



## **Biosecurity Practices and Potential Biological Risks in Poultry Farms in Agnibilekrou and in Peri Urban Areas of Abidjan**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. Authors SSS, FXL, and CN wrote the protocol, did the field work, did the statistical analysis of the data and wrote the first draft of the manuscript under the direction of the authors MCK, YK, YK who made their corrections for the validation of the final document submitted. All authors read and approved the final manuscript.*

### **Article Information**

DOI: 10.9734/AJMAH/2021/v19i630335

#### Editor(s):

(1) Dr. Ashish Anand, G. V. Montgomery Veteran Affairs Medical Center, USA.

#### Reviewers:

(1) Haroon Ali, H. N. B. Uttarakhand Medical University, India.

(2) Maksuk, Poltekkes Kemenkes Palembang, Indonesia.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/70079>

**Original Research Article**

**Received 18 April 2021**

**Accepted 23 June 2021**

**Published 26 June 2021**

### **ABSTRACT**

This study aimed to evaluate biosecurity practices and potential biological risks in poultry farms in Agnibilekrou and in the peri-urban areas of Abidjan. It took place from August to December 2008. A total of 219 poultry farms were surveyed, including 119 in Sector 3 and 100 in Sector 4. The results of this study show that only 22.7% of the farms have fences, 6.7% have roto-tanks and 30.3% have foot baths for the entrance and protection of the breeding area. In 22.7% of cases, poultry carcasses are thrown into the open air and in 25% of farms they are consumed. Nevertheless, 91% of these farms have well maintained surroundings. Waste is disposed of in 96% of open-air farms, poultry corpses in 69% of farms. The water consumed by the birds is surface water in 57% of the farms. In 81% of the farms, the birds are fed by divagation and in 19% of the cases by semi-divagation. Feed is soiled in 89% of farms. Poultry carcasses are thrown away in 43.5% of farms near the farm. Faced with such situations, the Ivorian government should strengthen training, awareness and encourage all actors in the poultry sector, especially farmers, to implement good biosecurity practices.

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*Keywords: Biosafety; biological risks; poultry; Agnibilékrou; peri-urban; Abidjan.*

## 1. INTRODUCTION

In order to secure the supply of meat products and reduce the level of imports, a livestock sector has been set up in a few decades. The policy of livestock development thus born in Côte d'Ivoire has gone through the delimitation of the different regions of the country. The south was reserved for the breeding of short-cycle animals, in particular pork and chicken. The North and the Center were dedicated to the breeding of large and small ruminants. Numerous investments by the State and support from the private sector in poultry farming have made it possible to move from self-consumption to commercial production. In 2000, local meat production accounted for 80% of national consumption. Local egg production represents 100% of national consumption. In parallel with the increase in production, Ivorian poultry farming has undergone considerable development. It employs more than 30,000 people with an annual turnover of more than 40 billion CFA francs. The livestock population is estimated at 30,000,000 head of poultry and covers 91% of poultry meat needs and all egg demand [1]. This sector generates other indirect jobs because it is the main outlet for many agricultural and agro-industrial products. Although the poultry industry is booming, it nevertheless faces enormous problems, especially pathological ones that have an impact on public health, since some of them are zoonotic. The latter cause significant losses of income related not only to the loss of animals, but also to the outflow of currency, the country being entirely an importer of veterinary products. The most significant pathological problem is the epizootic of Highly Pathogenic Avian Influenza (HPAI) that appeared in Côte d'Ivoire in February 2006.

Investors have also noticed that the poultry market in urban areas is rich in potential, especially since it is now easy to set up a production unit in a relatively short time to set up a production unit in a fairly short time. As a result, a industrial poultry farming in peri-urban and even urban areas has developed urban areas has developed. We are witnessing anarchic, improvised and/or periodic and/or periodical installations of several poultry farms represented by small units of farms very close to each other on unsuitable sites. Also, this poultry farming is practiced in a speculative way by individuals whose most of them have not

acquired any technical training that would allow them to practice hygiene in breeding. Although the poultry industry is growing rapidly, it is nevertheless experiencing enormous problems, especially pathological ones that have an impact on public health since some of them are zoonotic. These last ones cause important related not only to the losses of animals, but also to the outflow of currency outflow of currency; the country being entirely an importer of veterinary products.

