

**IMPORT RISK ANALYSIS OF HATCHING EGGS
AND ONE DAY OLD CHICKS IN SUDAN**

By

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Dedication

This work is dedicated to:

- *my mother and father who are always very careful and want the best for their sons and daughters,*
- *my wife who continually encourages, and motivates me*
- *and to those who supported me throughout my education life*

LIST OF ACRONYMS

Agent id.	Agent identification
AGID	agar gel immunodiffusion test
Agg.	Agglutination test
AHEDC	General Administration of Animal Health and Epizootic Diseases Control
AI	Avian Influenza
ELISA	Enzyme-Linked Immunosorbent Assay
FMARF	Federal Ministry of Animal Resources and Fisheries
HIT	Haemagglutination Inhibition Test
HPNAI	Highly Pathogenic Notifiable Avian Influenza
IRA	Import Risk Analysis
LPNAI	Low Pathogenicity Notifiable Avian Influenza
ND	Newcastle Disease
OIE	Office international des epizooties(World Organization for Animal Health)
QMHD	Quarantine and Meat Hygiene Department
RSAT	Rapid Serum Agglutination Test.
SENASA	National Health and Agrifood Quality Service - Argentina
SPS	Sanitary and Phytosanitary
SSMO	Sudanese Standards and Metrology Organization
STC	Specialized Technical Committee
VNT	Virus Neutralisation Test
WBTAT	whole blood tube agglutination test

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ABSTRACT

This study aimed to assess the probable risks associated with importation of hatching eggs and day old chicks, which come via Khartoum airport, and to evaluate the quality level of the Sudanese standards of these two commodities as well as the sanitary measures in place based on the international standards. Data were collected from the Federal Ministry of Animal Resources and Fisheries FMARF, the Sudanese Standards and Metrology Organization SSMO, and from the official website of the World Animal Health Organization OIE. For that purpose risk analysis was used following the guidelines as described in the OIE Terrestrial Animal Health Code 2009. Import risk analysis is the term used to cover the identification, assessment and management of risk associated with the importation of animals and animal-derived products. The results showed that a total of 11241209 chicks, and 62307030 layers and broilers hatching eggs were imported into Sudan in the period between 2005 and 2009, from 14 countries, which may comprise potential risk of introducing Avian Influenza, and many other diseases into the country, this was extrapolated from the poultry health status in the exporting countries; the Avian Influenza is endemic in Egypt, which represented the main exporting country of the two commodities in 2005. In 2006 about 18.3% (out of 235,626 susceptible population) were infected with Avian Influenza and 43.2% (n= 101,814) were destroyed due to the same reason in Sudan. The Sudanese standards of hatching eggs and day old chicks have not been set according to the OIE international standards. Moreover the sanitary measures in place were less stringent to achieve the appropriate level of protection. Therefore, a multidisciplinary scientific risk analysis approaches following OIE standards are recommended for the importation procedures and setting of the Sudanese standards.

.(OIE)

. 2009

2009

2005

62307030

11241209

14

43.2%

18.3%

2006

.2005

INTRODUCTION

The nature of the poultry and poultry products commodities flows in the international trade comprises risks of introducing and spreading of diseases from country to country. This can lead to probable outbreaks and unwanted impacts that permanently occur in all corners of the world. Some of the poultry diseases agents have regional impact; while others spread further e.g. pandemic of Highly Pathogenic Avian Influenza (HPAI) that occurred in many countries in Asia, Europe and Africa since 2003.

Because of the pressure of liberalized trade, the increasing demands of poultry industry inputs nationally, and the avian diseases globally, there is a need for transparent processes to arrive at decisions which minimize the risks, considering the competency of the veterinary services in controlling the disease and ensuring the safety of these commodities.

The World Trade Organization (WTO) standards are intended to provide clear identifiable references that are recognized internationally and encourage fair competition in free-market economies. The World Organization for Animal Health (OIE) Codes are recognized by the WTO as primary reference guides for international trade of animals and animal products. The chapter on import risk analysis in the OIE terrestrial animal health code has been extensively revised to reflect recent changes in this field of veterinary epidemiology.

Risk analysis, applied to animal and public health has mainly been used by bodies responsible for regulatory functions to deal with matters that pose potential dangers to the animals or humans. The Import risk analysis is a tool intended to provide the decision makers with import programs with an objective, repeatable, and defensible method of assessing these risks posed by the importation of these commodities.

Poultry industry constitutes a considerable contribution to food security, and livelihood of people. It expanded tremendously in the recent years by improvement in stocks performance as a result of selective breeding and hybridization.

Importation of hatching eggs and day old chicks involve a degree of disease risks. The Avian Influenza (AI) outbreak in 2006 caused great losses in the Sudanese poultry industry besides public health hazards in Khartoum state. These serious consequences could have been prevented if better sanitary measures, biosecurity and risk management were practiced. Sudan may need to improve specific conditions under which import sanitary procedure, e.g., laboratory testing, quarantine etc... can safeguard the poultry health status.

Since poultry industry sector has become very crucial to the Sudanese economy, with its considerable contribution to food security, the government along with coordination and communication with various stakeholders should protect it from all probable diseases.

This preliminary import risk analysis is an attempt intended as a decision-making tool to develop appropriate regulatory conditions for risk mitigation to address potential risks of poultry diseases introduction into the Sudan via Khartoum airport.

The objectives of this research are:

1. To assess the probable risks associated with importation of hatching eggs and day old chicks.
2. To evaluate the sanitary measures in place and Sudanese standards for the importation of hatching eggs and day old chicks' consignments.
3. To recommend ideas and plans to improve sanitary measures to mitigate disease risk created as result of importation of poultry and poultry products.

CHAPTER ONE

LITERATURE REVIEW

1. 1.The economic importance of poultry industry in Sudan:

Aviculture became intensive in Sudan mainly in Khartoum state in late 1970s for commercial production of day old chicks to meet the growing demand of small farmers to produce more table eggs and poultry meat. Thereafter the country entered the era of intensive poultry production. Nowadays, is entirely financed and organized by the private sector, providing about 30,000 job opportunities for veterinarians, agriculturists, animal production specialists, technicians, labour and others.

Currently, the mainstay of poultry production includes: Management of imported parent stocks, Production of broiler and layer day old chicks, Broiler and table eggs, at point of lay pullets and Poultry feeds (Federal Ministry of Animal Resources & Fisheries (FMARF), 2009)

The poultry chamber estimates the investments in poultry sector around 200 \$ millions, which contributes in food security in providing sources of animal proteins, as well as indirect participation in other economical sectors such as, agriculture, transportation, oils, cold storage, commerce, banking and insurance. Although the private sector is currently investing actively in poultry production across the states of the country, Khartoum State alone represents 70% - 85% of the industry. However, the term "poultry industry" is arbitrarily used if, measured on the fact that about 90% of the farms are, indeed, traditional open system.

The total number of housed chickens in 2006 was estimated at 40 million chickens which give a total annual production of 22, 000 metric ton of eggs and 18, 000 of meat.

Poultry in Khartoum State are estimated at 9.5 million birds distributed between the three towns; Khartoum (95%), Khartoum North (4%) and Omdurman (6%) reared on 615 – 619 poultry farm of which; 10 closed, 11 semi-closed system and 594 – 597 are traditional open system farms. Khartoum State investment in poultry is estimated at US\$ 152,500,000; 55 million for broiler and 97, 5 million for layer sectors.

Although, the chicken dominates the commercial poultry farming, few turkeys, ducks and geese are also raised on some chicken farms (Federal Ministry of Animal Resources & Fisheries (FMARF), 2009).

1.2. Diseases associated with importation of hatching eggs and day old chicks

The following are the OIE listed diseases (hazards) associated with poultry hatching eggs and day old chicks' trade: Avian chlamydiosis, Avian infectious bronchitis, Avian infectious laryngotracheitis, Avian mycoplasmosis (*M. gallisepticum*), Avian mycoplasmosis (*M. synoviae*), Fowl cholera, Fowl typhoid, Avian Influenza, Infectious bursal disease (Gumboro disease), Marek's disease, Newcastle disease, and Pullorum disease(OIE, 2010).

1.3. Status of Avian Influenza disease in Sudan and the veterinary authorities' response:

The disease was first reported in March 2006 in three foci in River Nile, Khartoum and Gazira states. Up to 1,200,000 birds died /or slaughtered in 216 farms in Khartoum state whereas in Gazira state, around 100 000 birds died / were slaughtered in 5 farms. Stamping out measures were applied (slaughtering and burying). Quarantine measures; movement control within the state and between the states; zoning and bio-security measures and disinfection of infected premises / establishments were also carried out.

In August 2006, six more confirmed cases (in one focus) of the disease were identified in South Sudan, Central Equatoria State, Juba town, 1600 Km south of Khartoum. All cases were reported in backyard chicken. Limited targeted vaccination was conducted in breeding farms (Anon, 2006).

The Government contributed funds to compensate up to 40% of the direct losses due to HPAI. It was estimated that total losses to the poultry industry amounted to 7.1 Billion Sudanese Dinars (equivalent to 35.5 Million US\$) which included losses related to deaths and depopulation of birds, rent of farms, workers salaries, deterioration in products prices, and loss of business. By the 25th of November 2007, the country officially communicated to OIE that it regained its HPAI free status (Anon, 2007).

1.4. Background of Risk Analysis:

A formal framework for 'risk analysis' was proposed by Covello and Merkhofer (1993) and was recommended for use in determining the 'appropriate level of protection' (ALOP) to be provided by border controls. Such a framework was needed for the implementation of the Sanitary and Phytosanitary (SPS) agreement of the World Trade Organization (WTO, 1994). Risk Assessment: developing scientific evidence and conducting risk assessments to ensure that measures are based on science and applied only to the extent necessary to protect health. (WTO, Article 5.1, 5.2 and 5.3.). A handbook was subsequently published, explaining the methodology in more details since 2004 (OIE 2004). This methodology was developed specifically to provide an objective framework for making decisions on inter-country trade, but it is applicable more generally to other areas of animal disease control, and more widely to other risky decision contexts. (Taylor, *et al.* 2009)

Risk was defined as the likelihood of the occurrence and the magnitude of the consequences of an adverse event; a measure of the probability of harm and the severity of impact of a hazard. Objective measurement and scientific repeatability are hallmarks of risk. In risk studies, it is common especially in oral communication to use "risk" synonymously with the likelihood (probability or frequency) of occurrence of a hazardous event. In such instances, the magnitude of the event is assumed to be significant (Ahl *et al*1993). In order for the risk to exist there must be: hazard, more than one outcome possible from the situation in which the hazard is involved and one or more of the possible outcomes must be unwanted. (Taylor, *et al* 2009)

Risk analysis was defined by the OIE as the process that includes hazard identification, risk assessment, risk management and risk communication. (OIE - Terrestrial Animal Health Code, 2009)

Import risk analysis (IRA): is the term used to cover the identification, assessment and management of risk associated with the importation of animals and animal-derived products, (Anon, 2001)

The relationship between Risk analysis and Epidemiology:

Epidemiology focuses on factors that influence the probability of disease (or other unwanted outcome occurring – 'risk factors'). In descriptive epidemiology risk factors are simply named as factors that tend to change (either increase or decrease) the probability of disease (or other unwanted outcomes). In the simplest epidemiological description risk factors are

qualitative. There is no indication of the relative importance of different factors or their quantitative effect on the outcome. There is also no indication of the time-sequence of the in which risk factors take effect, or of the mechanism by which they influence the risk. Risk analysis is the discipline that focuses in these details. (Taylor, *et al* 2009)

1.4.1. Hazards identification:

A hazard is something that is potentially harmful - to humans, other animals, plant or the environment. (Taylor, *et al* 2009).The hazard identification is the first step of any IRA, it involves identifying the pathogenic agents which could potentially produce adverse consequences associated with the importation of a commodity; it is a categorization step, identifying biological agents dichotomously as potential hazards or not. (OIE - Terrestrial Animal Health Code, 2009)

In reality, owing to lack of knowledge or incomplete information, not all the hazards are always identified. (Taylor, *et al* 2009)

