Assessment of Biosecurity in Confined Pig Farms in Urban and Peri-Urban Areas of Abidjan (Ivory Coast)

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Authors’ contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

ABSTRACT

The purpose of this study is to assess the status of biosecurity measures in confined pig farms in the urban and peri-urban areas of Abidjan in order to make recommendations for improving their sanitary conditions. This study was conducted in 76 confined pig farms in order to assess biosecurity practices. It consisted of administering a questionnaire to farmers in the urban and peri-urban areas of Abidjan. The analysis of the implementation of external biosecurity measures showed that 46.67% of the farms were not fenced, 85.20% were adjacent to other pig farms and the distance between them was less than 200m in 75.40% of cases. Similarly, 35.80% of the farms were located less than 100m from houses. Barriers to entry existed in 37.5% but only 2.8% and 8.82% of farms had signs for visitors and trucks and a vehicle disinfection device at the entrance respectively. Only 6.8% of the farms had foot baths at the entrance of the buildings. The vast majority of farmers stated that they quarantine new animals. The principles of internal biosecurity are very little respected. Workers wear work clothes on the majority of farms, but more than half of them go outside with them. The same working equipment is used in the different lodges without distinction of the age of the subjects and very little cleaned and disinfected. The disinfectants used are bleach and cresyl without any dilution standard. The presence of other animal species was noted and rodent control was not practised. The pathologies encountered are predominantly diarrhoea, and postweaning animals are the most affected.
Keywords: Biosecurity; livestock; pigs; urban; Abidjan

1. INTRODUCTION

Biosecurity measures are important to prevent or limit the risk of animals becoming infected with pathogens. Biosecurity is a term used to describe management measures to prevent the entry of pathogens (external biosecurity) or their spread within the farm (internal biosecurity). By reducing the introduction and spread of diseases on the farm, improving the level of biosecurity will reduce morbidity and mortality rates. Biosecurity is therefore an essential tool in eradication programs and daily animal health management [1,2,3]. All production systems have strengths and weaknesses, as is the case for the production and marketing of pork in the markets, which are poorly regulated. These practices seem to have a particularly important role in the persistence of certain pig diseases in the peri-urban environment [4,5]. However, pig production faces many health (African swine fever (ASF), zoonoses), technical (genetics, feeding) and social (acceptability of farms around residential areas) problems. Health issues remain a major concern. In sub-Saharan Africa, African swine fever (ASF) remains a constant threat; moreover, there are numerous pathologies that strongly impact production [6]. In fact, Côte d’Ivoire experienced an African Swine Fever (ASF) epizootic in 1996, the origin and spread of which were due to the non-respect of biosecurity measures [7]. This epizootic caused economic losses and a reduction in herds, which led to a decline in the zootechnical performance of the animals. In order to control ASF and other pig diseases in a sustainable way, it is useful to apply measures that guarantee the highest level of biosecurity in the whole production-consumption chain.

In the current economic context, these measures may appear as additional constraints requiring investments or changes in practices. Nevertheless, they contribute to the control of health: reduction of antibiotic use, optimization of performance [8]. Some authors have attempted to quantify the economic impact of the application of biosecurity and health control rules according to the design and management of the farm. Favourable practices result in a higher standardized margin of 182 euros/sow/year in France [9]. Increasing the level of biosecurity in pig farms is a long-term process that requires financial investment and a change in behavior [10]. One of the most common routes of transmission of infectious agents is direct contact between pigs: the movement of infected pigs in close physical contact with uninfected pigs plays a decisive role in the spread of disease [11]. As the development of antibiotic resistance is a serious threat to public health, many countries are now seeking to reduce the use of antibiotics in animal husbandry. Improving the level of biosecurity is one of the possible measures to promote the reduction of this use. This improvement can only be achieved in partnership with farmers [12].

In order to revive the Ivorian pig industry following the ASF epidemic, the Interprofessional Fund for Agricultural Research and Advice (FIRCA) initiated, at the request of industry stakeholders, a project to improve animal productivity by raising the genetic level of pig farms. This project is part of the implementation of the West Africa Agricultural Productivity Program (WAAPP), which aims to improve agricultural productivity. This increase in pig productivity is also targeted by the Projet de Relance par l’amélioration génétique de la Filière Porcine ivoirienne (PREFIPOR) of the Société Ivoirienne d’Abattage et de Charcuterie (SIVAC).

Certainly, the contribution of new blood in the pig farms in Côte d’Ivoire constitutes a base for a radiant development of the sector. However, a question remains, whether the beneficiaries offer appropriate sanitary conditions to develop the animals of improved breeds that are made available to them. In other words, are biosecurity measures planned and applied on pig farms in Côte d’Ivoire? In order to answer this question, we propose to review the current status of biosecurity measures in confined pig farms in the urban and peri-urban areas of Abidjan, and then to make recommendations for improving their sanitary conditions.

