on the probability of transmitting the virus to the poultry population.

Table 8-4 Summary

Exposure pathways	Information obtained	Source	Risk Category	Uncertainty
Exposure pathway 1: Probability of infection of resident wild birds after exposure to H5N1 HPAI from wild birds on trade transit and transmitting the virus to poultry population	• Species, number & susceptibility of the resident birds around BIP • Access to the holding site • Volume/frequency of wild birds traded • Duration wild birds kept in the air port in their cages • Disposal practice of dead birds and fomites • Presence of appropriate holding sites for birds on transit • Survival of the virus in the environment • Presence of poultry population around BIP • Possibility of contact b/n resident wild birds and poultry population	Airport Transit Supervisor, Perkins and Swayne (2003) EFSA (2006) Kwon et al. (2005) Airport Transit Supervisor Songserm et al 2005 Addis Ababa City Admin Bureau of Agriculture and Rural development	**medium**	**high uncertainty**
Exposure pathway 2: Probability that staff handling live and dead wild birds on trade transit get contaminated with H5N1 HPAI and transmit to poultry population	• Number of people involved in handling live and dead wild birds in transit • Procedures followed in handling live birds and disposal of dead birds • Proportion of staff handling transit birds owning poultry • Survival of the virus in contaminated material	Airport Transit Supervisor Airport Transit Supervisor Airport Transit Supervisor Soegsrm et al 2005	**low**	**high uncertainty**
Exposure pathway 3: Probability that vermin (rodents) get contaminated with H5N1 HPAI and transmit the virus to poultry population	• Presence and abundance of vermin around the holding premises and disposal pits. • Access to the holding site • Duration wild birds kept in the air port in their cages • Disposal practice of dead birds and fomites • Survival of the virus in contaminated environment	Airport Transit Supervisor Airport Transit Supervisor Airport Transit Supervisor Airport Transit Supervisor Songserm et al 2005	**Negligible**	**Medium**

	• Distance covered by rodents/day from their hole in search of their feed requirements • Presence of poultry around BIP • Biosecurity	Getachew Fentie 9Expert opinion) Bureau of Agriculture and rural Development for Addis Ababa City Administration Abebe Wossene (2006)		
Exposure pathway 4: Probability that wild birds on transit kept at airport infect DOC imports stored in the airport and the DOCs transmit H5N1 HPAI to the poultry population.	• Number and frequency of DOC imports • Place of storage of DOC and possibility of contact with wild birds on transit • Duration of stay in the air port • Susceptibility • Survival of the virus in the environment • Incubation period • Virus shedding behavior • Quarantine procedures followed	Bole International Airport Animal and Animal Products Quarantine and Inspection Unit Bole International Airport Animal and Animal Products Quarantine and Inspection Unit Bole International Airport Animal and Animal Products Quarantine and Inspection Unit Songserm et al 2005 OIE - Abebe Wossene (2006)	**Negligible**	**Medium**
Summary: ***The probability that domestic poultry in Ethiopia become infected by H5N1 HPAIV after the release of the virus by an infected traded wild bird transiting in Ethiopia***			**Medium**	**High uncertainty**

8.6. Overall risk estimate and conclusion for the probability that domestic poultry in Ethiopia become infected by H5N1 HPAIV after the release of the virus by an infected wild bird on trade transit?

The summary table above presents the risk estimates for all the exposure pathways. The probability for the pathways ranges from negligible to medium. The overall risk estimate for the domestic poultry in Ethiopia to become infected by H5N1 HPAIV after the release of the virus by an infected wild bird on trade transit is thus **medium with high uncertainty** (table 8-4). Using the interpretation given in Table 4.1, this means that the exposure of poultry population in Ethiopia to H5N1 HPAIV after the release of the virus by an infected wild bird on trade transit at the airport does occur regularly.

Important risk factors for the exposure of poultry population are resident wild birds and transit staff handling live and dead wild birds owning poultry. The risk associated with pathways for rodents and DOC imports stored at the airport are negligible for the contaminated rodents would not have effective contact with poultry. DOC imports on the other hand would not also have any appreciable contact with the transiting wild birds at the airport.The risk with the resident wild birds shall be reduced by strengthening the biosecurity system in the holding site at the airport. The risk with contaminated staff shall be reduced through following proper clothing and sanitary procedures including washing hands every time after handling the transit birds and disinfection of shoes.

It should be noted, however, that this qualitative probability estimate is associated with a high level of uncertainty. It is particularly high because of the lack of sufficient information on the species and number of resident wild birds living around the airport, their susceptibility and virus shading behaviour and their contact rate with domestic poultry population. So, care need to be taken in the interpretation of the results.

Data gaps and recommendation for future research

As indicated above, the major data gaps relate to lack of knowledge on the number and species of wild resident birds around the airport, their contact rate with domestic poultry population, their susceptibility to H5N1 HPAI virus, virus shedding behaviour and carrier status as well as number of poultry population around the airport. More studies are required to:

- identify species and number of resident wild birds available around the airport,
- identify those species of resident wild birds that are most closely associated with poultry holdings and their frequency of contact with domestic poultry population
- determine their susceptibility, carrier status and virus shedding behaviour, and
- To better understand/Know number and spatial distribution of poultry farms around the airport

9 Risk Assessment for Transmission of HPAI H5N1 between large scale commercial farms and small scale poultry farms

Risk Question 3*: What is the risk of transmission of HPAI (H5N1) from large commercial poultry farms to small scale poultry farms and vice versa?*

This assessment is based on data collected from a model district, Ada'a Liban, where both commercial and small scale commercial farms are present, in large number. Most data were collected using a structured questionnaire that had been distributed to a number of experts in the poultry industry to fill out either in groups (especially those working in the same institution) or individually.

Two separate risk questions were used to assess the likelihood of transmission of the disease between large scale commercial farms and small scale poultry farms. These are:

1. What is the risk of transmission of HPAI (H5N1) from large commercial poultry farms (LSCF) to small scale commercial poultry farms (SSCF)?

2. What is the risk of transmission of HPAI (H5N1) from small scale commercial poultry farms poultry farms (SSCF) to large scale commercial poultry farms poultry farms (LSCF)?

For each risk question, transmission pathways were developed, including both release of H5N1 from a farm and exposure of other farms to the virus. This chapter describes the structure of these transmission pathways and provides qualitative risk estimates for each level of pathway. An overall risk estimate for each pathway was obtained by combining risk estimates of release and exposure components.

For each of these risk questions, we considered a scenario where an initial farm was infected with HPAI H5N1, and assessed the risk of transmission to other farms. In the initially infected farm it was considered that, since HPAI H5N1 is a highly infectious disease, it rapidly spread to the whole flock or shed once introduced.

9.1. Risk question 1: Risk of transmission of HPAI (H5N1) from large scale commercial to small scale commercial poultry farms

9.1. 1. Overview of information required

The risk factors that were considered as being relevant for the transmission of HPAI H5N1 from LSCF to small SSCF, and therefore considered as constituting independent pathways, are: staff movement, equipment exchange, visitors, sales of compost/manure, sales of live poultry, sales of feed and farm bridge species such as dogs, cats and scavenging birds (vultures). The information required for each of the risk factor is depicted in table 9.1 below.