The first step in the process of (IRA) is the hazard identification which begins with the collation of a list of organisms, identifying all the hazards (pathogens) that could be associated with the importation of the hatching eggs and day old chicks. The pathogens that are (OIE) listed were compared with the pathogens that are present in Sudan (table 5)

All the previous diseases could be introduced to the country and comprised potential hazards, but the only disease that officially subjected to control program is the Avian Influenza, consequently and according to the OIE guidelines, the final hazard list contains only the Avian Influenza and it will be the only hazard in this risk analysis (figure 3)

Hazard Identification for Avian Influenza associated with imported hatching eggs and one day old chicks:

Aetiological agent Avian influenza (AI) viruses are influenza A viruses within the family Orthomyxoviridae. These viruses are characterised by antigenic surface glycoprotein haemagglutinin (types H1 – 16) and neuraminidase (N1 – 9) (Alexander, et al. 2000). Strains of AI are commonly separated into highly pathogenic strains (HPAI) and low pathogenic strains (LPAI) on the basis of their pathogenicity in chickens. All HPAI virus isolates have been subtypes H5 or H7 but not all H5 or H7 isolates have been highly pathogenic (Alexander, et al. 2003). Virulent H5 and H7 strains apparently arise by mutation from low pathogenic strains some time after the transfer of infection from the wild host to poultry. The ability of these mutated viruses to infect multiple tissues results in their high pathogenicity. The pathogenicity of AI virus strains varies depending upon the species infected. This has been illustrated by differences in responses of different species to experimental infections with an H5N1 strain of AI (Ashton, and Alexander, 1980) and differences in clinical and pathological presentation of natural AI infections in different species (Boudreault, and Hinshaw, 1980). In the reviews by Alexander (Alexander. 2003, and Senne, 2003) of reports of avian influenza over the period from 1997 to 2002, ten subtypes of AI are listed as having been identified in chickens. H1N1 subtype was identified in chickens in Canada in 1998 (Senne, 2003). It was a virus of this subtype that caused the pandemic in humans in 1918. H2N2 has been reported from the eggs of healthy chickens in the United States (Glaser, et al. 2006). An H2N2 virus was responsible for a human influenza pandemic in 1957. H3N6 subtype has been identified in chickens, quail, ducks and caged birds in Asia (Alexander, 2003, and, Liu, et al. 2003), and in chickens in the United States (Senne, 2003). An incident of H6N2 infection in flocks of laying chickens in California was associated with respiratory disease and decreased egg production (Senne, 2003). H9N2 subtype was recorded from chickens in Europe, Iran, Saudi Arabia (Alexander, 2003), and the United States (Senne, 2003). Guo *et al.* 2000) cite several reports of H9N2 infecting humans in China and Hong Kong. Viruses of this subtype have been reported as causing epidemics of avian influenza in turkeys in the United States (Bankowski, 1984) and chickens in Iran (Nili, et al. 2002).

Birds infected with H10N7 virus in Ontario, Canada showed respiratory disease and kidney necrosis (Senne, 2003). (Horimoto, and Kawaoka. 2001) reviewed cross-species infection with AI, particularly cross infections between ducks, pigs, and humans, and the mechanisms (adaptation and genetic re-assortment) for the development of strains with high levels of virulence in humans. These processes are aided by the intensive mix of humans, pigs, and ducks found in Asia.

1.4.2. Risk Assessment:

Risk assessment is the component of the analysis which estimates the risks associated with a hazard, this analysis is composed of four components, the release assessment, the exposure assessment, the consequence assessment, and the risk estimation. These components are defined in OIE guidelines and represent the international recommended components for animal health import risk analysis. (OIE - *Terrestrial Animal Health Code*, 2009)

Release assessment:

Release assessment consists of describing the biological pathway necessary for an importation activity to 'release' pathogenic agents into a particular environment, and estimating the probability of that complete process occurring, either qualitatively (in words) or quantitatively (as a numerical estimate). (OIE - *Terrestrial Animal Health Code*, 2009)

Release assessment of Avian Influenza Virus by imported hatching eggs and one day old chicks:

AI virus has been isolated from the internal contents of eggs from naturally-infected layer and breeder flocks with clinical disease and from an infected layer flock with no clinical signs (Cappucci, et al. 1985). Unpublished work by Brugh cited by Swayne and Beck (Swayne, and Beck. 2004) identified HPAI virus in 85 to 100 percent of eggs laid on days 3 and 4 following experimental inoculation. Although no reports of transmission of infection to chicks via infected eggs have been located, movement of egg trays and associated fomites were significant risk factors in the spread of AI infection during an epidemic in the Netherlands in 2003 (Thomas, et al. 2005).

Exposure assessment:

Exposure assessment as defined in the OIE guidelines, consists of describing the biological pathway necessary for exposure of *animals* and humans in the *importing country* to the *hazards* (in this case the pathogenic agents) released from a given *risk source*, and estimating the probability of the exposure(s) occurring, either qualitatively (in words) or quantitatively (as a numerical estimate). Inputs that may be required in the exposure assessment are including: Biological factors (e.g. Properties of the agent), country factors (e.g. human and animal demographics, customs and cultural practices, geographical and environmental characteristics), commodity factors (e.g. quantity of imported commodity, intended use of the imported animals or products and disposal practices. (OIE - *Terrestrial Animal Health Code*, 2009)

Exposure assessment of Avian Influenza by imported hatching eggs and one day old chicks:

This exposure assessment of AI is based in large part on an analysis of historical information regarding HPAI outbreaks that occurred in 2006 in Khartoum State, in this regard, available data of these events provides valuable insight into the past and potential pathways of entry, exposure, and mechanisms of disease spread in the country. This exposure assessment therefore uses such historical information to prioritize potential risk pathways for AI introduction and spread.

Inputs required in the exposure assessment:

1. Biological factors

- Properties of the agent:

The main means of spread is through virus passed in faeces or respiratory secretions. Spread may be directly into areas occupied by poultry, through contamination of water, or through carriage on fomites. Outdoor poultry flocks are more vulnerable to exposure to wild birds, and are therefore affected with AI more frequently than flocks maintained indoors. AI virus may be maintained in poultry flocks as LPAI, or LPAI may be introduced into an area by infected wild birds, mainly waterfowl, with gulls and sea birds playing a lesser role. Because of the relatively high prevalence of AI viruses in migratory waterfowl, commercial flocks located outdoors and on migratory pathways appear to be at highest risk.

Secondary spread is through transfer of infection from faeces, most commonly by people moving between flocks or properties. Spread of AI within live-bird markets has been found to be an important means of dissemination between poultry farms in both Asia (Kung, et al. 2003 and Sims, et al. 2003) and the north eastern United States (Bulaga, et al. 2003 and Mullaney, 2003). Market hygiene (including control of interspecies contact) has been found to be a critical factor in controlling spread within these environments.

2. Country factors

- Handling and transportation of hatching eggs and one day old chicks
- Customs and cultural practices:
 1. Sales systems of some importing companies depend on distribution of chicks to their clients near the airport and in the streets
 2. The packing materials (plastic crates) of chicks consignments are reused for other products e.g. Packing of vegetable etc...
 3. Marketing distribution of the products (layers and broilers chicks, table eggs, chickens etc...) in almost all the states.
 4. Lack of biosecurity
 5. Transmission through contaminated Fomites (crates and Vehicles
 6. Vaccination crews
 7. Wild birds
 8. Labors
- a. Commodity factors
 - Wide spread of the commodities and their products in the Sudan
 - Volumes of the imported commodities
- intended use of the imported animals or products

Population at risk:

- All the poultry commercial farms
- Live birds markets
- Backyard bird rearing
- Wild birds
- Human

Susceptible avian species:

Susceptible domestic population avian species include chickens, turkey, ducks, pigeons and free flying birds.

Consequence assessment:

Consequence assessment includes an evaluation of the consequences of importing a foreign animal disease with regard to animal and public health, and also considers relevant environmental and economic factors, and describes the potential consequences of a given exposure and estimates the probability of them occurring. (OIE - *Terrestrial Animal Health Code*, 2009)

Consequence assessment of Avian Influenza by imported hatching eggs and one day old chicks:

This consequence assessment provides general information regarding the type and magnitude of effects of HPAI introduction into the Sudan from an historical perspective. The major consequences of the outbreaks concerned animal health and economic costs of control, indemnity, and lost trade, the economic and animal health consequences of a disease outbreak in Khartoum State with a large concentration of poultry are likely to be substantial. These consequences include:

a. Direct consequences

- **Public health consequences.**

Losses in human lives:

In spite of occurrence of major outbreaks of AI in poultry population in four states only one human case was suspected. No more cases reported up-to-date (Anon, 2006).

In Sudan, the risk of human infection from an avian H5N1 virus can be expected to be similar to that seen in other African countries, notably Egypt, Nigeria and Niger (anon, 2007 - 2008).

Animal health implications:

The total number of depopulated farms was 220 (173 layers, 41 broilers and 6 breeder farms) and around 1,020,851 birds were destroyed in Khartoum. Khartoum state lost about 1,909,244 SDD in 2006 as cost of the birds. (anon, 2006).

Indirect consequences

- Cost of eradication:

Khartoum state expended about 37,500,000 SDD to conduct eradication (anon, 2006)

- Surveillance and control costs:

Below are the donation and projects working with the national program for control and eradication of AI in animal and human in the following table.

Table (1): The national projects for control and eradication of Avian Influenza.

Project	Activities	Budget / Cost
Livestock Epidemio-surveillance Project (LESP)	- Surveys, training courses. -Budget for HPAI emergency chamber.	42,800.000, S.D.
African Development Bank (ADB) project for HPAI surveys and Control	- 3workshops. Equipments for states laboratories. Support to Central Veterinary Research Laboratory (CVRL) and ELISA laboratory.	- 9.845.079 S.G. in 2009 - 350.000 S.G. in 2010
AU – IBAR SPINAP project for HPAI control	- 38 surveys - Training - 16 surveys in northern states - STOP AI workshop	- 1.050.000 \$, in 2009 - 2010.
FAO project OSRO/RAF/718/USA	- 4 workshops, GIS training – risk mapping of biosecurity - Equipment & training on GIS & statistics for the CVRL vets. - Establishing HPAI diagnostic lab. In the CVRL	100.000 \$, in 2009.

Source: (Anon, 2006- 2010 reports of General Administration of Animal Health and Epizootic Diseases Control (AHEDC))

- **Economic and trade disruption**

A ban was declared on all imports of poultry, poultry products and production inputs on October 2005 (Anon, 2006).

Compensation costs

The Government contributed funds to compensate up to 40% of the direct losses due to HPAI. It was estimated that total losses to the poultry industry amounted to 7.1 Billion Sudanese Dinars (equivalent to 35.5 Million US\$). (anon, 2006).

- **Potential trade losses**

- **Adverse consequences to the environment.**

Risk Estimation

Risk estimation consists of integrating the results from the release assessment, exposure assessment, and consequence assessment to produce overall measures of risks associated with the hazards identified at the outset (OIE - *Terrestrial Animal Health Code*, 2009).

1.4.3. Risk management:

It is the process of identifying, evaluating, selecting and implementing alternatives for mitigating risk. It is the pragmatic decision-making process concerned with regulating the risk. As a decision process, it is involved in evaluating options to diminish or control present and predicted hazards to the biological and/or fiscal health of agricultural commodities. The decisions made may result in preventive or restorative actions. Risk managers make implicit judgments about the safety of particular courses of action (Ahl et. al 1993).

The objective of risk management is to manage *risk* appropriately to ensure that a balance is achieved between a country's desire to minimize the likelihood or frequency of *disease* incursions and their consequences and its desire to import commodities and fulfill its obligations under *international trade* agreements. The international standards of the OIE are the preferred choice of *sanitary measures* for *risk management*. The application of these *sanitary measures* should be in accordance with the intentions in the standards (OIE - *Terrestrial Animal Health Code*, 2009.)