The most important pathological problem is the epizootic of Highly Pathogenic Avian Influenza. (HPAI) that appeared in Côte d'Ivoire in February 2006. According to [2], managing animal health in current production systems production systems, requires taking into account complex situations, partially indeterminate situations and to integrate the notions of technical and economic efficiency of actions to control pathological phenomena. The fight against HPAI requires an active and rapid response at a national, regional and regional and international level, as it is a major obstacle to international trade and international trade and to the progress of the poultry industry. HPAI, commonly referred to as "avian commonly called "avian flu" has become a global concern.

In Côte d'Ivoire, where the poultry sector is a very important component of the the economy, several actions have been taken (slaughter of poultry in infected compensation to farmers, vaccination, information and awareness raising of the population). information and sensitization of the population). The veterinarian, according to [3], should play a much more advisory role in the development of prevention and control programs. Various workshops on biosecurity measures have already been organized with the help of development with the help of development partners such as the FAO; the aim being to to prevent the risks of epizootics and contamination of the population. These biosecurity measures consist in strengthening the know-how and capacities of necessary to ensure the observance of good biosecurity practices in the poultry industry (farms, markets, borders, transport, etc.). To reduce risk factors or emergence of poultry diseases and to ensure a healthy poultry production system, it is necessary to evaluate the biosecurity practices implemented on the biosecurity practices in place on the farm in order to improve it.

In order to reduce the risk factors or emergence of poultry diseases and to ensure a healthy poultry production system, it is necessary to evaluate the biosecurity practices implemented in the farms with the aim of improving them. This is the context of our study, the general objective of which is to evaluate biosecurity practices and potential biological risks on poultry farms in Agnibilékrou and in the peri-urban areas of Abidjan.

## **2. MATERIAL AND METHODS**

### **2.1 Location and Period of Study**

This study took place from August to December 2008 in two regions of Côte d'Ivoire: the Lagoon region and the Middle Comoé region. In the lagoon region, the city of Abidjan and its periphery were considered.

In the Middle Comoé region, we were interested in the town of Agnibilékrou. This is a town bordering Ghana that includes the Comoé National Park.

In these two cities the climate is generally hot and humid with an average temperature which oscillates around 28°C on average as in all the rest of the country. These are two areas of high poultry production [4]. These towns have been epizootic foci, particularly for HPAI [5].

### **2.2 Materials**

#### **2.2.1 The farms**

The study included 219 farms, 119 of which were in the commercial sector (Sector 3) and 100 in the village system. The sampling was carried out by a non-probability method based on the technique known as "snowball sampling". In this method, the sample is built up gradually. In each zone visited, the farms to be surveyed were found on the basis of information provided by resource persons, namely private veterinarians, farmers and in the farms monitored by the field supervisor. Thus, when we visit a modern farm, we ask him to indicate other "similar" farms.

#### **2.2.2 Livestock management staff**

The supervisory staff is composed of veterinarians and livestock technicians.

#### **2.2.3 Personal protection material (equipment)**

It is composed of suits, boots, masks, gloves, hats in the form of helmet.

### **2.3 Study Method**

#### **2.3.1 Documentary survey**

Several documents were collected and then analyzed. The majority of them were taken from the internet but some were taken from seminars, workshops and other activities organized in Côte d'Ivoire on biosafety. The main parameters studied were the location and characteristics of the farms, the design of the buildings, the devices at the entrance and protection of the farming area and the sanitary control inside the building.

#### **2.3.2 Field survey**

##### *2.3.2.1 Elaboration of the survey questionnaires*

This pre-survey phase required field visits with poultry farmers and validation of the questionnaire through exchanges with farmers and the Inter-State School of Veterinary Science and Medicine (EISMV) in Dakar. The questionnaires focus on the 4 parameters that are essential for the evaluation of biosecurity in livestock.