Table 9-1 Data required for the assessment of H5N1 HPAIV transmission from LSCF to SSCF

Transmission pathways from LSCF to SSCF	**Data required**
Risk of transmission of HPAI (H5N1) through staff movement from LSCF to SSCF	• Number of staff working in LSCF having access to SSCF • Frequency of movement of staff from LSCF to SSCF • Biosecurity level of the LSCF • Biosecurity level at SSCF • Survival of the virus on cloths and premises used • Contact with poultry in LSCF and SSCF
Risk of transmission of HPAI (H5N1) from LSCF to SSCF through sales of live poultry (DOC, pullet and cockerels)	• Number and frequency of sales of live poultry by LSCF to SSCF • Quarantine practices
Risk of transmission of HPAI (H5N1) from LSCF to SSCF through equipment exchange and movement of vehicles.	• Existence of equipment exchange system and type of equipment exchanged • Frequency of exchange • Survival of the virus on equipment • Biosecurity level in LSCF & SSCF • Vehicles use (carry poultry, products equipment etc)
Risk of transmission of HPAI (H5N1) from LSCF to SSCF through visitors	• Number and type of visitors • Frequency of movement
Risk of transmission of HPAI (H5N1) from LSCF to SSCF through selling compost/manure	• Practice of moving compost/manure from LSCF to SSCFs • Volume and frequency of compost to SSCF • Survival of the virus through the composting process
Risk of feed in LSCF being contaminated and transmit the disease to SSCF	• Practice of selling to SSCF • Number of SSCF buying • Volume and frequency of selling • Survival of the virus in the feed
Risk of transmission of HPAIV(H5N1) from LSCF to SSCF through farm bridge species (dogs, cats and vulture) contaminated/ infected at LSCF	• Disposal practice of dead bodies at LSCFs • Access of dogs, cats and vulture to disposal pits at LSCF • Survival of the virus in carcass of dead birds and also fur of dogs cats and vulture • Susceptibility of dogs, cats and vulture to HPAI H5N1 virus • Frequency of contact between dog/cats/vulture and poultry in SSCF

9.1.2. Risk of transmission of HPAI (H5N1) through staff movement from LSCF to SSCF

Release: Risk of staff being contaminated at LSCF

Given that large commercial farms are infected with H5N1 HPAIV, the release of the virus via staff depends on the prevalence of infection in LSCF, detection-reporting -banning practices, number of staff working with LSCF having access to SCCF, proportion of staff that have contact with poultry, frequency of visit to SCCF, biosecurity level in both LSSF and SSCF, survival of the virus in the environment and the level of awareness of the LSCF staff.

Information available

Humans are potential mechanical vectors that facilitate the transmission of HPAI H5N1 virus from one farm to the other. Those whose occupations require them to have close and frequent contact with poultry are particularly considered to be the highest risk group.

The H5N1 HPAIV can survive for many weeks in wet poultry manure at a temperature of $4^{o}C$ to $25\,^{o}C$ for up to 10 days and at 25-32 ^{o}C for up to 4 days. The virus dies within a day or two in dry faeces. The concentration of virus shed in poultry faeces is high. A gram of infected faeces can contain as many as ten billion infectious viruses. People can carry contaminated manure from one infected LSCF to SSCF. It is thought that a small amount of contaminated dust adhering to boots or clothing is sufficient to transmit the virus from an infected LSCF to SSCF (Power, 2005).

The analysis of the opinions given by the experts revealed that 75% of the staff working in LSCF has direct contact with poultry on the farm. They also indicated that movement of staff from LSCF to SSCF is a common practice in all farms. About 9% of the staff of LSCFs have their own small scale commercial farms and another 8% work in other SSCFs on part time basis. Even under conditions where contagious disease is suspected, only 12 % of the staffs are likely to stop visiting other farms (Opinion provided by Alema, Genesis and ELFORA farms senior experts and veterinarians).

The biosecurity level of most LSCF is not as high as it is supposed to be. Only about 70% of the farms require their staff to use foot bath and or change their cloths and shoes when entering or leaving the farms (Opinion provided by Alema, Genesis and ELFORA farms senior experts and veterinarians). This opinion is in agreement with that made by Abebe Wossene (2006) in his assessment of the biosecurity level of the large commercial farms. He reported that the practice of using foot baths was non existent in some of the commercial farms visited. He further described that some of the footbaths did not have the disinfectant as the farms could not frequently replenish them especially in the dry season.

Given such a significant number of staff having direct contact with poultry in LSCF, their frequent movement between LSCFs and SSCFs, poor biosecurity levels in some of the farms, stability of the virus in contaminated material (especially at low temperatures) and low level of awareness of the staff about the disease; the risk that the virus will be transmitted to the SSCFs through movement of staff is therefore assessed to be **very high with high uncertainty.**

Exposure: Risk of exposure and transmission of H5N1 HPAI virus to SSCF poultry through movement of staff from LSCF

Abebe Wossene (2006) reported that the biosecurity level in most SSCF is very poor. The findings from the analysis of expert opinions also indicated that the biosecurity system is almost non existent.

Given the capacity of the virus in the faeces to survive up to four days in 25-32 ^{o}C, and the safeguard system in the SSCF is poor, the virus from LSCF can be transported to SSCF through contaminated staff. Therefore it is assessed that the risk of exposure and transmission of H5N1 HPAIV to SSCF poultry through movement of staff from LSCF is **high with high uncertainty**.

9.1.3. Risk of transmission of HPAI (H5N1) from LSCF to SSCF through sales of live birds (DOC, pullet and cockerels)

Release: Risk of releasing contaminated DOC, pullet and cockerels from LSCF

SSCFs usually obtain their replacement flocks from LSCFs, for example DOCs, pullets and cockerels. About 35% of the SSCF buy pullets and cockerels from LSCF. In Ada'a Liban, 11 SSCFs are supplied with DOCs from LSCFs every week.

Data obtained from the experts revealed that up to 20% of the LSCF may not report cases suspected as being HPAI. Even from the 80% who are likely to report, some 15% are not likely to comply with regulations. It is therefore possible that infected day old chicks and pullets/cockerels incubating the disease, especially in the first few days after the disease has been introduced into the flock, may be sold to SSCF while the information on their infection status is concealed.

Considering the fact that 20% of the LSCFs may not report cases suspected as being HPAI and 15% of those reporting are also not likely to comply with ban practices along with the poor biosecurity system in both types of farmers, the risk of releasing contaminated/infected DOC, pullet and cockerels from LSCF is **medium with high uncertainty**.

Exposure: Risk of exposure and transmission of H5N1 HPAI virus to SSCF poultry through live poultry movement

During an outbreak, farmers tend to be more concerned about the biosecurity of their chicken and are likely not to buy DOC/pullets/cockerel from infected farms. However, the risk of exposure of the disease through live poultry may occur in the early days of an outbreak before it becomes generalized (i.e. massive mortality is encountered), as up to 20% of the LSCF may not report cases suspected as being HPAI and even from the 80% who are likely to report, some 15% are not likely to comply with regulations (properly implement ban) and continue to sell live poultry. During this time, contaminated DOCs and Cockerels/pullets incubating the disease may be brought to SSCF. Given that new DOCs and Cockerels/pullets are not usually quarantined before being mixed with the flock in the farm, the probability that infection is transmitted to poultry in the SSCF is considered **high with high uncertainty**.

9.1.4. Risk of transmission of HPAI (H5N1) from LSCF to SSCF through equipment and vehicle exchange.

Release: Risk of releasing contaminated equipment and vehicle from LSCF

As described in the earlier sections, the virus in faeces can remain infective for about four days in temperature of 25-32 ^{o}C. A gram of infected faeces can contain up to ten billion of infectious viruses. Small amounts of contaminated manure may be carried in soiled equipments that are often shared between LSCF and SSCF. It is common for LSCF and SSCF to share equipment such as vaccination kits, crates and vehicles.

About 65% and 35% of the SSCF do get vaccination equipment and vehicles from LSCF respectively. The frequency with which the SSCFs use the vaccination equipment from the LSCFs is in the order of once per week. About 7% of the SSCF leave crates at LSCF and organize a system of rotation for the delivery of equipment. Crates in the LSCF shall be contaminated with infected faeces.