Risk management for importation of hatching eggs and one day old chicks:

As indicated in the *OIE Terrestrial Animal Health Code* 2009, the following options could be considered in order to effectively manage the risk:

I. Hatching Eggs:

- Recommendations for importation from a Notifiable Avian Influenza (NAI) free country, zone or compartment

The *Veterinary Authorities* should require the presentation of an *international veterinary certificate* attesting that:

1. The eggs came from a NAI free country, *zone* or *compartment*

2. the eggs were derived from parent *flocks* which had been kept in a NAI free country, *zone* or *compartment* for at least 21 days prior to and at the time of the collection of the eggs;
3. The eggs are transported in new or appropriately sanitized *containers*;
4. If the parent *flocks* have been vaccinated against NAI, it has been done in accordance with the provisions of the *Terrestrial Manual* and the nature of the vaccine used and the date of vaccination have been attached to the *certificate*.(OIE - *Terrestrial Animal Health Code, 2009.*)

- Recommendations for importation from a HPNAI free country, zone or compartment
The *Veterinary Authorities* should require the presentation of an *international veterinary certificate* attesting that:

1. The eggs came from a HPNAI free country, *zone* or *compartment*;
2. The eggs were derived from parent *flocks* which had been kept in a NAI free *establishment* for at least 21 days prior to and at the time of the collection of the eggs;
3. The eggs have had their surfaces sanitized (in accordance with Chapter 6.4.);
4. The eggs are transported in new or appropriately sanitized *containers*;
5. If the parent *flocks* have been vaccinated against NAI, it has been done in accordance with the provisions of the *Terrestrial Manual* and the nature of the vaccine used and the date of vaccination have been attached to the *certificate*. (OIE - *Terrestrial Animal Health Code, 2009.*)

II. One Day old chicks

- Recommendations for importation from a NAI free country, zone or compartment

Veterinary Authorities should require the presentation of an *international veterinary certificate* attesting that:

1. The *poultry* were kept in a NAI free country, *zone* or *compartment* since they were hatched;

2. The *poultry* were derived from parent *flocks* which had been kept in a NAI free country, *zone* or *compartment* for at least 21 days prior to and at the time of the collection of the eggs;

3. The *poultry* are transported in new or appropriately sanitized *containers*;

4. If the *poultry* or the parent *flocks* have been vaccinated against NAI, it has been done in accordance with the provisions of the *Terrestrial Manual* and the nature of the vaccine used and the date of vaccination have been attached to the *certificate* .(OIE - *Terrestrial Animal Health Code, 2009.*)

- Recommendations for importation from a HPNAI free country, zone or compartment
The Veterinary Authorities should require the presentation of an international veterinary certificate attesting that:

1. The *poultry* were kept in a HPNAI free country, zone or compartment since they were hatched;

2. The *poultry* were derived from parent *flocks* which had been kept in a NAI free establishment for at least 21 days prior to and at the time of the collection of the eggs;

3. The *poultry* are transported in new or appropriately sanitized containers;

4. if the *poultry* or the parent *flocks* have been vaccinated against NAI, it has been done in accordance with the provisions of the *Terrestrial Manual* and the nature of the vaccine used and the date of vaccination have been attached to the certificate (OIE - *Terrestrial Animal Health Code, 2009.*)

1.4.4. Risk communication:

It is the open exchange of information and opinion, leading to a better understanding of risk and risk related decisions; the processes by which the results of the risk assessment and proposed risk management measures are communicated to the decision-makers and interested parties in the importing and exporting countries. It is a tool to provide a forum for interchange with all concerned about the nature of hazards, the risk assessment and how the risks should be managed; a tool to assure unambiguous interchange of information among those affected by the outcome of risk assessment activities (Ahl et al 1993). Risk communication is the process by which information and opinions regarding hazards and risks are gathered from potentially affected and interested parties during a risk analysis, and

by which the results of the risk assessment and proposed risk management measures are communicated to the decision-makers and interested parties in the importing and exporting countries. It is a multidimensional and iterative process and should ideally begin at the start of the risk analysis process and continue throughout. (OIE - Terrestrial Animal Health Code, 2009).

Thus risk communication is expected to fulfill a number of functions:

- Exchanging information of a scientific or factual between all parties involved or interested in the risk issue.
- Providing information for the risk managers about the risk perceptions and acceptable level of risk among stakeholders.
- Disseminating information on the acceptability and feasibility of various possible risk mitigation measures.
- Disseminating information on the effects of decisions and actions, to allow for evaluation.
- Encouraging and establishing trust between the risk manager and all those affected by, or interested in, the risk issue.

(Taylor, *et al.* 2009)

1.5. Standards and regulations of the international trade:

standards are defined as limits and conditions that are set for the purpose of quality control and assurance, to determine the minimum and maximum acceptable level needed to maintain the product quality as well as the consumer health and safety including all the necessary conditions and procedures for quality assurance.(anon, 2005).

Standards have many roles and functions. Not only to establish a common trading language between buyers and sellers, but they also ensure public safety and the protection of the environment within and outside national borders. Moreover, in today's globalized production systems, standards ensure that parts produced across borders fit and that networks are compatible. Regulations and standards and the verification of their application through conformity assessment procedures have, therefore, many benefits. However, inappropriate regulations can result in high costs and inefficiencies in trading partner countries as well as in the domestic economy and have international repercussions. (anon, 1998, UN economic commission)

1.5.1. The OIE international standards:

The World Organization for Animal Health (OIE) develops and publishes two types of international health standards for animals and animal products – trade standards and biological standards. These standards are developed through elected Specialist Commissions and are adopted by OIE Members during the annual OIE General Session.

OIE standards are issued in four publications: the *Terrestrial Animal Health Code*, the *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals*, the *Aquatic Animal Health Code*, and the *Manual of Diagnostic Tests for Aquatic Animals*. These publications are regularly reviewed and updated.

The two OIE trade standards, the *Terrestrial Animal Health Code* and *Aquatic Animal Health Code*, aim to assure the sanitary safety of international trade in terrestrial animals (mammals, birds and bees) and aquatic animals (fish, molluscs and crustaceans), and their products. This assurance is achieved through the detailing of health measures to be used by the veterinary services or other competent authorities of importing and exporting countries in establishing health regulations for the safe importation of animals and animal products. Such measures aim to avoid the transfer of agents pathogenic for animals and/or humans.

In using the *Codes*, veterinary services and other competent authorities should recognize that the *Codes* are primarily reference guides for international trade. The health measures in the *Codes* take into account the nature of the commodity and the animal health status of the exporting country. As a first principle, the health measures make reference only to the animal health situation in the exporting country as they assume that the relevant pathogen either is not present in the importing country or, if it is present, that it is the subject of an official control or eradication program, and the health measures are based on an assessment of the risks presented by the commodity being traded (*OIE international standards, 2009*).

The *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals*, known as terrestrial manual, provide a harmonized approach to disease diagnosis by describing internationally agreed laboratory diagnostic techniques. It also includes requirements for the production and control of biological products (mainly vaccines). The aims of the *Manual* are to provide general information on sampling methods, good laboratory practice, etc and to provide detailed information for laboratory technicians on diagnostic tests. The *Terrestrial Manual* also provides information on the principles of veterinary vaccine production and, where appropriate, the requirements for vaccines or diagnostic biologicals. (*OIE international standards, 2009*).

Development and updating of OIE standards:

The OIE process for developing and updating standards is flexible and allows for continuous improvement to standards as the supporting scientific information justifies it.

OIE Specialist Commissions and Working Groups undertake the initial analysis and preparation of draft standards which are then circulated to Member Countries for review and comment. Draft standards are revised accordingly and then presented for adoption to the International Committee at the annual General Session of the OIE

Draft texts for new or updated standards are developed by small groups of independent experts selected from all regions, reviewed by the relevant Specialist Commission and then circulated to OIE Members for comment. These comments are reviewed by the experts and the Specialist Commissions, and appropriate changes made before the texts are resubmitted to OIE Members for adoption (*figure 1*).

Figure (1): Mechanism of setting up and updating an international standard.



Source: *the OIE international standards, 2009*.

1.5.2. Sudan and the WTO:

The WTO members countries are 153 since 2008, the observers (including Sudan) are 31, Sudan application for accession to the WTO was received in 11 October 1994; The Working Party on the accession of Sudan was established on 25 October 1994. Bilateral market access negotiations are underway on the basis of revised offers on goods and services and SPS/TBT check listed in 2006. (<http://www.wto.org>).

The Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) encourages the Members of the World Trade Organization to base their *sanitary measures* on international standards, guidelines and recommendations, where they exist. Members may choose to adopt a higher level of protection than that provided by international texts if there is a scientific justification or if the level of protection provided by the relevant international texts is considered to be inappropriate. In such circumstances, Members are subject to obligations relating to **risk assessment** and to a consistent approach of **risk management**.

The SPS Agreement encourages Governments to make a wider use of **risk analysis**; WTO Members shall undertake an assessment as appropriate to the circumstances of the actual *risk* involved. The SPS Agreement recognizes the OIE as the relevant international organization responsible for the development and promotion of international animal health standards, guidelines, and recommendations affecting trade in live *animals* and animal products. (OIE –Terrestrial Animal Health Code, 2009)

Members shall ensure that their sanitary or phytosanitary measures are based on an assessment, as appropriate to the circumstances, of the risks to human, animal or plant life or health, taking into account risk assessment techniques developed by the relevant international organizations. (SPS agreement 2009)

In the assessment of risks, Members shall take into account available scientific evidence; relevant processes and production methods; relevant inspection, sampling and testing methods; prevalence of specific diseases or pests; existence of pest- or disease-free areas; relevant ecological and environmental conditions; and quarantine or other treatment. (SPS agreement, 2009).

In cases where relevant scientific evidence is insufficient, a Member may provisionally adopt sanitary or phytosanitary measures on the basis of available pertinent information, including that from the relevant international organizations as well as from sanitary or phytosanitary measures applied by other Members. In such circumstances, Members shall seek to obtain the additional information necessary for a more objective assessment of risk

and review the sanitary or phytosanitary measure accordingly within a reasonable period of time. (SPS agreement 2009)

1.6. National standards:

In the Sudan, the Sudanese Standards & Metrology Organization (SSMO) is a scientific monitoring body responsible for setting policies and standards for all food and consumer products manufactured in the Sudan for local use as well as export or import. The (SSMO) has adopted the system of the Specialized Technical Committees (STC) to produce standards.

The (STC) are specialized committees in certain field composed of specialized members from different institutions, setting standards in their field beside other responsibilities. Figure (2) the mechanism of setting a Sudanese standard.

More than 300 standards adopted from international bodies such as International Standards Organization (ISO), 33 specialized technical committees dealing with specific sectors including Animal Resources. The STC include in its membership a group of multidisciplinary specialists and experts from the Scientific Research Institutions, Universities, Ministries, and the private sector. Source: (Anon, Sudanese standards guide 2005).