##### *2.3.2.2 Administration of the survey*

The questionnaires were administered to 219 farmers, 4 veterinary doctors and 12 livestock technicians in the form of open-ended interviews. The farms were also subjected to a formal diagnosis while collecting information on the basis of the questionnaire. This phase took place from September 2008 to mid-December 2008

#### **2.3.3 Statistical analysis**

In this study, the analysis method used is a descriptive analysis. Two computer programs were used to enter the raw data collected, perform statistical analyses and present the results. The EPI DATA 3.1 software was used to design the input masks for entering the data collected during the surveys. The advantage of this software is that it is easy to use and avoids the recording of erroneous data. SPSS.16 software was used for statistical analysis by determining frequencies and percentages of data. All data were qualitative data.

## **3. RESULTS**

### **3.1 Farm Surveys**

#### **3.1.1 Location and characteristics of the farms**

Concerning sector 3 or commercial sector, the survey showed that 43.7% of the farms are in

contact with other domestic birds and 63.7% of the farms are in contact with houses.

In sector 4 or village farms, 77% of the farms are in contact with other domestic birds and 93% of the farms are in contact with houses.

**3.1.2 Building design**

The buildings are mainly in the commercial sector, except in a few cases where we found some in village farms (Table 1).

In the commercial sector, the survey showed that 98.3% of the farms had modern buildings, 49.7% of which were oriented in the direction of the prevailing winds and the sun.

In the village farms, the survey showed that all the buildings were of the traditional type, with 1% of them facing in the direction of the prevailing winds and the sun.

**3.1.3 Devices at the entrance and protection of the breeding area**

In general, there are no devices at the entrance and protection of the breeding area in the village sector, see Table 2.

In the commercial sector, the survey showed that 22.7% of farms have a fence and 30.3% of farms have foot baths at the entrance to the buildings.

At the village level, 72% of farms dispose of waste and 69% of farms dispose of poultry carcasses in the open.

**3.1.4 Sanitary control inside the building**

The sanitary control inside the building is located at several levels: at the level of the layout, the management of the farm and the operators.

**3.1.4.1 Layout inside the building**

In the village livestock sector, there are no facilities inside the building (Table 3).

In the commercial sector, there is no principle of forward movement and no difference between the clean and soiled areas. At the level of the village farms, the water troughs and feeders are in 86% of the farms rudimentary.

**3.1.4.2 Conduct of the breeding**

In village livestock farming, there is no livestock management as such.

In the commercial sector, the survey showed that 29.4% of farms have a temperature measurement system, 67.2% of farms keep chronically ill animals and 34.5% of farms store manure near the chicken houses. At the level of village farms, it appears that 81% of the feed is based on divagation and soiled in 89% of farms by the droppings of rodents, domestic animals, birds...

**3.1.4.3 Livestock personnel**

In general, sector 4 does not have a breeding staff. This staff is represented by the owner of the chickens and his family (Table 4).

In the commercial sector, the survey showed that 22.7% of the farms have biosecurity measures in place and 2.5% of the farms have the assistance of veterinary doctors. At the level of village farms, 3% of farms have owners who are more or less familiar with biosecurity measures and 6% of farms receive visits and health advice from veterinary services. Abidjan alone accounts for 21.8% of the 30.3% obtained for regular training of employees and 16% of the 22.7% obtained for knowledge of biosecurity measures.

**Table 1. Building Design**

Building Design		In percent (%)	
		Area 3	Area 4
Type of building	Modern	98.3	0
	Traditional	1.7	4
Rudimentary materials for the construction of poultry houses		1.7	4
Number of buildings	1	41.2	4
	2 à 5	58.7	0
Respect of a distance of at least 20 m between buildings		10.9	0
Orientation of the buildings with respect to the direction of the prevailing winds and the sun		49.7	1

**Table 2. Entrance devices and protection of the breeding area**

Devices at the Entrance and Protection of the Breeding Area	In percent (%)	
	Area 3	Area 4
Presence of fence	22.7	0
Rotoluvé at the entrance of the farm	6.7	0
Maintained edges (at least 5m)	68.1	91
Prohibition to foreigners	4.2	0
badges To pets	0.8	0
Presence of a main door	33.6	0
Foot bath at the entrance of each building	30.3	0
Specific materials for each poultry house	96.6	4
Washing and disinfection of trucks authorized to enter	5	0
Ancillary premises (stores, checkrooms...)	82.4	0
Evacuation of Pits	1.7	0
waste, litter, Landfills	35.4	25
waste water Sold as a fertilizer	45.4	0
Dumped in the open	15	72
Fish food	2.5	0
Method for the Incineration	3.4	0
destruction of Landfill	48.7	16
poultry Dumped in the open	22.7	69
corpses Consumption	25	15