Vaccination equipment, crates and vehicles used for transporting chicks/pullets/cockerel may get contaminated at the large farm and carry the virus to the SSCF. With the low level of biosecurity in LSCFs, there is a high possibility of introducing the virus to SSCF when these equipment are exchanged. The risk for introduction of HPAI H5N1 from LSCF to SSCF through movement of equipment and vehicles is therefore assessed to be **high with high uncertainty**.

Exposure : Risk of exposure and transmission of HPAI H5N1 virus to SSCF poultry through contaminated equipment

Biosecurity levels in most small scale commercial farms are very poor; this makes them to be very vulnerable to disease incursions. Most farms are unlikely to disinfect or thoroughly clean and dry their equipment on sunlight. The likelihood of exposure of the poultry in SSCF to H5N1 HPAI from LSCF through equipment/vehicle exchange is therefore **high with high uncertainty**.

9.1.5. Risk of transmission of HPAI (H5N1) from LSCF to SSCF through visitors

Release: Risk of visitors being contaminated from LSCF

Visitors contaminated with infected faeces at the LSCF can transmit the disease to the SSCF in the same way as staff contaminated with infected faeces (section 9.1.2). The difference lies with the frequency of movement and probability of being contaminated. LSCF have 10-15 visitors per week. About 12% of them have contact with poultry. Accordingly the risk for release of HPAI H5N1 from LSCF through movement of visitors is assessed to be **medium with high uncertainty** as the level of contamination is not as high as that of staff.

Exposure: Risk of exposure and transmission of H5N1 HPAI virus to SSCF poultry through movement of visitors from LSCF

The biosecurity system is so poor and the probability of exposure of the poultry population in SSCF is therefore **medium with high uncertainty**.

9.1.6. Risk of transmission of HPAI (H5N1) from LSCF to SSCF through selling compost/manure

Release: Risk of releasing contaminated compost/manure from LSCF

Compost selling by LSCF to SSCF is not a common practice in Ada'a Liban district. Compost from LSCFs is often sold to ornamental tree and horticultural crop growers and cattle owners (as feed). Composting of infected bird carcasses has been shown to lead to shortened periods of viral stability (Senne et al., 1994). As the litter is relatively old, the amount of virus remaining is likely to be low. The low pH and high temperature resulting from the fermentation process will also make the survival rate low. The risk for the introduction of the H5N1 HPAI from LSCF to SSCF through compost is **negligible with medium uncertainty**. Hence, the probability of transmitting the infection is not assessed further.

9.1.7. Risk of feed in LSCF being contaminated and transmit the disease to SSCF

Release: risk of releasing contaminated feeds from LSCF

Most SSCFs do not prepare their own feed. They buy feed from companies that produce only commercial feed or from LSCFs having a feed processing unit along with the breeding stock. The frequency with which SSCF buy feed is about 2-3 times per month. The feed manufacturing process is sufficient enough to kill the virus. The contamination should therefore be after production of the feed. Contamination of feed with faeces is possible but the extent of this happening is usually small as the area for production and storage of feeds is separate from where poultry are kept. The staffs working in the feed mills are also different from those working in poultry sheds. The likelihood of the commercial feed to be contaminated with infected faeces is therefore considered **very low with medium uncertainty**.

Exposure: Risk of exposure and transmission of HPAI H5N1 virus to SSCF poultry through contaminated feeds

Since the frequency of purchase is 2-3 times per month (10-15 days), the virus might be able to survive in the first few days. There is therefore a possibility of poultry in the SSCF being exposed to the virus through feed from LSCFs. The probability is, however, assessed to be **low with high uncertainty.**

9.1.8. Risk of transmission of HPAIV(H5N1) from LSCF to SSCF through farm bridge species (dogs, cats and vulture) contaminated/ infected at LSCF

Release: Risk of dogs, cats and vulture infected/contaminated with H5N1 HPAIV from dead bodies disposed of in an open space or from feces on LSCF.

Most large commercial farms do not have closed pits for disposal of waste and dead bodies. Only 10% of them have it (Opinion provided by Alema, Genesis and ELFORA farms senior experts and veterinarians). Vultures are abundant in the study area. They have unlimited access to the open pits in the LSCF. Stray dogs and cats are also common. Access to pits for dogs and cats varies from farm to farm depending on the type of fences used. In some farms the fences are so high and tight denying access to dogs and cats, and in some (for example Alema Farm) the fences are short so that prohibition of cats and dogs is not possible (Abebe Wossene, 2006).

The potential role of cats and dogs in the epidemiology of H5N1, after natural infections, were reported in different countries. Domestic cats were found susceptible to H5N1 HPAI infection (Kuiken et al., 2004). In addition, results from experimental studies supported field observations: cats shed the virus and are able to transmit the infection to other cats, thus potentially to other animals (Burgos & Burgos, 2007; Thiry et al., 2007; Marschall & Hartmann, 2008; Beeler, 2009). Although results from experimental studies show that dogs can also be infected with H5N1 (Riks et al., 2007; Burgos & Burgos, 2007; Giese et al., 2008), their susceptibility seems lower and their shedding is reduced, suggesting that they are unlikely to play a role in the transmission of the disease (Beeler, 2009).

Vultures are also susceptible to H5N1 HPAIV infection. Virus transmission from domestic to wild birds has rarely been observed but it appears to be a likely scenario since vultures feed on dead poultry. During an outbreak of HPAI (H5N1) in an intensive farming system in Ouagadougou in 2006, a large group of vulture showed clinical disease and virus isolation on samples from 3 birds confirmed infection with HPAI H5N1 (Ducatez M.et al., 2007)

In addition to the risk of infection of cats, dogs and vulture, the possibility of animals acting as mechanical vectors may exist. There is no direct evidence showing animals acting as mechanical vectors in the transmission of H5N1 HPAIV, and the opinion that "dogs and cats are less likely to be a mechanical vector as they groom and clean themselves regularly" has been expressed (Songserm, expert opinion, in: Ksemsuwan S. et al., Qualitative Risk Assessment of HPAI Risk Introduction and Transmission in Industrial Poultry Farms in Thailand 2008 available at http://www.hpai-research.net/working_papers.html). However, because of the concentration of virus in feces and its survival, HPAI H5N1 could be transmitted between farms by animals becoming contaminated (Alexander D.J., 2007). In addition, virus survival in carcasses has been demonstrated to occur and may play a significant role in local spread of infection among wild birds, and for infection of scavenging species. The virus can survive in carcasses of infected animals for a varying period of time, which will depend on environmental temperature. The period of infectivity will increase with decreasing temperature (EFSA ,2006).

With the access that these farm bridge species have to the open disposal pits at the LSCF or to areas contaminated with feces, the susceptibility of the species to the virus and survival rate of the virus in carcass and feces, the risk of dogs, cats and vulture being infected/contaminated with H5N1 HPAIV from dead bodies disposed of in an open space or feces from infected birds present on LSCF is therefore considered **high with medium uncertainty.**

Exposure: Risk of exposure and transmission of HPAI H5N1 virus to SSCF poultry population through farm bridge species (vulture, dogs and cats) infected/contaminated at LSCF

As described above these farm bridge species can potentially become infected/contaminated at LSCF. After infection, cats and birds such as vulture excrete the virus, which suggests that they could be a source of transmission (Burgos & Burgos, 2007; Thiry et al., 2007; Marschall & Hartmann, 2008; Beeler, 2009). Exposure of poultry in SSCF to the virus therefore depends on accessof farm bridge species, to the poultry house on other farms, and the type and duration - or frequency - of contact with the poultry population. As these animals do not stay close to poultry and the virus shedding behavior in cats is often through respiratory tract which requires close contact, the risk of exposure and transmission of HPAI H5N1 virus to SSCF poultry through infected/contaminated vulture, dogs and cats at LSCF is considered **low with high uncertainty**.