OIE tests for international poultry trade:

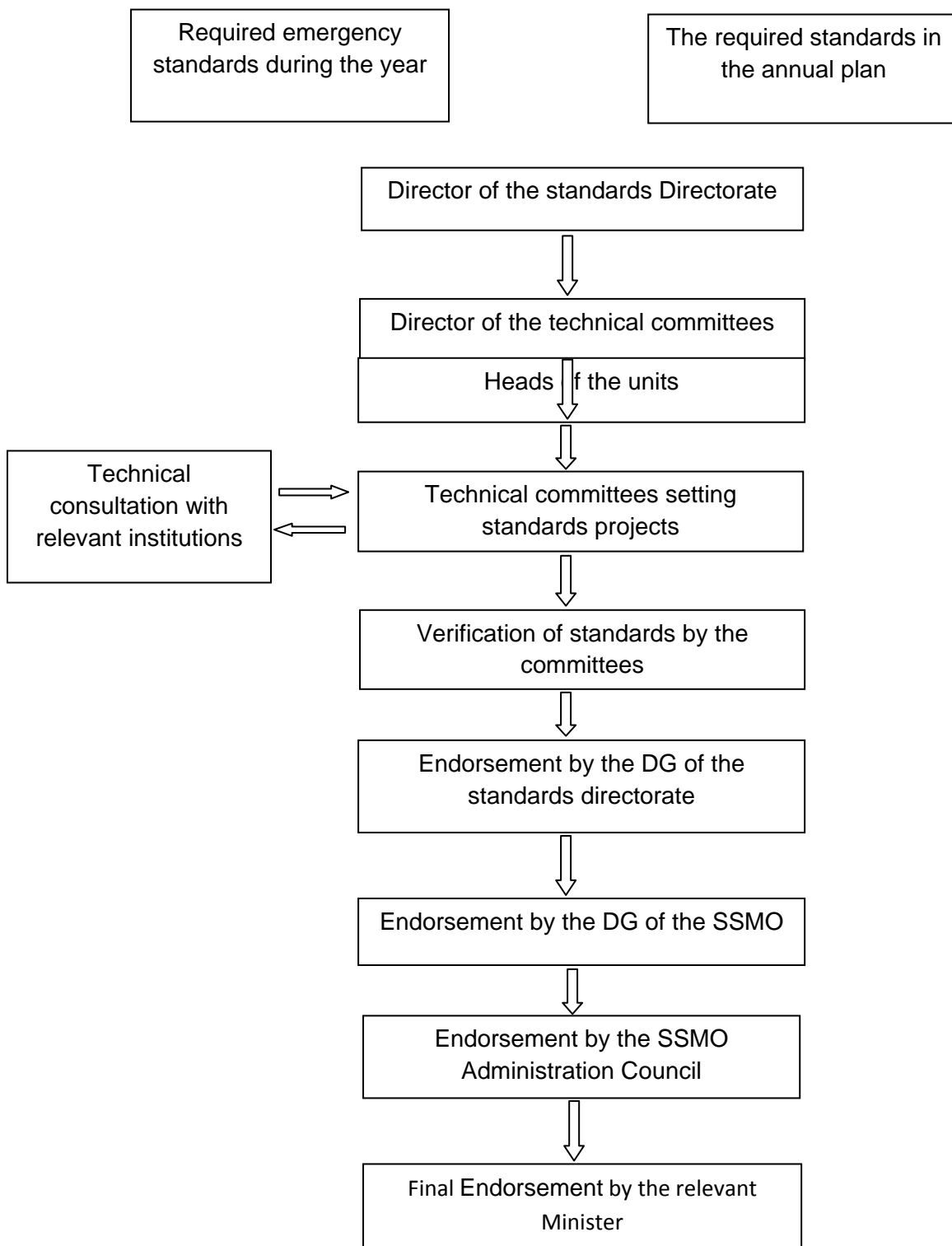
The diagnostic tests are presented in table (2), in two categories 'prescribed' and 'alternative'. Prescribed tests are required by the OIE *Terrestrial Animal Health Code* for the international movement of animals and animal products and are considered optimal for determining the health status of animals. Alternative tests are those that are suitable for the diagnosis of disease within a local setting, and can also be used in the import/export of animals after bilateral agreement. At present it is not possible to have prescribed tests for every listed disease.

Table (2): List of OIE tests for international poultry trade.

Disease name	OIE Prescribed tests	OIE Alternative tests
Avian chlamydiosis	-	-
Avian infectious bronchitis	-	ELISA, HI, VNT
Avian infectious laryngotracheitis	-	AGID, ELISA, VNT
Avian influenza	Virus isolation with pathogenicity testing	AGID, HIT
Avian mycoplasmosis (<i>Mycoplasma gallisepticum</i> , <i>M. synoviae</i>)	-	Agg., HIT
Avian tuberculosis	-	Agent id. Tuberculin test
Fowl cholera	-	-
Fowl pox	-	-
Fowl typhoid and Pullorum disease	-	Agent id., Agg.
Infectious bursal disease (Gumboro disease)	-	AGID, ELISA
Marek's disease	-	AGID
Newcastle disease	Virus isolation	HIT

Source: The OIE *Terrestrial Manual* 2009

Figure (2): Mechanism of setting up a Sudanese standard.



Source: SSMO, national standards guide, 2005

1.6.1. The Specialized Technical Committee of poultry:

Composed of members from the following institutions that participate in setting and updating the Sudanese standards of poultry:

- The Animal Resources Research Corporation (ARRC).
- The Federal Ministry of Animal Resources and Fisheries (FMARF).
- Ministry of Agriculture and Animal Resources and Irrigation– Khartoum State
- University of Sudan for Sciences and Technology.
- Poultry Industry Chamber – Sudanese Businessmen Union
- National Economic Security.
- Sudan Standards and Metrology Organization.

(Anon, 2005)

1.6.2. The Sudanese standard of hatching eggs:

(م س د ق 2318/2008)

This standard was first set by the SSMO/ STC of poultry in 2003 and updated in 2008, it is specialized in fertilized eggs suitable for production of commercial chicks.

Definition of the commodity: Hatching eggs were defined as the fertile eggs that come from mixing of males and females of parents and grand parent breeding stocks farms destined to produce chicks.

The standard requirements:

1. Should be sourced from pure high production and disease free breeding flocks.
2. External requirements: homogenous size, 52 – 65 gm weight for layer hatching eggs, and 57 – 67 gm weight for broilers hatching eggs, oval shape, with clean thick uncracked egg shells.
3. Internal requirements: the air sac should be fixed in the broad extreme and not too big, with centered one yolk, contain neither blood spots, meat spots nor germinal disks – clear fixed non-watery albumin.

The sanitized eggs should be stored – not more than 7days – in a temperature between 15-20 °C, and humidity between 75 -80%.

4. Packing and transportations requirements: hatching eggs should be packed in clean sanitized cases; packing should not exceed 5.

5. Rows of racks; transportation vehicles should be sanitized before using for another farm, and avoid radiations.

(م س د ق 3888/2007)

1.6.3. The Sudanese standards for importation of chicks:

It was set by the STC of poultry in 2004 and updated in 2007; it is specialized in imported or locally produced chicks for commercial purposes.

Definition of the commodity: Chick is defined as the hatched bird from hatching egg between one day – 8 weeks old chick, destined for grand parents stocks, parent stocks, layers stocks, and broilers stocks.

Standard requirements:

1. Should be sourced from a well known breed in poultry industry.
2. Parents or grand-parents should be disease free breeding flocks, and the hatcheries subjected to periodical inspection.
3. The label should include the hatching date (age) and the purpose of breeding.
4. Sexing error should not exceed 1- 2% in layers chicks.
5. Veterinary health certificate from the veterinary services of the exporting country assuring that.
 - a. The grand parents, parents stocks and the day old chick were vaccinated against (Marek's disease) and (infectious bronchitis).
 - b. The day old chicks are free from clinical signs of the following disease on the day of loading: fowl cholera, S. pullorum-gallinarum, fowl Tuberculosis, Avian leukosis complex, Marek's disease, Fowl pox, Infectious bronchitis, Infectious bursal disease, Infectious Laryngotrachitis, Newcastle disease, Asperogelosis,
 - c. Parent stock should be free from clinical sign of the following diseases: Fowl plague, Newcastle disease, Fowl cholera, Salmonellosis, chronic respiratory disease, Fowl pox 90 days prior to exportation.
 - d. The parents' farms should be free from Fowl plague and Newcastle disease 90 prior to exportation.

Health requirements for production and importation of chicks:

- i. Parents should be free from vertically transmitted diseases such as; Salmonellosis, Mycoplasmosis, E.coli infection...etc.

- ii. Hatching conditions should be optimum.
- iii. Chicks should be sourced from good quality hatching eggs in optimum conditions and free from contamination.
- iv. Samples should be taken from every consignment and assess the immune level against Salmonellosis and Mycoplasmosis.
- v. Day old chicks should be vaccinated against Marek's disease and Infectious bronchitis.
- vi. Mortality rate should not exceed 2% in one week after arrival in optimum breeding condition.

Quality requirements:

- 1. Chicks should be clean and free from dirt.
- 2. Chicks should be homogenous in size.

1.7. Procedures for Importing Poultry Hatching Eggs and day old chicks into the Sudan:

Poultry hatching eggs and day old chicks import arrangements are made following presentation of import documents from the Ministry of Foreign Trade.

I. Import permit:

All hatching eggs and day old chicks of poultry imported into the Sudan must be accompanied by the FMARF **import permit**; the latter will be issued for each single consignment only. Quarantine and Meat Hygiene Department FMARF always checks for the current status of the exporting country for HPAI at the OIE World Animal Health Database (WAHID) website. The importer must supply the following:

- 1- Current veterinary health certificate issued by veterinary authority responsible for animal health of the national government in the exporting country of origin.
- 2- Certificate of origin.
- 3- Number of the eggs, or chick to be imported.
- 4- Date of the proposed importation.
- 5- Commercial invoice.
- 6- Administrative fees.

*All the documents and certificates should be authenticated from the Sudanese embassy in the exporting country.

II. Post-arrival conformity assessment:

1- Visual inspection:

Upon arrival in Khartoum airport, the consignments are visually inspected by the joint committee of Veterinary inspectors from (QMHD) and SSMO.

2- Verification of the consignments with the documents.

3- **Veterinary health certificate** and **quality certificate** decision will be taken based on finding, hence consignment is checked either rejected or accepted.

- The importation procedure does not include laboratory tests conducted by the Sudanese veterinary services prior to entry permit of the consignments of the two commodities.

*Source: FMARF Quarantine and Meat Hygiene Department QMHD.

Laboratory check of poultry hatching eggs and day old chicks in Sudan:

Laboratory tests started in Feb. 2008, as part of the work plan of the animal health and epizootics control - Khartoum State (AHEDC-KS), quality control of chicks produced in Khartoum state and is performed by the (AHEDC-KS) diagnostic laboratory, to assess the immune levels of 4 poultry diseases (IBD, ND, Mycoplasmosis, and Salmonellosis) as below:

a. **Hatcheries sampling:** the testing is performed once per month. Sampling is designed to monitor the chicks' maternal immunity against the 4 diseases.

b. **Parents stocks sampling:** the testing is performed twice per year. Sampling is designed to assess parents' stocks immunity level against the 4 diseases.

These tests are voluntarily done according to the wish of the importing companies, and are not part of the importation procedures of these two commodities, and the results of these tests do not comprise any actions from the veterinary authority towards these companies. (AHEDC-Khartoum State, 2009).

1.8. Procedures of importation of live birds and hatching eggs in Argentina:

Live birds and hatching eggs are imported into Argentina under a permit issued by Argentina National Health and Agrifood Quality Service (SENASA). To obtain the permit, a potential importer sends a request to (SENASA) to import the designated commodity or commodities into Argentina through a particular port at a specified time. If there is insufficient history

provided with the request, the request is forwarded to the (SENASA) quarantine section for review. Permits are issued for a 30-day period. Live imports are allowed to proceed to destination for quarantine on arrival. Imports are allowed only from a region approved by (SENASA). Approval of the region requires an inspection and evaluation of the region's animal health status by (SENASA). The shipment must be accompanied by the permit when it arrives at the border. Most imports are subject to control measures, which usually include quarantine for live animals. The conditions of the permit are determined based on information provided on the importer. The importer pays all fees, including one for the permit. Live poultry (with the exception of pet birds) is subject to a 30-day quarantine irrespective of origin. Several designated quarantine facilities are inspected and registered by (SENASA). Baby chicks are sent to quarantine areas located in commercial establishments. These facilities are also inspected and approved by (SENASA). Fertile eggs imported through Ezeiza airport are hatched at the airport and sampled there before being sent to the designated quarantine facility.

In transit flights (e.g. flights that originate in Spain arriving in Argentina through Chile) are considered low risk although they may be coming from a higher risk country since all live birds are quarantined. In transit land travel of live birds through Argentine territory requires a permit to allow the shipment to pass through Argentina. Samples are taken from baby chicks the day after they arrive for serological testing during the quarantine period. Samples from imports of hatching eggs are taken after the eggs hatch at the import facility in Ezeiza airport, and the birds are then sent to the quarantine facility. Tests are conducted for END, avian influenza, mycoplasmosis, and *Salmonella enteritidis*. Shipments are released when the test results are completed. This may take approximately 10 days. Testing is actually duplicated in many instances since commercial importers will often have private veterinarians conduct tests in addition to the tests conducted by (SENASA)(Anon, 2004).