**Table 3. Interior layout of the building**

Interior Design of the Building	In percent (%)	
	Area 3	Sector4
Existence of a clean zone and a soiled zone	0	0
Principle of forward motion	0	0
Waterproofing of poultry house floors	73.1	0
Smooth internal wall	43.7	0
Floor and wall hygiene in buildings	37.8	0
Drainage system for cleaning water outside of the surroundings and access roads	34.6	0
Drinkers, feeders and other materials and equipment removable for easy cleaning and disinfection	85.7	11
Rudimentary troughs and feeders	0	86

**Table 4. Livestock Personnel**

The Breeding Staff	In percent (%)	
	Area 3	Area 4
Regular technical and theoretical training of employees	30.3	0
Knowledge of biosafety measures	22.7	3
Change of shoes, clothes and washing of hands before any intervention in the buildings of breeding	92.4	0
Passage through the foot bath before entering the henhouse	28.6	0
Technical assistance		
Veterinary Doctor	2.5	0
Livestock Technician	71.4	0
Doctor and technician	4.2	0
Visits, advice and health visits by the veterinary services	40.3	6
Precise knowledge of the origin of the inputs	95.8	10

### 3.1.5 Other information

Other information was obtained in the farms, namely

#### Health problems:

- 54.6% of the farms in sector 3 have health problems;
- 92% of the farms in sector 4 also have health problems.

#### Type of owners

- 29.4% of the farms in sector 3 have owners whose main function is breeding or related to it. In sector 4 this percentage is four (4) %.

#### Illiteracy of farmers and employees

- In 33.6% of the farms in sector 3, farmers and employees are illiterate.
- In 58.7% of the farms in Sector 4, the farmers are illiterate.

## 4. DISCUSSION

### 4.1 Location and Characteristics of Farms

The location and characteristics of the farms are consistent with those described by [6,7,8]. Our study reveals that in sector 3 or commercial sector, the number of poultry can reach more than 5,000 in some farms. Our results are more or less in agreement with [9]. Furthermore, there is no direct relationship between farm size and biosecurity level [10]. The results obtained in sector 4 are in agreement with those of [11], who reports that each peasant family has a relatively small number of hens [11]. These results are also consistent with those of [7] when they state that the lack of surveillance is marked.

### 4.2 Building Design

Our study reveals that the rearing buildings in Sector 3 are poorly oriented with respect to prevailing winds and sunlight. Our observations are thus in agreement with those reported by [8] when he says that the orientation of the buildings does not respect the direction of the prevailing winds and the sun [8]. In addition, a report by [6] emphasizes the poor design of buildings [6]. A very low rate of farms respects the distance between buildings. Our results are also in

agreement with the results of [12] which also found that on most of the farms visited, the buildings are close together and the distance between buildings does not meet the normal distance between buildings of 30 m. Now, if the buildings are not spaced far enough apart on the farm, there are risks of airborne contamination from one building to another. ITAVI recommends a minimum distance of 30 meters and the planting of trees between two buildings to reduce the microbial load of the circulating air [13]. The poultry guide for West Africa recommends a distance of 15 meters [14]. This could be justified by ignorance of this distance or the negligence of breeders who, wanting to earn more, build many buildings on a small site. The non-respect of this principle would be the origin of sanitary problems of mortality and decrease of zootechnical performances [8].

### 4.3 Entrance Devices and Protection of the Rearing Area

There are no devices at the entrance and protection of the breeding area in sector 4. However, the surroundings of the farms are maintained, waste from some farms is disposed of in dumps and corpses from other farms are buried. This could be explained by the fact that the breeding sites are generally located in the owners' homes. [12] also noted in Côte d'Ivoire in 2015, a proximity of the farms with the houses in [12]. This proximity results in the negative influence of certain human activities on these farms, such as the discharge of wastewater and any other product from households. The cohabitation of humans with these animals may involve the risk of increasing the possibility of human contamination as indicated by [15].