9.1.9. Overall conclusion on the H5N1 HPAIV (LSCF to SSCF) transmission pathways: release and exposure assessments

Table 9.2 presents the risk estimates for all risk pathways in the transmission of H5N1 HPAIV from LSCF to SSCF. Conditional on the LSCF being infected with H5N1 HPAIV, the overall risk of transmission to SSCF via staff movement, live poultry sales, equipment exchange, visitors, feed and farm bridge species is high.

Staff movement, live poultry sales and equipment/vehicle exchange represent high risks with high uncertainties. The risk could be reduced through increasing the awareness of the staff, gradually limiting staff working in LSCF from owning poultry farms or working in other poultry farms - although this may be an issue for economic reasons, avoiding equipment exchange when possible or more generally through improving biosecurity.

It needs to be recognized, however, that there are high uncertainties in the estimates. As much of the data used in this assessment is based on expert opinion, systematic data collection on all the parameters considered and further concretizing the information and adjusting the biosecurity system accordingly is required.

Table 9-2 Overall risk estimates: risk of transmission of HPAI from LSCF to SSCF

Pathways	Release		Exposure		Overall Risk	
	Risk	Uncertainty	Risk	Uncertainty	Risk	Uncertainty
Staff movement	Very high	High	High	High	High	High
Live poultry	High	High	High	High	High	High
Equipment exchange	High	High	High	High	High	High
Visitors	Medium	High	High	High	Medium	High
Feed	Very low	Medium	Low	High	Very low	High
Farm Bridge species	High	Medium	Low	High	Low	High

9.2. Risk question 2: Transmission of HPAI (H5N1) from small scale commercial poultry farms (SSCF) to large scale commercial poultry farms (LSCF)

9.2.1. Overview of information required for risk question 2

The risk factors relevant for the transmission of HPAI H5N1 from SSCF to small LSCF are staff movement, equipment exchange, visitors. The information required for the analysis of the pathways through which these factors would effect transmission is depicted in table 8.2.

Table 9-3 Data required for the assessment of H5N1 HPAIV transmission from SSCF to LSCF

Transmission pathways from SSCF to LSCF	Data required
Risk of transmission of HPAI (H5N1) through staff movement from SSCF to LSCF	• Number of staff working in SSCF having access to LSCF • Frequency of movement of staff from SSCF to LSCF • Biosecurity level of the SSCF & LSCF • Contact with poultry in LSCF • Survival of the virus on cloths and premises used
Risk of transmission of HPAI (H5N1) from SSCF to LSCF through equipment exchange	• Existence of equipment exchange system and type of equipment exchanged • Frequency of exchange • Survival of the virus on equipment • Biosecurity level • Vehicle (carry poultry, products equipment etc)
Risk of transmission of HPAI (H5N1) from SSCF to LSCF through visitors	• Number and type of visitors • Frequency of movement
Risk of transmission of HPAIV(H5N1) from SSCF to LSCF through farm bridge species (dogs, cats and vulture) contaminated/ infected at SSCF	• Disposal practice of dead bodies at SSCFs • Access of dogs, cats and vulture to disposal pits at SSCF • Survival of the virus in carcass of dead birds and also fur of dogs cats and vulture • Susceptibility of dogs, cats and vulture to HPAI H5N1 virus • Frequency of contact between dog/cats/vulture and poultry in LSCF

9.2.2. Risk of transmission of HPAI (H5N1) through staff movement from SSCF to LSCF

Release: Risk of staff being contaminated from SSCF

The role of staff movement in the transmission of H5N1 HPAI virus from one farm to the other and the stability of the virus in the faeces and contaminated dust adhering to boots and clothing are discussed in section 9.1.2 of this report.

Analysis of opinion of experts revealed that about 92% of staffs working in SSCFs have direct contact with poultry on the farm. Movement of staff from SSCF to LSCF is a common practice in all farms because 20% of staffs of SSCF work in LSCF.

The biosecurity level of most SSCFs is very poor and they do not have disinfection and sanitary facilities (foot bath, washing facilities). The type of housing used does not prevent predators, rodents and wild birds from coming in contact with poultry. The SSCF also do not have isolation rooms for sick birds (Abebe Wossene, 2006). It is only about 7% of the farms that require their staff to use foot bath and or change their cloths and shoes when entering or leaving the farms (Opinion provided by Alema, Genesis and ELFORA farms senior experts and veterinarians).

Given such significant number of staff moving into the SSCF, presence of poor safeguarding system, the risk of release of HPAI H5N1 from SSCF through movement of staff is therefore assessed to be **high with high uncertainty**.

Exposure: Risk of exposure and transmission of H5N1 HPAI virus to poultry within LSCF through movement of staff from SSCF

Abebe Wossene (2006) reported that the biosecurity level in most LSCF has some omission which will expose the poultry population to H5N1 HPAI virus. The findings from the analysis of expert opinions also indicated that 30% of the farms do not require their staff to use foot bath and or change their cloths and shoes when entering or leaving the farms (Opinion provided by Alema, Genesis and Elfora farms senior experts and veterinarians).

Given the capacity of the virus in the faeces to survive up to four days in 25-32 ^{o}C, and the low biosecurity levels in some of the LSCF, the virus from SSCF can be transported to LSCF through contaminated staff. The transmission could however be not as high as from large to small commercial farms because of better biosecurity system in LSCFs. Therefore the risk of exposure and transmission of H5N1 HPAI virus to poultry within LSCF through movement of staff from SSCF is assessed **medium** with **high uncertainty**.

9.2.3. Risk of transmission of HPAI (H5N1) from SSCF to LSCF through equipment /vehicle exchange

Release: Risk of releasing contaminated equipment from SSCF

The stability of H5N1 HPAI virus in faeces and contaminated equipment as well as its role in the transmission from one farm to the other is discussed in section 9.1.4 of this document.

Crates, vehicles and sacks are some of the items that are exchanged between SSCF and LSCF. Vehicles from LSCF often enter into the SSCF (35%) to deliver poultry, feeds and other inputs. Some LSCF also leave crates (24%) and sacks (6%) at the SSC to be collected later following an established rotational system that involves a network of farms (Opinion provided by Alema, Genesis and ELFORA farms senior experts and veterinarians)

These delivery facilities will have a very high likelihood of being contaminated with faeces in the SSCF and would be carried to LSCF with these contaminants as the disinfection process in SSCF is poor.

The risk of release of HPAI H5N1 from SSCF through movement of equipment and vehicles is therefore assessed to be **high with high uncertainty**.

Exposure: Risk of exposure and transmission of HPAI H5N1 virus to LSCF poultry through contaminated equipment from SSCF

The biosecurity system in most LSCFs is not always good though it may reduce the risk of exposure of poultry to a number of diseases. There is, however, a possibility that the H5N1 HPAIV may be transmitted from SSCFs to LSCF via equipment and vehicles. The likelihood of exposure of the poultry in LSCF to H5N1 HPAI from SSCF through equipment/vehicle exchange is therefore **medium with high uncertainty**.

9.2.4. Risk of transmission of HPAI (H5N1) from SSCF to LSCF through visitors

Release: Risk of visitors being contaminated from SSCF

Visitors contaminated with infected faeces at the SSCF can transmit the disease to the LSCF in the same way staff contaminated with infected faeces do (section 9.1.2). The difference lies with the frequency of movement and probability of being contaminated. Each SSCF have 15 visitors per week. About 90% of which have contact with poultry. Accordingly the risk of release of HPAI H5N1 from SSCF to LSCF through movement of visitors shall be assessed **medium with high uncertainty** as the level of contamination is not as high as that of the staff.

Exposure: Risk of exposure and transmission of H5N1 HPAI virus to LSCF poultry through movement of visitors from SSCF

The biosecurity system in LSCF has some role to play in minimizing the introduction of the hazard, as 70% of them have good system in place. The risk of exposure of the poultry population in LSCF from SSCF is therefore considered **medium with high uncertainty**.