CHAPTER TWO

MATERIALS AND METHODS

2.1 Area of Study

2.1.1 Location

Khartoum International airport KIAP is the major international airport in Sudan, situated in 15° 35' 22" North, 32° 33' 11" East in Khartoum town, one of the three towns comprising Khartoum capital. It forms the exit of imported commodities to other states by road network. KIAP is the only entry point through which 100% of the total amount of hatching eggs and one day old chicks come into the country.

2.1.2 Staff

A) Staff of the Sudanese Standards and Metrology Organization airport – branch:

4 Veterinarians

4 Accountants

4 Drivers

B) Staff of the Quarantine and Meat Hygiene Department (QMHD) at the airport:

23 Veterinarians

3 Technicians

3 Labors

1 accountant

1 Driver

2.1.3 Sanitary procedures at Khartoum airport for the importation of hatching eggs and one day old chicks' consignments:

A joint committee composed of the Quarantine and Meat Hygiene Department (QMHD) (FMARF), and the Sudanese Standards and Metrology Organization SSMO, working 24 hours a day, inspecting the imported consignments of hatching eggs and day old chicks.

The following steps are implemented by the joint committee as standard national procedures:

1. Preliminary verification of documents of the consignments
2. Visual inspection:

Upon arrival in Khartoum airport, the consignments are visually inspected by the joint committee of Veterinary inspectors from (QMHD) and SSMO.

3. Verification of the consignments with the documents.
4. Certification of **veterinary health certificate** and **quality certificate**, or rejection of the consignment according to the findings.
5. There is no animal quarantine facility at the Khartoum international airport.
6. Neither the **(QMHD)** nor the **(SSMO)** collect samples and laboratory tests prior to issuance of entry permit of the commodities.

2.2. Data collection:

Data on the imported consignments of hatching eggs and one day old chicks, the national sanitary procedures of importation and the national poultry health status were collected from the monthly and the annual reports of the period from 2005 to 2009, from the Federal Ministry of Animal Resources and Fisheries (FMARF) – departments of Information and Statistics (**ISD**), Quarantine and Meat Hygiene Department (**QMHD**), Animal Health and Epizootics Control Department (**AHEDC**). Data were also collected from the Sudanese Standards and Metrology Organization (**SSMO**) – National Standard Directorate, and from direct observation in the (SSMO) Khartoum airport branch. Data about the exporting country poultry health status of Avian Influenza (AI) were collected from the (**OIE**) - World Animal Health Information Department (**WAHID**).

Other data were collected from the World Trade Organization (**WTO**), the Sanitary and Phytosanitary (**SPS**) agreement, and some other sources.

2.3. Data Analysis:

Data of the imported consignments of day old chicks and hatching eggs were presented in tables (6, 7 and 8) and figures (5 and 6).

Comparisons of the national standards of hatching eggs and day old chicks with the OIE recommendations, and national procedures of importation of hatching eggs and day old chicks' consignments were presented in tables (3 and 4) and figures (1 and 2) to explain the results.

The preliminary Risk Assessment:

The methodology used in this risk analysis follows the guidelines as described in Section 2 of the OIE Terrestrial Animal Health Code (2009) is shown in figure (3).

In this preliminary qualitative risk analysis these steps are followed:

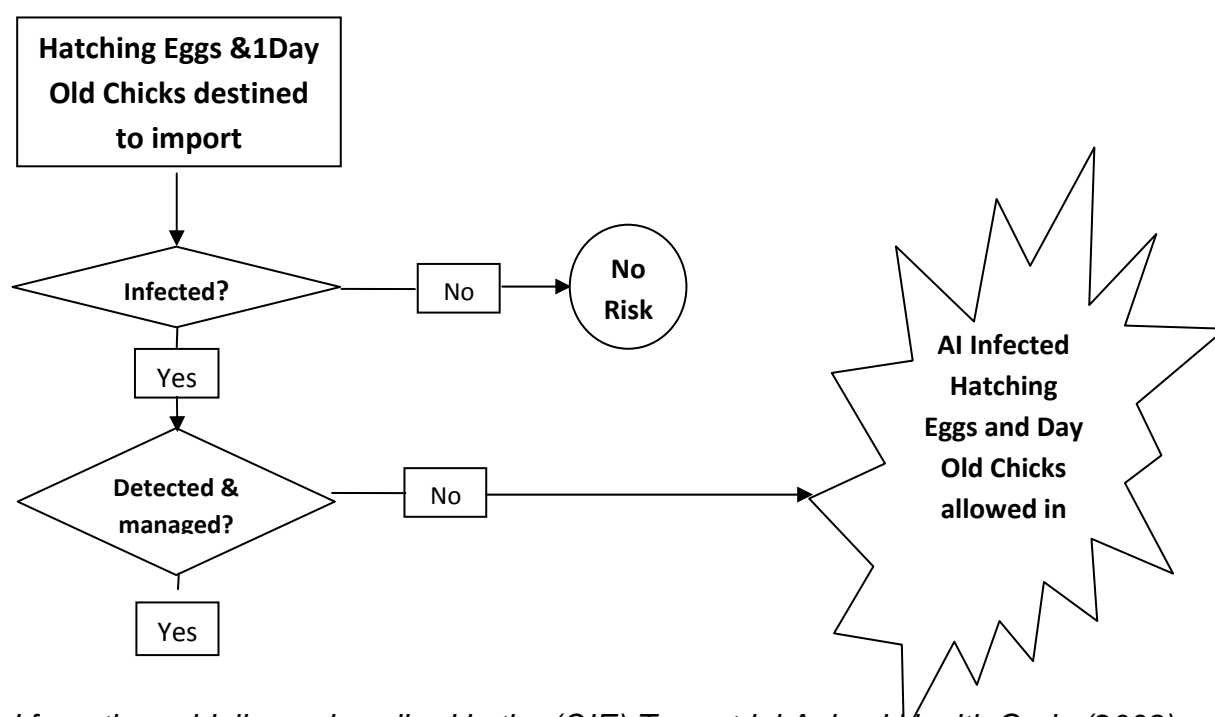
I. Hazard Identification

II. Risk Assessment:

- 1- **Release assessment** – the likelihood of the organism being imported in the commodity.
- 2- **Exposure assessment** – the likelihood of the animals or human in Sudan being exposed to the potential hazard.
- 3- **Consequence assessment** – the consequences of entry, establishment or spread of the organism.
- 4- **Risk estimation** – a conclusion on the risk posed by the organism, consists of integrating the results from release assessment, exposure assessment, and consequence assessment to produce qualitative measures of health and environmental risks. If the risk is no-negligible, then the organism is classified as a hazard.

III. Risk Management.

Figure (3): Risk Pathway for Avian Influenza entry by infected Hatching Eggs and One Day Old Chicks into Sudan.



Adapted from the guidelines, described in the (OIE) Terrestrial Animal Health Code (2009).

Figure (4) describes the Risk Analysis approach trying to answer the following risk questions:

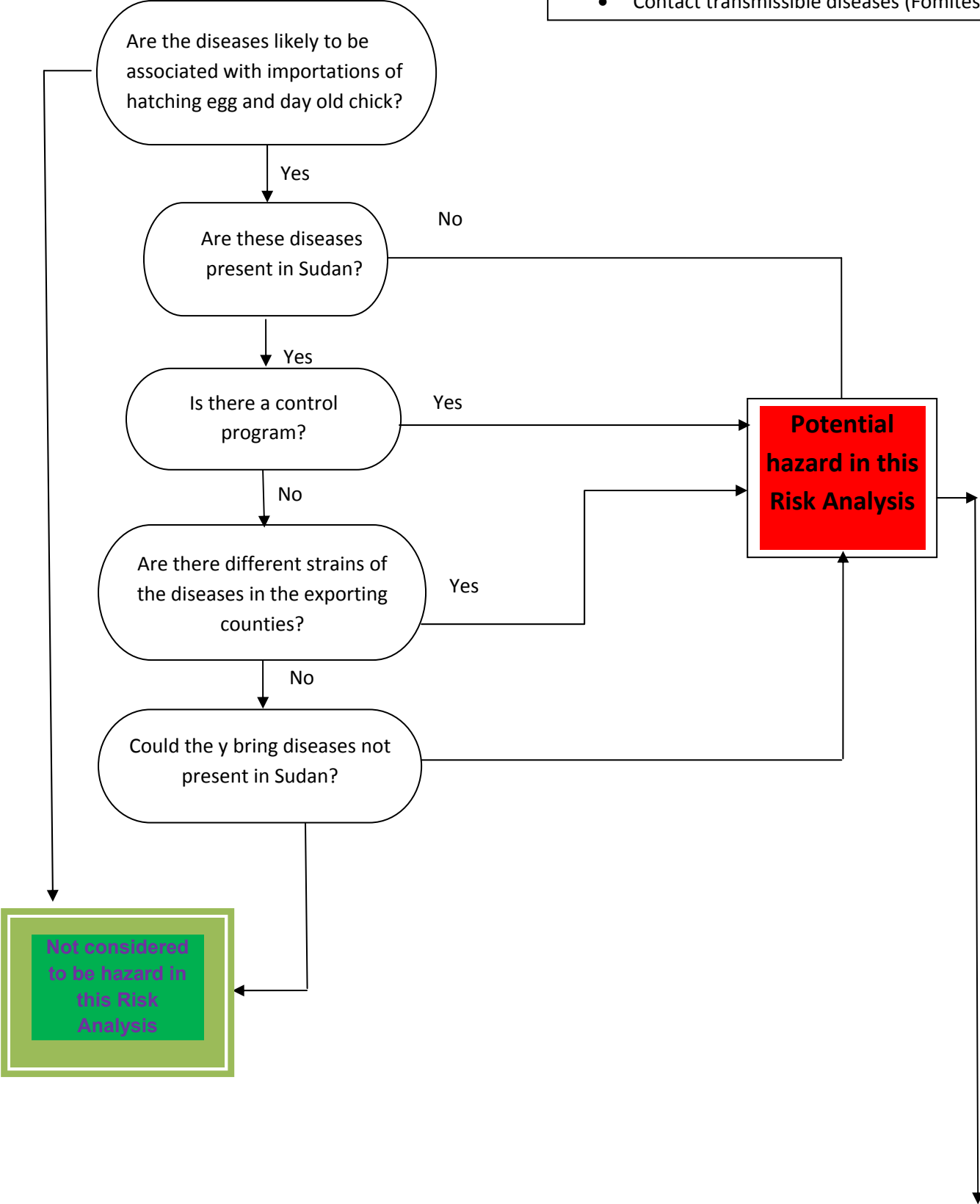
- Are the consignments of hatching eggs and day old chicks considered as potential hazards?
- What is the likelihood of a HPAI entering, establishing or spreading in Sudan by the importation of these commodities?
- Can the etiological agents HPAIV be detected by the Sudanese measures at the Khartoum Airport?
- What are the magnitudes of harm that will result from HPAI to poultry, human life or health, and the environment?

Figure (4): The risk analysis process.