2. METHODOLOGY

2.1 Study Area and Period

The study took place from October to December 2014 in the urban and peri-urban area of Abidjan (Abidjan, Anyama, Bingerville, Songon). This area represented, in the former administrative division, the District of Abidjan. The pig farms are grouped in breeding areas located on the outskirts of the city of Abidjan and in the surrounding towns.
2.2 Materials

- Farms

The study focused on confined pig farms in the study area. Confined pig farms (fao, 2011) are considered to be all structures with live pigs in a pen, regardless of their distribution in the buildings or the size of the herd.

- Survey Form

A questionnaire with three (3) sections covering farm information, external biosecurity measures and internal biosecurity measures applied, was administered.

2.3 Study Methods

- Sampling

The sample was built up progressively using a "snowball" sampling method. Indeed, in each zone visited, the farms to be surveyed corresponding to the profile sought were found on the basis of indications from previous farms visited, thanks to private veterinarians, agents of the Ministry of Animal Resources and Fisheries, farmers' associations and support structures.

- Field survey

The questionnaire was validated after a pre-survey with 10 respondents, including farmers, veterinarians, teachers and other stakeholders in the pork sector. It was administered by a single auditor, in the form of an interview with a farm worker or the owner.

- Data Analysis

The data collected were recorded and analyzed with SPHINX Plus2 V5 software.

3. RESULTS

3.1 Characteristics of Confined Pig Farms

- Socio-professional status of the farmers

70% of the farms belong to individuals and the majority of the farmers (82.67%) are men aged between 25 and 50 years in 58.10% of cases. Pig farming is the main activity of 52.24% of these farmers. The farmers who have another activity work either in the public service (30%) or in the private sector (44%). Some of them are self-employed (22%). Only 4% are students.

- Technical staff

The farms are monitored by a farm manager. On some farms, the farm manager worked under the supervision of an animal health specialist. The technical staff is unqualified in 75% of the farms. The majority (62.90%) of the farms were managed by people who had no training in animal husbandry, and of these farm managers, 43.30% had less than 5 years of professional experience. Of the farms visited, only 8% used the services of veterinary doctors.

- Specificities of the farms

  - Characteristics of the farms

In the surveyed area, 14.90% of the confined pig farms were takeovers of former bankrupt farms in which the farm buildings were rented to one or more farmers. The farms in which the visited pig farms were located were 29.30% mixed farms that raised other animal species in addition to pigs. Some farms had one to five other livestock species besides pigs. The species most associated with pork was poultry, which was found on 26.67% of the farms visited. Three types of farms were encountered, with a clear predominance (90.70%) of farrow-to-finish farms.

In the confined pig farm, the animals were certainly raised in buildings, but these had different characteristics. The buildings were semi-open in 98.70% of the farms (Fig. 1), which had the disadvantage of allowing contact between pigs and foraging birds or pests. All buildings were cemented and almost all (98.70%) had a tin roof.

- Structure of the herd

Several breeds of pigs were encountered: purebred exotic pigs (Landrace, Duroc, Largewhite), mixed breeds and local breeds. In order of importance, we found mixed breeds on 93.42% of the farms, pure breeds on 10.53%, and local breeds on only 1.32% of the farms (Fig. 2).

On the farms visited, the number of pigs ranged from 5 to 4000, with an average of 269.45 pigs per farm. Farms with less than 100 animals represented 55.10%. On these farms, the total number of pigs varies according to the births and exits of pigs that have reached selling weight.
The breeding nucleus is the best way to evaluate the size of a herd. Thus, 37.3% of the farms had less than 10 breeding sows.

**Animal feeding**

Feeding includes both water and feed. The sources of water used by the farmers are diverse. The majority (65%) of farmers used well water, compared to 16% (borehole water), 14% (running water) and 5% (pump water).

As for feed, the study shows that only 5.30% of the farmers used industrial feed from companies specialized in feed production. The remaining 94.70% composed their own feed.

The composition of the rations is specific to each farm, but the 5 most used raw materials were, in order of importance: wheat bran (69.33%), coconut cake (64.00%), rice flour (57.33%), shell powder (52%) and cracked corn (52%). Note that corn bran was also used by 45.33% of the farmers.

![Fig. 1. Semi-open cement barn covered by a roof made of artisanal material](image1)

![Fig. 2. Mixed breed pigs under their mothers](image2)
3.2 Practice of Biosecurity Measures

- **External biosecurity measures**
  - **Location of farms**

The confined pig farms were mostly (85.20%) adjacent to other pig farms located within 200m in 75.40% of the cases. The nearest houses to the farms surveyed were less than 100m away.