9.2.5. Risk of transmission of HPAIV (H5N1) from SSCF to LSCF through farm bridge species (dogs, cats and vulture) contaminated/ infected at SSCFs

Release: Risk of dogs, cats and vulture infected/contaminated with H5N1 HPAIV from dead bodies disposed of in an open space at SSCFs.

The susceptibility, virus shedding behavior and contamination of the farm bridge species and stability of the virus in carcass are described under section 9.1.8. According to the opinion provided by Alema, Genesis and Elfora farms senior experts and veterinarians, it is only 3% of the SSCF do have closed pits for disposal of waste and dead bodies. As the biosecurity system in SSCF is very low, the farm bridge species have unlimited access to the open disposal pits. The risk of dogs, cats and vulture getting infected/contaminated with H5N1 HPAIV from dead bodies disposed of in an open space at SSCFs is therefore **very high with high uncertainty**.

Exposure: Risk of exposure and transmission of HPAI H5N1 virus to LSCF poultry population through vulture, dogs and cats infected/contaminated at SSCF

As described under section 9.1.8 exposure of poultry in LSCF to the virus through vulture, dogs and cats infected/contaminated at SSCF depends on access of these animals to poultry houses, type and duration or frequency of contacts with the poultry population. As the biosecurity system in large commercial farms is relatively tight, farm bridge animals do not stay close to poultry and the virus shedding behavior is often through respiratory tract which requires close contact; risk of exposure and transmission of HPAI H5N1 virus to LSCF poultry through vulture, dogs and cats infected/contaminated at SSCF is assessed **very low with high uncertainty**.

9.2.6 Overall conclusion on the H5N1 HPAIV (SSCF to LSCF) transmission pathways:

Table 9.6 presents the risk estimates for all risk factors assessed for transmission of H5N1 HPAI from SSCF to LSCF. Given the SSCFs are infected with H5N1 HPAI virus, the risk of transmission to LSCF via staff movement, equipment exchange and visitors is medium with high uncertainty.

As the biosecurity system in SSCF is very low the most important action that can be taken to reduce the risk is to improve the biosecurity system. Increasing the level of awareness of the small scale commercial farmers and providing proper follow-up, incentive for compliance and support through Government extension system may help to enhance the level of biosecurity of these farms.

As had been suggested for LSCF to SSCF pathways, there is also a need to collect more data for a thorough assessment of SSCF to LSCF risk pathways. This may identify extra biosecurity issues that might be addressed to reduce the risk of transmission of the disease between the farms.

Table 9-6 Overall risk estimates: transmission of HPAI from SSCF to LSCF

Pathways	Release		Exposure		Overall Risk	
	Risk	Uncertainty	Risk	Uncertainty	Risk	Uncertainty
Staff movement	High	High	Medium	High	Medium	High
Equipment exchange	High	High	Medium	High	Medium	High
Visitors	Medium	High	Medium	High	Medium	High
Farm Bridge species	Very high	High	very low	High	very low	High

10 Overall Summary and recommendations

10.1. Overall results

As it may be recalled from the proceeding sections, particularly section 5, the risk questions that were being addressed in this assessment are:

> *What is the risk of introduction of HPAI (H5N1) via legal and illegal trade of wild birds transiting in Ethiopia?*
>
> *What is the probability that domestic poultry in Ethiopia become infected by H5N1 HPAIV after the release of the virus by an infected traded wild bird transiting in Ethiopia?*
>
> *What is the risk of transmission of HPAI (H5N1) between large commercial poultry farms and small scale commercial poultry farms?*

For the first two risk questions the relevant conclusions drawn from this assessment are that the probability of release of H5N1 HPAIV into Ethiopia through transiting wild birds (via air) is very low (medium uncertainty) (Table 7.2) and the risk that domestic poultry in Ethiopia becoming infected by H5N1 HPAIV after the release of the virus by an infected wild bird on trade transit is medium with high uncertainty (table 8.4). The global risk estimate for the occurrence of H5N1 HPAI in poultry population in Ethiopia as a result of the introduction of the hazard through trade transiting wild birds (via air) is therefore assessed to be **very low with high uncertainty** (table 10.1) Using the interpretation given in Table 4.1, this means that the occurrence of the disease is very rare but cannot be excluded.

It is evident that the overall risk is very low as a result of the very low risk of introduction of the pathogen to Ethiopia through the BIPs. It is, however, important to note that if an infected wild bird on trade transit happens to reach at BIP, it can pass undetected for there is no reliable veterinary check at the airport and the virus can escape out of BIP easily for there are no appropriate holding facilities that can assure biocontainment of the virus. These steps in the release risk pathways should be considered as being critical control points where appropriate intervention measures can be applied. For the exposure risk pathways, resident wild birds and staff handling transiting birds contaminated with H5N1 HPAI and have poultry are important risk factors for the spread to the disease to the poultry population.

Table 10-1 Summary conclusions from the qualitative risk assessment on introduction of HPAI (H5N1) virus into Ethiopia Via wild birds transiting in the country and subsequent exposure of the domestic poultry population.

	Risk Pathway	Risk	Uncertainty
Release	A wild bird transiting in Ethiopia being infected with H5N1 HPAI virus.	Very low	Medium
Release	Detection of the infected	Very high	medium
Release	Biocontainment of the virus within the facility of the border inspection point should undetected infection from the transiting wild birds be present.	High	Medium

Overall risk estimate for the release		**Very Low**	**Medium**
Exposure	Probability of infection of resident wild birds after exposure to H5N1 HPAI from wild birds on trade transit and transmitting the virus to poultry population	Medium	High
Exposure	Probability that staff handling live and dead wild birds on trade transit get contaminated with H5N1 HPAI and transmit to poultry population	Low	high
Exposure	Probability that vermin (rodents) get contaminated with H5N1 HPAI and transmit the virus to poultry population	Negligible	Medium
Exposure	Probability that wild birds on transit kept at airport infect DOC imports stored in the airport and the DOCs transmit H5N1 HPAI to the poultry population.	Negligible	Medium
Overall risk estimate for the Exposure		**Medium**	**High**
Summary: Release-exposure combined	**Probability of occurrence (Release X Exposure) of HPAI (H5N1) in poultry population of Ethiopia as a result of wild bird trade transiting in Ethiopia**	**Very low**	**high**

As described in the glossary and definitions section, the consequence/transmission assessment in the context of this study determines the risk of transmission of H5N1 HPAI virus between large scale and small scale commercial poultry farms, following infection in a farm of either sectors. This assessment revealed that the most important risk factors in the transmission of HPAI (H5N1) from LSCF to SSCF are staff movement, sales of live poultry, equipment exchange and to lesser extent visitors (Table10.2). For the transmission of HPAI (H5N1) from small scale to large scale poultry farms, the most important risk factors are staff movement, equipment exchange and visitors (Table 10.2). The combined risk estimate for the transmission between LSCF and SSCF is summarized schematically in Fig 10-1.