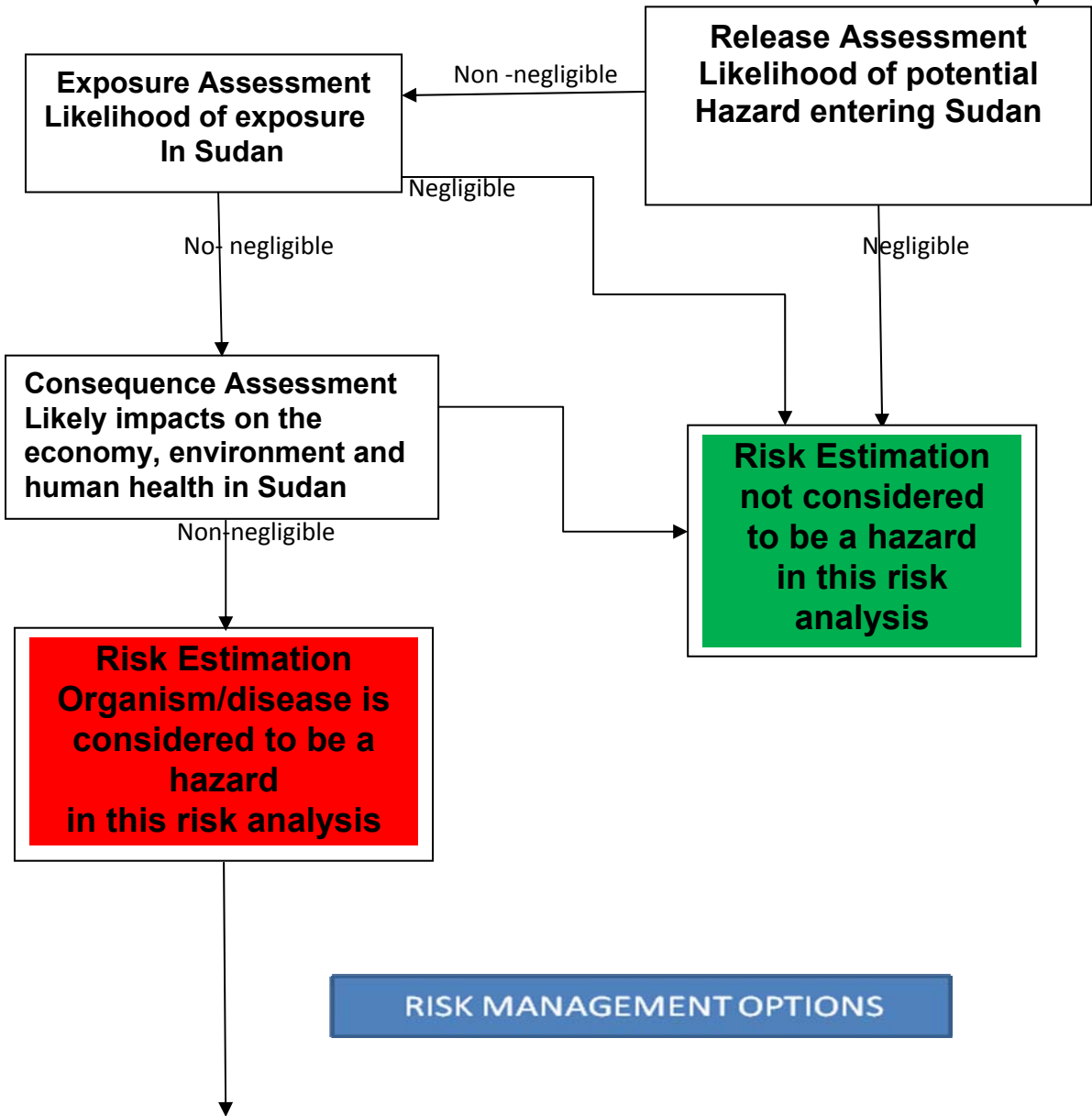
HAZARD Identification

A List of poultry diseases (hazards)

- Vertically transmissible diseases (Eggs)
- Contact transmissible (Chicks)
- Contact transmissible diseases (Fomites).



RISK ASSESSMENT



What options are available to manage risk?

What is the effect of each measure on the level of risk?

Adapted from the Biosecurity New Zealand *Import risk analysis: Hatching eggs of chickens from the European Union, Canada, the United States of America, and Australia, 2009*

CHAPTER THREE

RESULTS

This research is designed to assess the probable risk associated with importation of hatching eggs and one day old chicks and to evaluate the quality level of the Sudanese sanitary measures on these two commodities and other procedures in place based on the international standards. Compared with a similar developing country, the Sudanese procedures for the importation of hatching eggs and day old chicks' consignments, were not based on scientific risk analysis, for instance, there was no documented procedures for a formal decision based on risk analysis, as well as no laboratory tests were conducted (table 3). Comparisons of the Sudanese standards of hatching eggs and one day old chicks with the international recommendations revealed that the OIE recommendations are not specified in the Sudanese standard of hatching eggs, the rest of the criteria are presented in table (4). Regarding the Sudan poultry health status, during the 2006 outbreak, about 18.3% (out of 235,626 susceptible population) were reported to be infected with Avian Influenza (AI), and 34% (n= 101,814) were destroyed. While Infectious Bursal Disease (IBD) was reported in 2008, out of 6000 susceptible population 68.3% (n= 4100) were reported to be infected (table 5). A total of 11,241,209 chicks, and 62,307,030 layers and broilers hatching eggs were imported from 14 countries into the Sudan in the period 2005 – 2009. This may comprise potential risk of introducing (AI) and many other diseases into the country. In viewing the poultry health status in the exporting countries, (AI) is endemic in Egypt, which represented the main exporting country of the two commodities in 2005, and was resolved in the rest of the countries according to the OIE notification (table 6,7- figures 5, 6). In Sudan Ommat and Elhaj Soleiman were the most importing companies of hatching eggs and one day old chicks respectively during the period 2005 – 2009 (table 8).

Table (3): Comparison between Sudan and Argentina in sanitary procedures of importation of hatching eggs and eggs and one day old chicks.

Activity/ status	Sudan	Argentina
WTO membership	Observer	Member since 1995
OIE membership	Yes	Yes
National standard of Hatching Eggs and One Day Old Chicks conformity with the OIE standards	No	Yes
Import risk Analysis	No documented procedure for a formal decision making process, based on risk analysis was presented.	Conducted
Quarantine and control measures at the port of entry	- Visual inspection - No quarantine facility Infected commodities can not be detected	Hatching Eggs are hatched at the airport Day Old Chicks kept in a quarantine approved by the Veterinary Services
Laboratory Tests	No laboratory test is conducted, (only visual examination). And the shipment is released in no time after that	Serological tests are conducted for E Newcastle Disease (END), AI, mycoplasmosis, and <i>Salmonellosis</i> , (these hazards are determined by import risk analysis) And the shipment is released after approx 10 days

Table (4): Comparison between the Sudanese standards of hatching eggs and one day old chick with the OIE recommendations and standards.

Criteria	OIE recommendation	National standard of Hatching Egg	National standard of Day Old Chicks
Hazard identification in the Hatching Eggs & Day Old Chicks trade	Avian chlamydiosis, IB, ILT, mycoplasmosis (<i>M. gallisepticum</i> - <i>M. synoviae</i>), Fowl cholera, Fowl typhoid, HPAI & LPAI, IBD, Marek's disease, ND, Pullorum disease, avian tuberculosis,	Not specified	fowl cholera, <i>S. pullorum-gallinarum</i> , fowl Tuberculosis, Avian leukosis, Marek's disease, Fowl pox, IB, IBD, ILT, ND, Asperogelosis,
Vaccinated or not vaccinated against	IB,ILT, HPAI,NAI, FC, IBD, MD	Not specified	DOC and parent and grand parents should be vaccinated against MD, IB
One Day Old Chicks show no clinical signs of	Salmonellosis, chlamidiosis,	—	fowl cholera, fowl Tuberculosis, Avian leukosis, Marek's disease, Fowl pox, IB, IBD, ILT, ND, Asperogelosis, <i>S. pullorum-gallinarum</i>
One Day Old Chicks parents/hatcheries free from	Salmonellosis, IB, ILT, HPAI,NAI, mycoplasmosis, FC, Pullorum disease, IBD,	—	<ul style="list-style-type: none"> • Salmonellosis, Mycoplasmosis, <i>E. coli</i> • Fowl plague, ND, FC, Salmonellosis, CRD, Fowl pox 90 days prior to exportation.
One Day Old Chicks parent vaccinated against	IB, ILT, FC, IBD	—	Not specified
Hatching Eggs parents/hatcheries free from	Salmonellosis, ILT, HPAI, NAI, IB, Mycoplasmosis, Avian tuberculosis, Pullorum disease	Not specified	—
Hatching Eggs & One Day Old Chicks parent vaccinated against	Marek's disease	Not specified	MD,IB
Come from establishments/hatcheries which comply with the hygiene and disease security procedures referred to in Chapter 6.4.	Yes	Not specified	Not specified
Identified diseases subjected to laboratory tests	All the listed disease with the OIE approved lab. Tests in the terrestrial manual	Not specified	Samples should be taken from every consignment and monitor the immune response against Salmonellosis and Mycoplasmosis.
Approved laboratory tests methods	ELISA, HIT, VNT Agent id. AGID, ELISA, agg. Tuberculin test	Not specified	Not specified

Legend: IB= Infectious Bronchitis, ILT= Infectious Laryngotracheitis, FC= Fowl Cholera, IBD= Infectious Bursal Disease, ND= Newcastle Disease, MD= Marek's Disease, CRD= Chronic Respiratory Disease, ELISA= Enzyme-Linked Immunosorbent Assay, VNT= Virus Neutralization Test, HIT= Haemagglutination Inhibition test.

Table (5): Summary of OIE-listed poultry diseases/infections present in Sudan 2005 – 2009.

Year	OIE-Listed disease	Occurrence	Serotype(s)	New outbreaks	Total outbreaks	Control measures	Routine Vaccinated	Susceptible	Cases	Deaths	Destroyed	Ring vaccinated
2005	New castle Disease(ND)	+	No	6	6			130539	32366 (24.8%)	130 (1%)	0	130539
2006	Highly Pathogenic Avian Influenza (HPAI)	+	H5N1	21	21	Qi S Z V	874000	235626	43050 (18.3%)	43050 (18.3%)	101814 (43.2%)	0
	New castle Disease(ND)	+	No	3	3	....	....	715	705 (98.6%)	18 (2.5%)	0	1300
	M. gallisepticum	+	No	4	4	....	....	....	....	....	....	....
2007	New castle Disease(ND)	+	....	....	....	M Qi V T	69000	....	....	....	....	....
	Infectious Bursal Disease (IBD)	+	....	....	....	M Qi V T	9000	....	....	....	....	....
2008	Infectious Bursal Disease (IBD)	+	No	4	4	Z	....	6000	4100 (68.3%)	2685 (44.8%)	0	0
	M. gallisepticum	+	No	1	1	T	....	245003	30090 (12.3%)	5357 (21.9%)	0	0
	Pullorum disease	+	No	2	2	T	....	245023	30096 (1.2%)	5359 (2.2%)	0	0
2009	New castle Disease(ND) (domestic)	+	....	....	....	Qf Z V	485200	....	....	....	....	....
	Avian infectious Bronchitis(IB) (Domestic)	+	....	....	....	T	....	....	....	....	....	....
	Infectious Bursal Disease (IBD)	+	No	1	1	Z V	136138000	1800	200 (11.1%)	100 (5.5%)	100 (5.5%)	1600

Source: OIE World Animal Health Information Database (WAHID), 2005 – 2009.

Legend: **Qf** = precautions at the borders, **M** = monitoring, **Te** = screening, **Gsu** = general surveillance, **Tsu** = targeted surveillance, **Qi** = movement control, **S** = stamping out, **Sp** = modified stamping out, **Z** = zoning, **Vp** = vaccination prohibited, **V** = routine vaccination, **T** = treatment, **Cr** = control of wild reservoir, **Cn** = control of arthropods

Table (6) Exporting countries notifications of Avian Influenza to the OIE and dates they resolved infection.