The results obtained in sector 3 are in agreement with those described by [4] and are not consistent with the biosecurity measures described by [6]. The presence of a fence is essential for biosecurity isolation. ITAVI recommends tightly fenced buildings with at least two windows [12]. According to Article 6.4.4 of the Terrestrial Animal Health Code, "wherever possible, all interior surfaces of poultry houses should be made of concrete or other impervious materials and should be designed to permit adequate cleaning and disinfection" [16]. The lack of fencing on most farms may be due to a lack of financial resources. It may also be due to the fact that farmers do not find it important to put up a fence for a barn with employees staying nearby. The lack of fencing allows other animals

to enter the farm. These results corroborate those of [12], who noted an accessibility of unwanted animals such as mice, nematodes and rodents to these facilities [12]. Yet it is known that these animals can carry pathogens such as Salmonella [17]. The lack of fencing in 25% of the facilities gives free access to the farm to outside animals such as cattle, sheep, turkey, dogs and cats. This lack of fencing at the farm level may be a factor in the degradation of hygiene on these farms. Consequently, it could have a negative impact on production on the one hand and on the other hand, represent possible causes of transmission of certain zoonoses to poultry [17,18]. According to these same authors, easy access to poultry facilities to cattle, sheep, dogs, cats, reptiles, insects and rodents significantly increases the risk of contamination. The role of these animals in the transmission of enterobacteria and in particular of the Salmonella genus is known and documented [18,19,20].

The lack of a rotolue, foot baths and prohibition signs, the washing and disinfection of trucks authorized to enter the farm, and the absence of a change of footwear before entering the farm could be explained by an ignorance or neglect of these biosecurity measures by farmers or a lack of financial means on the part of farmers. This neglect of biosecurity measures (including lack of footwear change and personal hygiene) has been noted in Finland where only 13% of backyard farm owners claim to change their footwear before entering the premises [21], and in Cote d'Ivoire by [12], where only 34% of workers carry out their activities without changing their work clothes. This constitutes a health risk both for them and for the animals on the farm. Better yet, they become sources of entry for pathogens in their work environment. After using the toilet, 10% of workers do not wash their hands systematically. Moreover, stress and immune suppression are believed to promote the establishment of Salmonella [20,22,23].

Article 6.4.5 of the Terrestrial Animal Health Code states that "All staff and visitors entering a poultry house must wash their hands with soap and water or clean them with a disinfectant. They are also required to change their footwear, use a boot spray and a foot bath containing a properly maintained disinfectant. The disinfectant solution in the foot bath must be renewed regularly to ensure its effectiveness, according to the manufacturer's instructions" [16].

In our study, on farms where producers reported that they still use foot baths, it was not verified

whether these foot baths actually contain disinfectant and whether the disinfectant is regularly renewed.

The surroundings of the farms are in most cases maintained. This could be justified by the fact that the farms are located either in the middle of the city or on the outskirts. In the latter case, the surroundings are used for growing food. The waste products, especially litter, are used as fertilizer in the market gardens as well as in the small banana, cassava and yam fields maintained by the workers around the farms. In general, this litter is not treated before use and could be a risk factor, a potential source of contamination if it contains pathogens. Some farms evacuate their litter wherever they want, this also constitutes a potential risk factor. Litter is also used as fish feed. Poultry carcasses are destroyed by burial on most farms. The open disposal and human consumption of these birds would not only be a source of human contamination if the deaths are due to zoonotic diseases, but also a source of pathogen spread (open disposal) with the help of wild birds.

#### **4.4 Sanitary Control inside the Building**

##### **4.4.1 Fitting out inside the building**

With the exception of the watertightness of the floor of the barns, which is acceptable for sector 3, the other factors of the building layout are more or less not respected. These results are consistent with those described by [6]. This could be explained by the lack of knowledge or the absence of a proposal to farmers for a typical building layout that takes these principles into account. These management factors do not exist in Sector 4, especially since there are generally no livestock buildings. In sector 3, water troughs, feeders and other materials and equipment are removable, which facilitates cleaning and disinfection of these elements in almost all farms, as required by biosecurity practices. In sector 4, the troughs and feeders are rudimentary (old plates, cans, etc.), which does not facilitate their cleaning. This proves the lack of investment in this sector.