Table 10-2 Combined risk estimates for the introduction and transmission of HPAI H5N1 between LSCF and SSCF

Pathways	Overall Risk			
	(LSCF to SSCF)		(SSCF to LSCF)	
	Risk	Uncertainty	Risk	Uncertainty
Staff movement	High	High	Medium	high
Live poultry	High	High	-	-
Equipment exchange	High	High	Medium	high
Visitors	Medium	High	Medium	high
Feed	Very low	High	-	-
Farm bridge species	Low	High	Very low	high

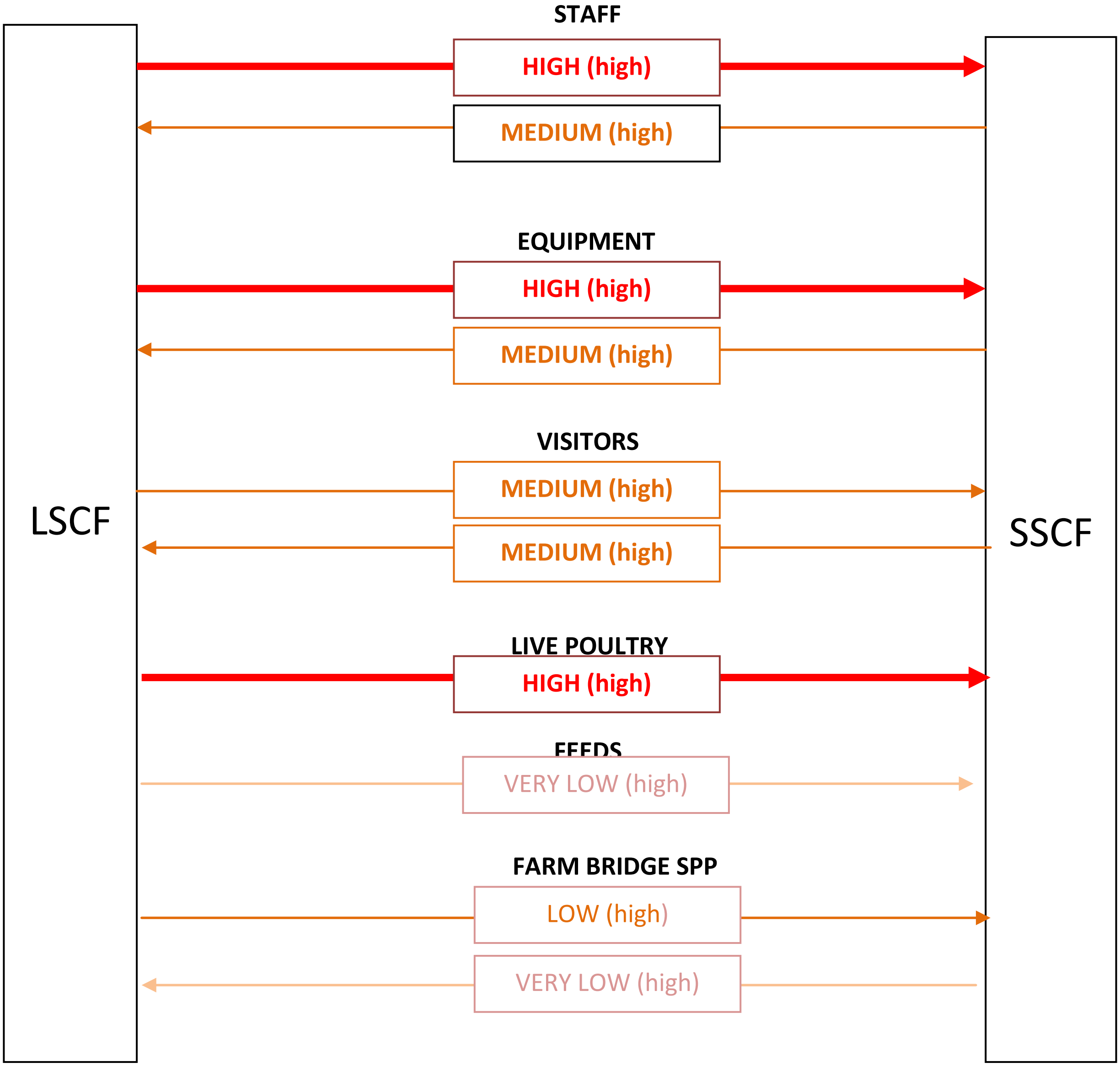

Figure 10-1 Overview of the Risk estimates (and uncertainty) for the different transmission pathways between Large Scale Commercial Farm (LSCF) and Small Scale Commercial Farm (SSCF).

10.2. Recommendations for preventive control measures

The critical control points that need to be emphasised and actions to be taken in order to reduce the risks of introduction, subsequent exposure of poultry population and transmission of the virus between LSCF and SSCF are suggested as follows:

10.2.1. Introduction and subsequent exposure of the poultry population

To reduce the risk of introduction of H5N1 HPAI and subsequent exposure of the poultry population through transiting wild birds, enforcement of the following measures would make a large contribution:

10.2.1.1. Ethiopia should require transit permit from wild bird exporting countries. The permit should ensure that the exporting country must be a member of the OIE and the consignment is accompanied by an animal health certificate (valid for 5 days only), signed by an official veterinarian, guaranteeing that :

- The birds have been kept for at least 21 days or since hatching on a holding registered by the competent authority of the exporting country.
- The birds have been examined on the day of loading and showed no clinical signs of disease and were fit to travel.
- The crates or cages are being used for the first time or have been cleaned and disinfected as instructed by the competent authority, allow visual inspection of the birds and contain only birds from the same establishment.

10.2.1.2. Currently there is no veterinary check and follow-up of wild birds trade transiting in Ethiopia. This risk assessment revealed that the absence of veterinary check at the BIP (airport) has high risk for the introduction of the virus through transiting wild birds. It is recommended that a unit responsible for the checking/inspecting wild birds transiting the BIP be established. Alternatively, the Bole International Airport Animal and Animal Products Quarantine and Inspection Units could be mandated to carry out this inspection in addition to the other responsibilities they have.

10.2.1.3. Absence of appropriate holding facility for keeping the transiting wild birds in the airport is another critical factor associated with high risk of introduction. The waiting ground does not preclude the resident wild birds and rodents from accessing the holding ground. They also do not have disposal pits and a room for isolating those birds that are found sick on arrival. The risk of the H5N1 HPIV escaping from the facility should it be introduced via transiting wild birds is high. The facility should therefore be refurbished.

10.2.1.4. Wild bird transit attendants should be trained on safe handling of transit birds and provided with sufficient protective clothing that should always be used within the facility. The facility should also introduce biosecurity practices such as discouraging the use of street clothes while handling birds, washing hands before and after work and disinfecting equipment used in the facility periodically.

10.2.1.5. Enhance the biosecurity of the small scale poultry farms around the airport so that the poultry population around the airport is not exposed to the resident wild birds that have come in contact with the transiting birds or fomites. The biosecurity practices are difficult to apply in backyard poultry production system. Though difficult to implement as there is no incentive for the farmers, educating farmers on the subject and undergoing active surveillance in the poultry around the airport may help.

10.2.2. Measures that should be taken to reduce the risk of transmission of H5N1 HPAI from LSCF to SSCF and vice versa.

Results of the risk assessment revealed that movement of staff, sales of live poultry, equipment exchange and visitors are important risk factors in the transmission of the virus.

10.2.2.1. Staff movement and visitors

- The movement of staff from large to small scale commercial farms is attributed to the fact that some of the staff own small scale poultry farms and some are moving for they are paid for the service they render. Such a practice carries very high risk of cross contamination from the biosecurity point of view and should be discouraged/stopped. To this end Staffs working in large poultry farms could be advised/convinced not to own poultry of their own. As this might have potential economic implication on staff at LSCF, if substantial proportion of income of the staff comes from SSCF visit, it is necessity to look for alternative sources of income.
- Provide protective clothing, including boots, to anyone visiting the flock
- Prevent access of strangers to areas where poultry are housed
- Provide baths with disinfectant for boots
- Ensure that all clothing used on the farm does not leave the farm
- Ensure that all animal health officials and visitors visiting affected premises are conscientious that they could be responsible for spread of infection and disease

As to why those factors mentioned above are not respected requires Knowledge, Attitude and Practice (KAP) assessment, which was not covered in this study of the individual farms. But it seems more of economic reason as maintaining good level of biosecurity and sanitary measures have substantial cost implications. Abebe Wossene (2006), in his study on poultry biosecurity in Ethiopia reported that the dry weather in the study area which requires frequent replenishment, in fact economic reason, is one reason that the owners ascribe to. Undertaking cost benefit analysis to show farmers that maintaining biosecurity has advantage over the statuesque should also be considered.