Country	Date of Notification	Disease	Reason for Notification	Disease manifestation	No of Outbreaks	Date resolved
Egypt	18/02/2006	HPAI	Reoccurrence	Clinical disease	1086	endemic disease 07/07/2008
France	20/02/2006	HPAI	Reoccurrence	Clinical disease	38	18/04/2006
France	25/02/2006	HPAI	Reoccurrence	Clinical disease	1	18/03/2006
France	05/07/2007	HPAI	First occurrence	Clinical disease	3	14/08/2007
France	02/02/2009	LPAI	Reoccurrence	Clinical disease	2	17/04/2009
France	16/11/2009	LPAI	Reoccurrence	Sub-clinical infection	1	02/03/2010
France	21/01/2010	Pandemic A/H1N1 virus	Emerging disease		1	01/02/2010
Germany	08/11/2006	HPAI	Reoccurrence	Clinical disease	1	03/09/2006
Germany	16/02/2006	HPAI	Reoccurrence	Clinical disease	123	03/09/2006
Germany	06/04/2006	HPAI	Reoccurrence	Clinical disease	1	28/07/2006
Germany	18/12/2007	HPAI	Reoccurrence	Clinical disease	3	28/01/2008
Germany	26/06/2007	HPAI	Reoccurrence	Clinical disease	301	30/10/2007
Germany	07/07/2007	HPAI	Reoccurrence	Clinical disease	3	18/09/2007
Germany	10/10/2008	HPAI	Reoccurrence	Sub-clinical infection	1	14/10/2008
Germany	17/10/2008	LPAI	Reoccurrence	Clinical disease	35	18/02/2009
Jordan	27/03/2006	HPAI	First occurrence	Clinical disease	1	27/03/2006
K.S.A.	31/03/2007	HPAI	First occurrence	Clinical disease	1	27/03/2007
K.S.A.	19/11/2007	HPAI	Reoccurrence	Clinical disease	29	29/01/2008
South Africa	03/07/2006	HPAI	Reoccurrence	Clinical disease	24	26/07/2006
U. K.	06/04/2006	HPAI	Reoccurrence	Clinical disease	1	01/05/2006
U. K.	13/11/2007	HPAI	Reoccurrence	Clinical disease	2	29/04/2008
U. K.	03/02/2007	HPAI	Reoccurrence	Clinical disease	1	25/06/2007
U. K.	25/05/2007	LPAI	First occurrence	Clinical disease	1	15/06/2007
U. K.	15/06/2007	LPAI	Reoccurrence	Sub-clinical infection	1	06/07/2007
U. K.	11/01/2008	HPAI	Reoccurrence	Clinical disease	2	27/03/2008
U. K.	05/06/2008	HPAI	New strain	Clinical disease	1	20/08/2008

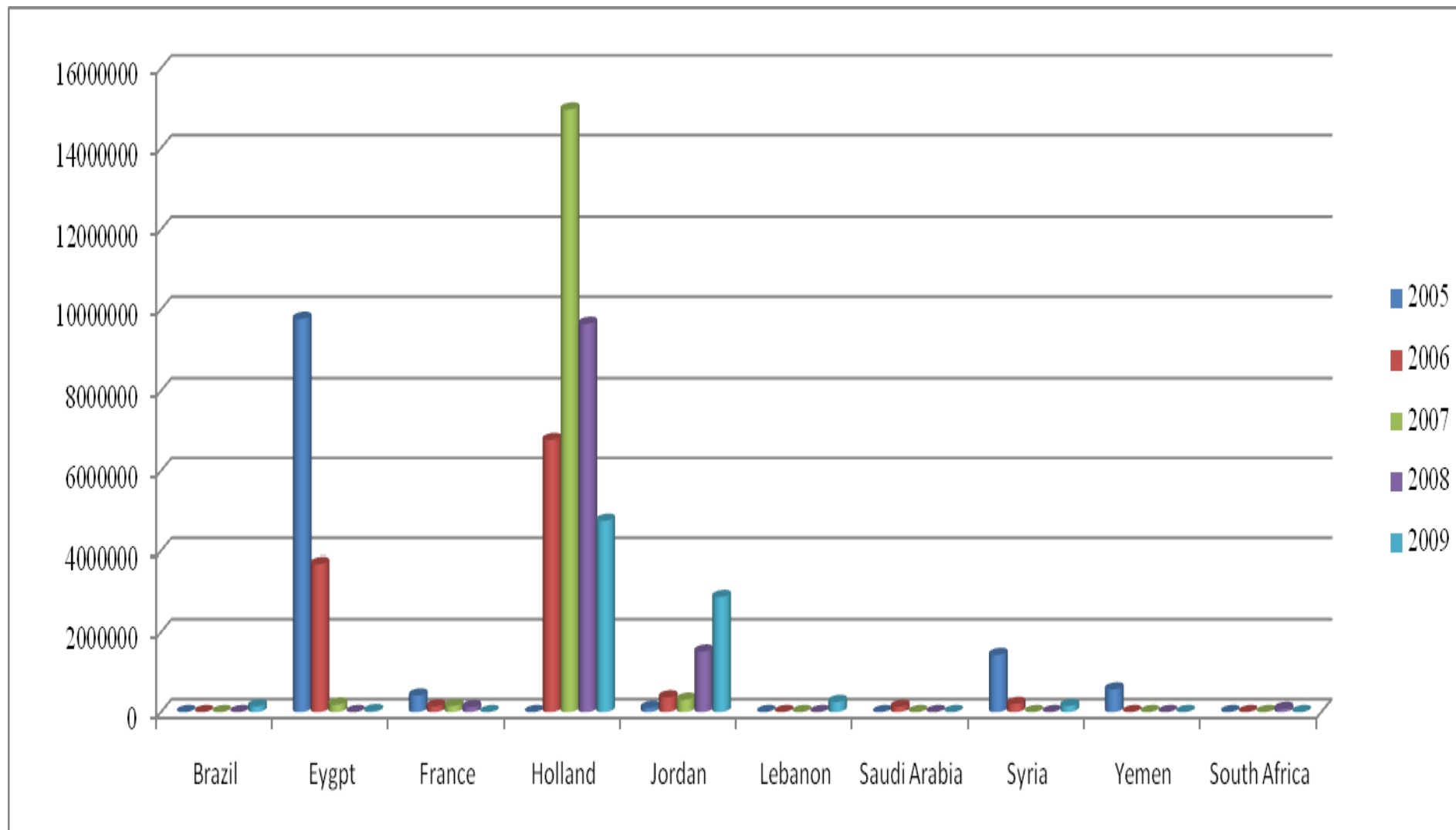
U. K.	18/09/2009	Pandemic Influenza A H1N1	Emerging disease		7	15/01/2010
U.S. A.	03/04/2007	LPAI	Reoccurrence	Sub-clinical infection	1	06/05/2007
U.S. A.	23/07/2007	LPAI	Reoccurrence	Sub-clinical infection	1	20/09/2007
U.S. A.	23/07/2007	LPAI	Reoccurrence	Sub-clinical infection	1	04/08/2007
U.S. A.	04/09/2008	LPAI	Reoccurrence	Sub-clinical infection	1	29/10/2008
U.S. A.	11/06/2008	LPAI	Reoccurrence	Sub-clinical infection	1	14/07/2008
U.S. A.	30/11/2009	pandemic A/H1N1 influenza virus	Emerging disease		1	21/12/2009
U.S. A.	03/11/2009	Pandemic A/H1N1 influenza	Emerging disease		1	01/12/2009
U.S. A.	06/04/2009	LPAI	Reoccurrence	Sub-clinical infection	1	13/07/2009
U.S. A.	06/08/2009	LPAI	Reoccurrence	Sub-clinical infection	1	15/12/2009

**Source: OIE World Animal Health Information Database 2005 – 2009.*

Table (7): Estimation of Avian influenza Risks in the imported consignments of Hatching eggs& One Day old chicks during the period from 2005 to 2009.

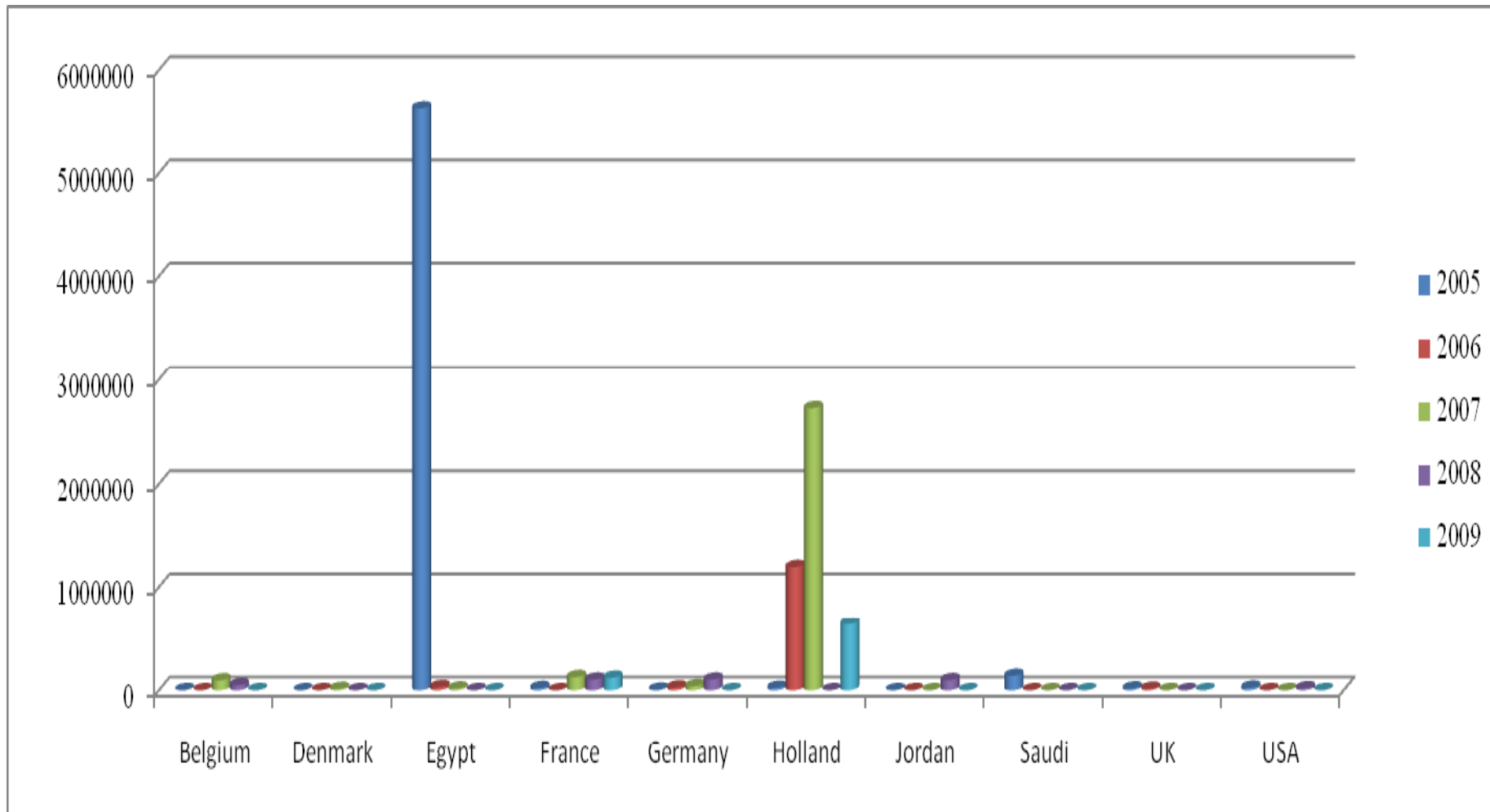
Exporting Country	Source of Hazard (quantity of commodity)		Risk factors (Concerning AI status & consignment quantity)	Risk Estimation
	Hatching eggs	One Day old chicks		
Belgium	0	140652	Not reported, low quantity	Low
Brazil	144000	0	Not reported	Low
Denmark	0	11648	Not reported, one consignment	Low
Egypt	17195480	5679161	Endemic, huge amounts of the commodities	High
France	831280	363517	Reported, resolved	Medium
Germany	0	168454	Reported, resolved	Medium
Holland	36134170	4572953	Not reported, frequent consignments, huge amounts	Low
Jordan	5182920	95904	Reported, resolved, frequent consignments	High
Lebanon	253440	0	Not reported	Low
Saudi Arabia	129600	137120	Reported, resolved	High
South Africa	78480	0	Reported, resolved, one consignment	Medium
UK	0	29900	Reported, resolved, low quantities	Medium
USA	0	41900	Reported, resolved, low quantities	Medium
Yemen	67960	0	Not reported	Low
Total	62307030 Eggs	11241209 chicks	-	MEDIUM

Figure (5): Quantities and origins of imported Hatching Eggs, to Sudan during the Period 2005 -2009.



Source: federal ministry of animal resources and fisheries monthly reports 2005 – 2009

Figure (6): Numbers and origins of imported one day old chicks, to Sudan, during the Period 2005 -2009.



Source: federal ministry of animal resources and fisheries monthly reports 2005 – 2009.