##### **4.4.2 Conduct of the breeding**

The results obtained in sector 3 show that certain management factors (animals from healthy hatcheries, single-batchery rearing, etc.) are more or less respected. These results are in agreement with those of [3,9]. These results

could be explained by the fact that all day-old chick production structures are well known in Côte d'Ivoire. Imported chicks are quarantined and tested by LANADA. The problem arises when chicks from border countries are introduced illegally (as in the case of Agnibilékro, which borders Ghana). In Sector 3, more than half of the farms visited clean and disinfect their materials and equipment once a day. Ideally, this should be done at least twice a day, but few farms do this. The most commonly used product for disinfection is sodium hypochloride. Other disinfectants are less used. This could be due to the high cost of these products as mentioned by the farmers. The keeping of sick animals, the use of feed soiled by rodent droppings (sector 4), the storage of manure and the disposal of dead animals near the farm are contrary to good animal husbandry practices as cited by [5] and therefore agree with the description of [4]. All these elements constitute potential risk factors. The cleaning, washing and disinfection of buildings after each batch is well understood by farmers. The sanitary vacuum is an extension of disinfection. Indeed, disinfection allows the destruction of almost all micro-organisms and those that are resistant will be killed by natural physical agents such as oxygen from the air, ultraviolet rays from sunlight, desiccation, etc. The crawl space must last at least 2 weeks [24]. A crawl space is considered effective when it is longer than 3 weeks with one week for decontamination and the rest of the time for vacancy. It should be noted that the use of a stamping-out period in West Africa is very approximate [25].

Biosecurity recommends disinfection with an officially recognized bactericidal and/or virucidal and/or fungicidal product. There are several types of disinfectants, but apart from detergents, sodium hypochloride (bleach) and/or virkon (active chlorine), other disinfectants are used very little in this sector. This could be explained either by the lack of knowledge of these products in this sector, or by the difficulties of access to these products, or by the high cost that depends on their quality. In sector 4, there is practically no livestock management, and this is in agreement with DIOP (1982) [26] when he says that rational standards of herd management are practically relegated to second place in this type of livestock farming.

#### **4.5 Other information**

The results obtained with regard to health problems are not surprising. These problems are

the consequences of the lack of hygiene and the absence or weak application of biosecurity practices. These problems are most pronounced in Sector 4 and are consistent with those mentioned by other authors such as [27,28,29]. when they speak of pathological constraints. Illiteracy and non-compliance with instructions could justify the lack of hygiene and the poor application of biosecurity measures [27,28,29].

### **5. CONCLUSION**

A total of 219 poultry farms were surveyed, including 119 in Sector 3 and 100 in Sector 4. The results of this study show that only 22.7% of the farms have fences, 6.7% have roto-tanks and 30.3% have foot baths for the entrance and protection of the breeding area. In 22.7% of cases, poultry carcasses are thrown into the open air and in 25% of farms they are consumed. Nevertheless, 91% of these farms have well maintained surroundings. Waste is disposed of in 96% of open-air farms, poultry corpses in 69% of farms. The water consumed by the birds is surface water in 57% of the farms. In 81% of the farms, the birds are fed by divagation and in 19% of the cases by semi-divagation. Feed is soiled in 89% of farms. Poultry carcasses are thrown away in 43.5% of farms near the farm. Faced with this situation, the Ivorian government should strengthen training, awareness and encourage all stakeholders in the poultry sector, particularly farmers, to implement good biosecurity practices. It should also provide them with a guide of good biosecurity measures, an evaluation form of these biosecurity practices and the veterinary agents necessary for the proper conduct of these operations in order to ensure not only the sanitary safety of poultry but also that of humans.

### **CONSENT**

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

### **ETHICAL APPROAL**

It is not applicable.

### **COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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