10.2.2.2. Equipment/vehicle exchange

- Avoid exchange of equipment if possible; if exchanging cannot be avoided make sure that it is well cleaned, dried and disinfected before use.

- Thoroughly clean and disinfect vehicle entering and leaving the farm, the tires and under carriage of the vehicle should be included in the process

10.2.2.3. Live poultry

- Before taking the live poultry from LSCF ensure that flock are healthy; obtain health certification if possible
- Establish a quarantine area for housing new animals, keeping them away from flocks already on the farm
- Use separate workers to handle the different animals if possible, if separate workers cannot be used, handle and feed the new animals last

10.3. Quality of data used

The data for the exercise was obtained from literature, face to face questionnaire (Airport data), reports (wild life authority and customs posts) and expert opinion elicitation process. The quality varies with the source it is drawn from.

10.3.1. Data from the airport and border posts

Data from the airport was acquired from structured questionnaire administered to the transit cargo supervisor at the airport. With regard to the responses from cargo supervisor, we were able to capture almost all information sought. We noted, however, that systematic documentation of information on transiting wild birds is lacking so that retrieving the required data was not an easy task. Because of this, figures with respect to number of transiting birds were estimations by the transit supervisor based on ranges from various transits. This, together with the fact that the information was obtained from one respondent (the supervisor) may have caused certain deficiencies in the quality of the data (figures of wild birds transiting each time). Attempts to substantiate the responses of the cargo supervisor with an input from the quarantine and inspection post head based at the airport did not yield much, as people in the quarantine and inspection post were not involved (had no access) in the transiting wild birds inspection activity.

Data from road-check points on the border line with neighboring countries was obtained from boarder customs posts through Wild Life Authority. The monthly compilations of the reports have some interruptions and this in itself may have an impact on the quality.

10.3.2. Data from expert opinion elicitation

The quality of information from expert opinion is determined by the skill of the expert whose opinion is sought on the subject. The data used for the transmission assessment is largely based on the opinion of experts drawn from commercial farms as others whom we considered as potential “experts” fail to reply acknowledging that they are not good to respond to this kind of questionnaire, despite our persistent efforts to make it clear. The fact that the opinion response used for this qualitative risk originated from senior staffs working in LSCF who have also exposure to SSC somehow enhanced the data quality. Nevertheless, as it is based purely on their opinion and the variability observed among experts on responses to certain issues gives hint that there might be some deficiencies in the quality of the data and interpretations should be made carefully.

With this regard we tend to suggest that such data gathering should be done in a kind of opinion elicitation workshops, as this could improve data quality, where experts come together and will be briefed to have common understanding about the intended exercise.

10.4. Data gaps and Recommendations for future research

In general, depending on the availability of data, risk estimations can be performed in qualitative or quantitative ways. This risk assessment is conducted as a qualitative assessment, as most of the quantitative data required for each input parameter in the risk pathways were not available or sufficient (data gaps) to carry out quantitative analysis.

The following are data gaps identified and future research areas suggested:

10.4.1. Release

- From the 11 species of wild birds trade transiting in Ethiopia, only three (Zebra finches, Budgerigars and parrots) have some data on their susceptibility to the virus. Virological studies to determine the virus shedding behavior and carrier status of these three species of wild birds need to be conducted, and degree of susceptibility, virus shading behaviour and carrier status for the remaining eight species should also be investigated.
- Assessing the reliability of the surveillance and certification procedure applied in the exporting countries is also an area that should be looked into.

10.4.2. Exposure

- Studies to:
  - identify species and number of resident wild birds available around the airport,
  - identify those species of wild birds that are most closely associated with poultry holdings,
  - determine their susceptibility, carrier status and virus shedding behaviour; and
  - investigate methods that shall improve the biosecurity system in backyard poultry are required
  - Determine contact rate and frequency of contact of resident wild birds with both transiting wild birds and domestic poultry population surrounding the air port

10.4.3. Transmission between large and small commercial farms

- As much of the data used in this assessment was based on expert opinion, good record keeping of inputs/outputs/visits and practices in large scale commercial poultry farms and sample based or systematic data collection on small scale commercial poultry farms on the parameters considered and further concretizing the information and adjusting the biosecurity system accordingly is required.

- There is also a need to find out the factors that discourage LSCF from maintaining the required biosecurity standards in the farms. Their practices may be influenced by economic considerations viz-a-viz the type and level of risk of exposure to diseases that are endemic in their areas of operation. Their practices may, however, change should the H5N1 HPIAV get into the country.

- According to the data from expert opinion elicitation questionnaire about 20% of the farmers would not report a suspicion of contagious disease suggestive of HPAI, Newcastle etc. and from the 80% that would report about 15% would not comply with regulations. Investigating the reason why they would not reporting and comply with regulations is important.

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12 Annexes

Annex 1. List of workshop participants

	Participant	Institute	Phone	Fax	Email
1	Dr Berhe Gerbreezgiabher	MOARD	911254377		berheg@gmail.com
3	Dr Mesfin Sahle	NAHDIC	251-1-0113380898	251-1-3380220	mesfinsahle@ymail.com
4	Negussie Negash	Poultry replication centre, Awasa	251-1-0916823352		
6	Dr Kifle Argaw	Wildlife Autority			kifleargaw@yahoo.com
7	Dr Melesse Balcha	NAHDIC	911544630		melesse_balcha2000@yahoo.co.uk
8	Nesiru Tekie,	Retailer	0112137395		-
9	Solenne Costard	RVC	+44 (0)1707666430		scostard@RVC.AC.UK
10	Hassen Chaka	NAHDIC	0911407988		hasscha@yahoo.com
11	Serge Nzietchueng	ILRI			s.nzietchueng@cgiar.org
12	Tadelle Dessie	ILRI			t.dessie@cgiar.org
13	Sally Crafter	ILRI			s.crafter@cgiar.org
14	Dr Wondwossen Asfew	SPS-LMM	0911695624		wondwosen@sig.ORG.ET
15	Dr Fekadu Shiferaw	Wildlife Autority	0911243537		fdesta@yahoo.com
16	Minaj Teki	Merkato trader	0112137398		
17	Laike Mariam Yigezu	SPS-LMM	0911686326		laike@siga.org.et

Annex 2

Questionnaire on the risk of introduction of HPAI to Ethiopia via wild birds transiting Bole International Airport, Addis Ababa

Introduction:

This questionnaire is designed to collect data for qualitative risk assessment of the risk of introduction of HPAI to Ethiopia via wild birds transiting through Bole International Airport, mainly, and via those traded/transiting by road. We would be grateful if you supported all or most of your responses with data or reports. You could also invite your colleague(s) to supplement your responses. The information that would be generated from this activity would help in planning HPAI surveillance in the country.

Section 1: Questions for the Airport (airline) and/or Customs staffs

Informant name (s) and position: ____

a. For each consignment of wild birds transited via the airport in the last six months, indicate:

#	Country of Origin	Spp.	Duration of flight	Number in consignment	Legality [a] (tick appropriate choice)		Remarks
					Legal	Illegal	
1							
2							
3							
4							
5							
6							
7							
8							
9							

N.B: [a] having transport certificate

b. Does the airport have facility/facilities specifically meant for holding transiting wild birds before being cleared?