Table (8) Estimation of AI exposure risk of the imported consignment of Hatching eggs& One Day old chicks to the poultry population in Sudan:

Importing company	Hatching eggs	One Day old chicks	Risk factors	Risk estimation
47 importing companies	0	260268	<ul style="list-style-type: none"> ▪ Sales systems of some importing companies depend on distribution of chicks to their clients near the airport and in the streets, ▪ sometimes the chicks consignments are transported from the airport in public vehicles (spread the HPAIV to man and animal) ▪ The packing materials (plastic crates) of chicks consignments are used for other products e.g. Packing of vegetables...etc. ▪ Marketing distribution of the products (layers and broilers chicks, table eggs, chickens) in almost all the states. ▪ Lack of biosecurity Transmission through contaminated Fomites (crates and Vehicles) - Vaccination crews - Wild birds - Labors - Visitors 	Exposure risk is High
	65520	0		
	29790	0		
	4233420	365321		
	28800	18000		
	0	81154		
	70560	430960		
	2520	0		
	8763080	476002		
	0	309220		
	0	139560		
	0	1067600		
	6498880	153544		
	114480	0		
	0	25000		
	693360	439272		
	783360	38160		
	38160	430400		
	99000	1341857		
	1009800	82700		
	78480	42984		
	170640	786832		
	57240	20800		
	174400	26700		
	2692520	470659		
	90000	0		
	76320	0		
	72000	136172		
	0	514128		
	0	184400		
	0	283610		
	0	41600		
	0	12000		
	0	10000		
	1763820	467960		
	150560	1099900		
	0	80000		
	0	806574		
	0	210000		
	101540	103840		
13209940	529371			
0	45900			
7119220	276008			
4711200	0			
0	12572			
3325300	203140			
106110	842212			
Total	56330020	13367048		

CHAPTER FOUR

DISCUSSION

This study was designed to assess the probable risks associated with importation of hatching eggs and one day old chicks and to evaluate the quality level of the Sudanese standards of these two commodities and the sanitary measures in place based on the international standards.

The results showed that the importation of the day old chicks and hatching eggs comprises potential risk of introducing AI and many other poultry diseases into the country. The Sudanese standards of hatching eggs and one day old chicks have not been set according to scientifically based risks estimations and the sanitary measures in place are less stringent to achieve the appropriate level of protection.

The SPS Agreement strongly encourages Members to base their health regulations to protect themselves against the animal and public health risks associated with the importation of animals and animal products on OIE international standards such as the *Terrestrial Code*, requiring WTO Members to harmonize their sanitary and phytosanitary measures on the standards guidelines and recommendations produced, (OIE –Terrestrial Animal Health Code 2009), unless relevant standards are absent, or there is scientific based risk analysis justification for a more stringent level of protection than that provided by a standard, (SPS agreement 2009).

Since Sudan is now negotiating for WTO accession, it should put in place standards and measures that are required to achieve its health protection objectives, providing measures that are technically and economically feasible.

Despite the fact that it was set by a specialized technical committee from different institutions the, Sudanese standards for importation of hatching eggs as shown in table (4):

- Has not stated sanitary requirements, and has not specified any hazard, despite the potential hazards associated with commodity in the OIE code,
- The status of vaccination of the parent stocks against the poultry diseases are not specified
- The status of parent stocks of freedom from OIE-listed diseases is not specified.
- There is no indication of compliance with international hygiene and disease security procedures referred to in Chapter 6.4. of OIE terrestrial code for establishments/hatcheries from which the hatching eggs come.
- Laboratory tests to monitor poultry diseases are not stated in this standard.

- The text of the standard is published only in Arabic language, and it is not circulated to stakeholders, there is a need to publish the standard in English as well for all interested parties nationally and internationally.

Also the Sudanese standards for importation of day old chicks shown in table (4):

- the Sudanese standard of day old chicks has stated several (OIE)-listed diseases as the primary hazards associated with initiating importation of this commodity from foreign regions, but it was not set according to the OIE recommendations
- The standard stated that samples should be taken from every consignment to monitor the immune response against only two diseases (Salmonellosis, Mycoplasmosis). The OIE stated many other serious diseases, e.g. AI IB, MD, etc... and are recommended to be tested to check the presence of the agents, besides assessing the immunity against them. The diseases that subjected to laboratory tests should be determined by scientific assessment.
- There is no indication to the laboratory tests methods approved by the Sudanese veterinary authority in the certificates required by this standard. The OIE has listed the approved and alternative laboratory tests methods recognized in the international poultry trade. The Sudanese standard should specify the laboratory tests methods that are recognized by the Sudanese authority.
- There is no indication of compliance with international hygiene and disease security procedures referred to in Chapter 6.4. of OIE terrestrial code for establishments/hatcheries from which the day old chicks come.
- The text of the standard is published only in Arabic language, and it is not circulated to stakeholders, there is a need to publish the standard in English as well for all interested parties nationally and internationally.

As seen from the results the Sudanese standards of hatching eggs, and one day old chicks have not been set according to scientifically based risks estimations, and so, have less stringent imports requirements when compared with the international standards, this can not achieve the Appropriate Level of Protection (**ALOP**).

Comparing with the procedures applied in a similar developing country (Argentina), table (3), there was no animals quarantine facility at the Khartoum airport. A quarantine station approved by the Sudanese veterinary authority should be established at the Khartoum airport and all the consignments of hatching eggs and one day old chicks should pass through this quarantined station before the entry into the country.

Sampling of every consignment of day old chicks to monitor the chicks' immunity against (Salmonellosis, Mycoplasmosis) is not practiced in the procedures, though it was stated in the Sudanese standard of importation of one day old chicks, these two diseases and others determined according to scientific risk assessment should be sampled, then the consignments release depend on the test results.

The type and method of transportation of chicks' consignments from the airport depend on the wishes of the consignees. Sometimes, they are carried in public transportation, which are not subjected to disinfection and sterilization that may enhance transmission of disease agents to or from the chicks. Transportation from the airport should be considered as part of the importation procedures, and only specified vehicles designed specifically for this purpose are allowed to transport the day old chicks.

Animal Health and Epizootics Diseases Control (AHEDC) - Federal Ministry of Animal Resources and Fisheries (FMARF), facilitated by an extensive and well resourced veterinary infrastructure, has the capacity to design prevention, control and eradication programs for selected diseases and has the expertise to assess disease control efforts on a scientific basis, however the poultry health and diseases control programs has just started in the last few years despite the importance of commercial poultry industry to the national economy, which started long time ago and there are other poultry diseases affecting this sector, table (5).

The import risk assessment:

In this study the chicks, hatching eggs as well as the Fomites (contaminated packing materials, bedding & vehicles), may serve as potential sources of poultry diseases agents into the Sudan. The Avian Influenza is the only disease that is subjected to official control program. It was developed in response to the escalating global threat of the disease and not as a scientific prioritization of poultry diseases. Fundamental review is needed to monitor other poultry diseases and assess their impacts on the aviculture, public health, economy and the environment in Sudan.

The importation of one day old chicks and hatching eggs comprises potential risk of introducing (AI) and many other diseases into the country, as stated in the OIE Terrestrial code 2009. Notifiable Avian Influenza (NAI) viruses must be considered to have the potential to lead to the development of disease and are classified as potential hazards in the hatching eggs and day old chicks' commodities. There are also a number of non-(NAI) viruses subtype with the capacity to cause disease in poultry. The full

potential for such disease relationship is not understood and genetic changes in non-(NAI) strains, or encounters with new potential hosts, may result in disease.

Therefore all avian influenza viruses are classified as potential hazards in hatching eggs and day old chicks' commodities.

There are many factors affecting the likelihood of (AI) entering into Sudan via Khartoum airport, shown in tables (6 and 7) in the results; namely the exporting country status of the (AI), and the quantity of the imported commodities in the period of the study. A total of 11241209 chicks were imported from 10 countries, 7 of which were declared AI infected by the OIE. A total of 62307030 layer and broiler hatching eggs were imported from 10 countries, 5 of which were declared infected by the OIE in the period of the 2005-2009. Though, some exporting countries has resolved AI outbreaks, but still The overall risk estimation of introducing AI of these two factors is **Medium**.

The most important factor is the Sudanese veterinary services sanitary measures and importation procedures of these two commodities practiced. Firstly as stated above the Sudanese standards of these two commodities are less stringent import requirements which can not meet the appropriate level of protection (ALOP) from hazards associated with them, table (4). So the risk estimation is **high**. Secondly there is no regular routine laboratory tests conducted by the national veterinary authority as required in the procedures (except monitoring the level of immunity against Salmonellosis, Mycoplasmosis stated in the standard of day old chicks - which is not practiced). Only the visual examination to the consignments is practiced, table (3). Thus the (AIV) and any other disease etiological agents can not be detected at the Khartoum airport and the risk estimation is **high**. There is lack of bio-security measures in the handling and the equipments used and transportation of consignments of the day old chicks and hatching eggs by the labors and inspectors at the airport, table (8). Sometimes the day old chicks are transported by public transportation from the airport, so the risk estimation is **high**.

The release assessment for (AI) viruses is considered to be **non-negligible- risk**.

The likelihood of exposure of the imported hazard form the consignments of the day old chicks and hatching eggs with the national herd and the environment and cause spread of the pathogen into the country depend on many factors, as shown in figures (5) quantities of imported hatching eggs, figures (6) quantities of imported day old chicks. Other factors include: the behavior of some importing company sales systems that distribute chicks to their clients near the airport and in the streets directly after being released from the airport which comprise risk of introducing the pathogen to man and poultry ,The packing materials (plastic crates) of chicks consignments are used for other

products e.g. Packing of vegetables...etc. It also comprises potential risk of spreading the pathogens. The wide range marketing distribution of poultry products (layers and broilers chicks, table eggs, chickens etc...) all over the Sudanese states, lack of biosecurity in the custom and culture practiced in handling of the poultry products, transmission through contaminated Fomites (crates and Vehicles), vaccination crews, wild birds, labors, visitors etc... table (8). These entire factors contribute in dissemination the introduced pathogens to the population at risk in the country, and the overall estimation of spreading the pathogen is **high**. The exposure assessment for AI viruses is considered to be **non-negligible**.

Indicating the historical information of the HPAI that occurred in Sudan in 2006, regarding the adverse consequences including:

Direct consequences shown in the reports of AHEDC, FMARF and AHEDC Khartoum states including: public health consequences, losses in human lives, Animal health implications

Indirect consequences, as indicated in the reports of AHEDC, FMARF and AHEDC Khartoum states, and in table (1) including: cost of eradication, surveillance and control costs, compensation costs, potential trade losses, adverse consequences to the environment.

The magnitude of the consequence assessment is considerably **high**.

Because entry, exposure, and consequence assessments are **non-negligible**, the risk estimate is **non-negligible** and avian influenza viruses are classified as a hazard in the commodity. Therefore, risk management measures can be justified.

Conclusions and Recommendations:

In order to manage the risks of imported hatching eggs and one day old chicks, the following are recommended:

1. The Sudanese veterinary authorities should adopt the OIE standards and recommendations, as indicated in articles 10.4.7., 10.4.8., 10.4.10, 10.4.11.OIE - *Terrestrial Animal Health Code 2009*.
2. All consignments of hatching eggs and one day old chicks must be kept in quarantine station approved by (FMARF) at the Khartoum international airport and samples are collected and tested using methods described in the *OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals* for Avian Influenza viruses and completed with negative results prior to clearance.
3. Since the veterinary services are the first line of defense against most public health hazards, and the Sudan is now negotiating for WTO accession, so the following are recommended:
 - I. Science based- risk analysis following OIE standards should be undertaken, by a multidisciplinary team in setting and updating the:
 - Preparedness contingency plans for controlling animal diseases
 - Sudanese standards of animals and animals' products generally and standards of one day old chicks and hatching eggs in particular, publishing them in both Arabic and English and be circulated to relevant partners, applied, monitored in a professional and transparent manner, so that a safe international trade in animals and animal products can be guaranteed.
 - II. Provide reliability to quality assessments and certifications SSMO and the national veterinary services should always co-operate on the basis of sound scientific principles, technical, ensuring transparency, address any weaknesses identified.
 - III. Conduction of database capacity systems - in both SSMO and the national veterinary services - of animal and animals' products besides efficiency in reporting systems that consistently provide valid and precise analysis.
 - IV. Because of the complexities involved, the conduction of a full import risk analysis is now regarded as a distinct scientific discipline; training is essential, and learning from already conducted Import Risk Analysis is highly recommended.

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