- **Access to the farm**

To prevent pathogens from entering the farm from outside, protective devices are in place. 53.33% of the farms surveyed were fenced. The most commonly used fencing material was cement in 21.33% of the farms visited, followed by homemade material in 17.33% of the farms (Fig. 3). Fences were present at the entrance of 37.5% of the farms, but only 2.8% of the farms had signs prohibiting entry. Most farms (91.18%) did not have any vehicle disinfection devices at the entrance.

Outsiders had access to the buildings in 72.97% of the farms compared to only 24.32% that required permission from the owner before access. The absence of a foot bath at the entrance to the farm buildings was noted in almost all the farms visited (93.20%).

In 79.03% of the farms, the quarantine of new animals was noted but only 29.03% respected the recommended quarantine time.

Various exchanges are made between farms in 46.80% of cases, but 33.90% concern animals. Regarding the sanitary control system, the results of the survey show that the protocol for access to the breeding building was almost non-existent in the farms (98.60%). The health status of the farms of origin was unknown by 46.7% of the owners. However, almost all of them (96.90%) took the precaution of checking the apparent health status of the animal before letting it enter their farm. These animals entering 70.60% of the farms surveyed were purchased from different farms.

- **Internal biosafety measures**
  - **Staff hygiene**

We noticed that in the vast majority of farms (89%), the employees had clothes used exclusively for work in the livestock buildings. However, in 56.70% of the cases, the workers left the farm with their work clothes. On most farms, the workers used the same cleaning equipment in the pens of the different categories of pigs (83.80%), without respecting a precise order (74.30%). After use, the equipment is simply cleaned with water in 25% of the farms.

- **Cleaning and disinfection of livestock buildings**

The cleaning of the boxes consists of a sweeping and a rinsing with simple water and is preferably done twice a day. Disinfection in most farms is done with bleach or ice pellets added to the water used to rinse the boxes.

- **Breeding management**

For the management, a book of follow-up of the breeding is used in 53.80% of the farms. Natural breeding was performed in 96.1% of the farms, 83.10% of which had their own sire, and only 3.90% of the farms practiced artificial insemination (Fig. 4). Banding was used on 47.90% of the farms.

- **Waste management and cadavers**

The dead bodies were thrown directly into nature (33.70%), buried (32.60%) or consumed by the staff (26.10%). In the majority of cases, the waste from the farms was disposed of in nature in 44.40% of cases, or just behind the building in 30.90% of farms (Fig. 5).

- **Disease management**

The most frequently observed diseases on farms are diarrhea (80% of farms), followed by parasites with a predominance of scabies (56%), then respiratory diseases (46.67%), (Fig. 6). Weaned pigs are the most affected. In the event of a disease outbreak in a farm, 63% of farmers isolate sick animals for treatment, compared to 30% who treat them on site. In the absence of improvement of the health status, despite the treatment, the animals are slaughtered for sale in 38.50% of farms.

- **Medical prophylaxis**

64.80% of the farms have implemented medical prophylaxis, but only 10% of the farmers claimed to vaccinate their animals against parvovirus.
Fig. 3. Fence made of artisanal material

Fig. 4. Reproduction by artificial insemination

Fig. 5. Hog waste discarded in the environment
Watering and feeding of animals

The watering of animals is done in the great majority of farms (64.90%) with well water and in 16.20% and 13.50% of farms respectively with borehole water and running water. 69.01% of the farmers affirmed to treat water and the most used product is bleach in 60.56% of cases.

With regard to animal feeding, of the 17.33% of farmers who incorporated swill into the ration, only 1.33% proceeded to heat treat it. The mixing of the feed was done in 65.10% of the farms on bare soil.

Rodents and other animals

Rodents are present especially in the stores of food storage. The control of these rodents is absent in 27.42% of the farms, but in 32.26%, 20.97% and 16.13% of the farms, cats, traps and rat poison are used to control rodents.

Animals were found roaming in 25.40% of the farms visited and may enter the buildings (43.48%). 33.33% of them are domestic animals. In 32.70% of the farms, pigs may leave their housing and roam around the farm.

4. DISCUSSION

4.1 Socio-Professional Status of the Breeders

The results obtained during the survey indicate that 93.4% of the farms. The results of the survey indicate that 93.4% of the farms belong to private individuals. In addition, pig farming is the main activity of 52.24% of these farmers activity of 52.24% of these farmers. These results are almost identical to those obtained by TRA BI 53.8% in Côte d'Ivoire [12]. However, they differ from those of ABDALLAH-NGUERTOUM who showed that in Bangui (Central African Republic) pig farming was a secondary activity with only 12% of farmers working full time. Also, contrary to this study, our results show that pig farming is a real source of income for farmers [13]. The development of this activity seems to be linked to the high demand for pork in Côte d'Ivoire [12].