Yes [___] No [___]

i. If Yes, can the facility/facilities be shared with other birds (poultry, DOC, etc)?
   Yes [___] No [___]

ii. Apart from the airport staffs, who else has access to the facility/facilities?
   ____

   ____

iii. How many times are these holding facilities cleaned in a week?
   ____

iv. Can I have a look at the holding facilities?
   Inspect them and indicate their status

   Appropriate [___] Inappropriate [___]

(Appropriate – aerated, ample space, sealed to exclude vermin/resident birds etc)

v. Can vermin/rodents access the holding facilities? Yes [___] No [___]
   If yes, indicate the species of vermin/rodents ____________________________

vi. Can the resident wild birds access the holding facilities? Yes [___] No [___]
   If yes, indicate the species of the resident wild birds________________________

vii. While in the airport, can transiting wild birds come in contact with:
   Fomite/Equipments e.g. cage, containers? Yes [___] No [___]

   Imported poultry feed? Yes [___] No [___]

   Day old chicks? Yes [___] No [___]

viii. Referring to question vii above, how long (in hours) would the contact be maintained (on average per transit) between wild bird and:
   Fomite/Equipments e.g. cage, containers or feed? ___________

   Imported poultry feed? _________________

   Day old chicks? ___________

c. In the last six months, did you receive any sick wild birds or was there a time when some developed illness while in the airport?
   Yes [___] No [___]

i. If Yes, give the following details for each consignment that had at least one bird sick/developed illness

#	Country of origin	Spp. of birds sick/developed illness	Number/proportion on sick in the batch	Action taken (euthanized, caged, returned, quarantined, Other)
1				
2				
3				
4				
5				

N.B: caged= kept outside in the airport; quarantined= kept in designated place for follow up

____

ii. Does the airport has a specific facility for keeping sick birds before any action is taken?

Yes [___] No [___]

d. In the last year, did you receive any dead wild birds in the consignments?
Yes [___] No [___]

i. If yes, indicate the following details for each consignment that has at least one dead wild bird:

#	Country of origin	Proportion dead in the consignment	Spp.	Disposal of dead birds		Decision on other live birds if present (euthanized, caged, returned, quarantined, Other
				Proper	Improper	
1						
2						
3						
4						
5						

N.B: Proper disposal – using closed pit with no access of vermin/other birds or burnt and buried

Caged= kept outside in the airport; quarantined= kept in designated place for follow up

ii. Does the airport has disposal pits? Yes [___]No [___]; If yes, can these pits be accessed by:

Vermin? Yes [___] No [___]

Resident wild birds? Yes [___] No [___]

Others animals (dogs, cats, etc) Yes [___] No [___]

e. For the staff working in the airline cargo section, indicate:

i. The number/proportion that deal directly, therefore come in contact, with transiting live/dead wild birds and average number of hours in which the staff directly handle wild birds per consignment

Action	# of Personnel involved	Average Contact hours	Remark
Loading /unloading			
Tow(from air craft side to cargo terminal or vice versa)			
Put in the designated facility			
Feeding and watering			

ii. Whether the staffs use protective clothing, disinfectants? Yes [___] No [___]

iii. Proportion of those staff working directly with transiting wild birds who keep poultry at home? _______________

f. Additional comments, suggestions and opinion provided (plus observation)
____
____
____
____
____
____

____

Section 2: Questions for the quarantine post staff at Bole airport

Informant **name (s) and position**: ____

a. For each consignment of wild birds transited via the airport in the last six months (and followed up by your staff (s)), indicate:

#	Country of origin	Spp	Susceptibility to HPAI	Number in the consignment	Legality[b] (tick appropriate choice)		Clinical exam done?		HPAI status of the exporting country (OIE report)	Remarks
					Legal	Illegal	Yes	No		
1										
2										
3										
4										
5										
6										
7										
8										
9										

N.B: [b] having health certificate

If mixed species – list all under remarks

i. Does the air port have appropriate holding facilities for holding transiting wild birds?

Yes [___] No [___]

ii. Do you attend (follow up) regularly all transiting wild birds at Bole air ports?

Yes [___] No [___]

If No, why? ____

b. If there has been any instance where sick wild Birds have transited the airport in the last six months, indicate the details of each consignment by:

#	Country of origin	Species	Susceptibility to HPAI (yes, no)	Number/Proportion of birds that were sick	Action taken by the quarantine staff (euthanized, caged, returned, quarantined, Other)	Were poultry/DOCs stored in same confinement? (yes, no)	Remark
1							

2							
3							
4							
5							
6							
7							
8							
9							

N.B: Caged= kept outside in the airport; quarantined= kept in designated place for follow up

i. Is there an appropriate place for holding sick birds at the airport before any action is taken: Yes [___] No [___]

ii. Is there a facility assigned to serve as quarantine for wild birds transiting the airport if there is a need to do so? Yes [___]   No [___]

iii. If yes, can the quarantine facilities be accessed by:

Vermin's/rodents? Yes [___] No [___]

If yes, indicate the species of vermin/rodents _______________________

Resident wild birds? Yes [___] No [___]

Species (incl. vultures) ______________

Susceptibility of the resident birds to HPAI_______________

Duration of time (in hours) over which resident birds are observed around quarantine facilities______

c. Is there a possibility of sick wild birds kept either at the airport or quarantined coming in contact with and/or contaminating via fomites (faeces, feed, equipment, cages, etc) that would be later taken out of the airport/quarantine?

Yes [___]   No [___]

i. How many times in a week is the quarantine cleaned? ___________________

d. If there have been cases of dead wild birds arriving at the airport, indicate the details of each consignment having at least one bird dead by:

#	Country of origin	Species	Proportion dead in the consignment	Susceptibility to HPAI	Action taken		Decision on other live birds if present (returned, caged, euthanized, other)	Remark
					proper	Improper		
1								
2								
3								
4								
5								
6								

N.B: If more than one species – list all under remarks

Proper disposal – using closed pit with no access of vermin/other birds or burnt and buried

i. If the airport has disposal pits, can these pits be accessed by:

Vermin? Yes [___] No [___]

Resident wild birds? Yes [___] No [___]

Other animals (e.g dogs, cats, etc) Yes [___] No [___]

e. For the staff working in quarantine at bole international airport, indicate:

i. The proportion that deal directly, therefore come in contact, with transiting live/dead wild birds _____________

ii. The average number of hours in which the staff directly handle wild birds per consignment ______________

iii. Whether the staffs use protective clothing, disinfectants? Yes [___] No [___]

iv. Proportion of those staff working directly with imported wild birds who keep poultry at home? _______________

f. Additional comments, suggestions and opinion provided (plus observation)

____
____
____
____
____
____

Section 3: Questions for the NAHDIC staff(s)

Informant name (s) and position: ____

a. Have you ever received any reports about sick/apparently sick birds transiting Bole international airport in the last one year? Yes [___] No [___]
b. If Yes, how frequent and when were the reports given? _______________________
c. Did you confirm the causes of the perceived illness? Yes [___] No [___]
d. What was the possible cause(s) identified)? _________________________
e. How long does it take for the laboratory to respond to such reports (in days), to including advise on the action to be taken after obtaining laboratory results, __________?
f. Additional comments, suggestions and opinion provided:

____
____
____.

Section 4: Questions for the wild life Authority:

Informant name (s) and position: ____

a. Identification of the species of wild birds transiting Bole international airport

b. Determining the susceptibility to HPAI, incubation period and carrier status of wild birds imported via the airport

c. Determining the species of resident wild bird (including vultures) and their susceptibility to HPAI in and around the Airport facilities if any.

d. Identification of potential risk posts across the borders and contact persons addresses at the posts (it could also be custom staff)

#	Potential risk posts	Contact person	Contact address(telephone)
1			
2			
3			
4			

e. List of questions to ask the key informants at the identified border posts via telephone (only for birds coming in)

i. Have you had wild birds transiting the post in the last one year?
ii. If yes, how many consignments did you handled in the year?
iii. If yes, were any of the consignments handled had sick wild birds?
iv. What number/proportion of the consignment(s) had sick birds?
v. What actions were taken on the sick wild birds? (returned, euthanized, allowed to cross)
vi. If euthanized, how were the birds disposed of? (burnt and buried, disposal pits, thrown away)
vii. Can the disposal sites be accessed by vermin/wild birds/dogs or other animals?