Pig farming in Côte d'Ivoire is mainly carried out by men, which corroborates the observations made in other countries by ABDALLAH-NGUERTOUM in Central Africa, AYSSIWEDE in Benin, TRA BI in Côte d'Ivoire and UMUTONI in Burkina Faso [12,13,14,15]. On the other hand, in Senegal, the studies carried out in village settings have shown that women are more involved in pig farming. In Senegal, however, studies conducted in village settings have shown that women are more involved in pig farming [16,17].

4. 2 Technical Staff

The vast majority of the farms investigated (62.90% of the cases) were monitored on a daily basis by technical personnel who were of the cases) by technical staff who had not received any training in animal husbandry techniques. Only 8% of the farms were monitored by veterinary doctors. These results could be explained by the concern of the farmers to reduce their salary costs. In general, farmers
consider that employing technical staff trained on the job is less expensive. Although they have some experience in the field, the experience acquired in the field, the level of technical-sanitary training of livestock

The level of technical-sanitary training of livestock employees is still low. This was revealed by ANADER during the general census of modern pig farmers in Côte d'Ivoire [18]. Through this study, it is also clear that the level of collaboration between pig farmers and animal health specialists remains insufficient.

4.3 Specificity of the Farms

The surveys reveal that 29.3% of the farms associated in their exploitation pig farming with other animal species. Among the five species surveyed, poultry predominated with a prevalence of 26.67%. These results are in agreement with those obtained by TRA BI [12]. However, they differ from those obtained by ABDALLAH-NGUERTOUM in Central Africa (55%) and MISSOHOU in Senegal (40%) [13,16]. Although this type of farm (multi-species breeding) has a relatively lower proportion relatively lower than those practicing exclusively pig farming (single species), the health risks can be significant. Indeed, according to ROSSEL et al. (2006), contact between pig farms and poultry is a risk factor for a risk factor of salmonella seropositivity in pigs at the end of fattening. The breeding buildings are 14.90% rented. The same findings were made by ANADER/FIRCA [18]. On the other hand, in Senegal, surveys reveal a percentage (48.1%) of farmers who rent buildings [19]. Also, buildings on the same farm can be rented to one or more farmers. This type of rental constitutes a health risk insofar as two or more different farms with different practices and microbial populations are found close. The non-respect of the recommended distances between farms can favor the inter-farm contamination between farms. This was demonstrated by ROSE and MADEC whose studies indicate that the greater the number of pig farms within a 2 km radius, the greater the risk of contamination of 2 km, the higher the risk of at least two (02) influenza syndromes per year [20].

4.1 External Biosecurity Measures

Location of the farms

The confined pig farms investigated were 85.20% adjacent to other pig farms and 75.40% were located within 200m. The distance between these farms seems unsatisfactory, which would expose these different farms to important risks of exogenous contamination. In fact, according to the SMP, farms should be located as far as possible from other farms, i.e. 2 km in rural areas. A minimum of 200m could be tolerated in high concentration areas, provided that all neighboring farms respect the same biosecurity measures [21].

On-farm access

External biosecurity measures aim to reduce the risk of disease introduction from outside the farm. The absence of protective devices on the farm namely; fence in 46.67% of farms, barrier with prohibition sign in 97.2%, vehicle disinfection device at entry in 91.18% of farms, could increase the risk of introducing biological pathogens into the farm. CASAL et al showed that the average annual risk of introducing new and more important infections occurs through the entry of people into the farm, namely the personnel working there (2.79%) or visitors (5.17%) [22]. This represents respectively 23% and 42% of the total risk of introduction of diseases in the farm.

Also, the absence of a foot bath at the entrance of the buildings was noted in 93.2% of the farms. This is contrary to the observations made in Brittany (France) where more than 50% of the farmers have foot baths at the entrance of the buildings [23]. Indeed, the pig farmers surveyed tended to believe that the use of foot baths would be exclusively reserved for poultry farming, which they consider more susceptible to diseases.

In addition, about 21% of the farmers did not observe quarantine, while 50% observed a short quarantine (less than 4 weeks), yet more than 46% of them were unaware of the sanitary status of the many farms from which pigs were purchased. Surveys in Brittany, France, by CALVAR et al. showed that 44% of farmers practiced long quarantine (more than 6 weeks), 27% used short quarantine, and 29% used standard quarantine (6 weeks) [23]. The lack of quarantine or its poor practice revealed by our study could be related to the failure to take into account the quarantine room when developing the construction plan of the farms in question. If the biosecurity measures in these farms are not respected, cross-contamination within the farm or between farms might occur, which would have serious biological and economic consequences.

Further studies should be conducted to determine the level of contamination and the origin of the introduction of new disease strains. This would help to better understand the role of biosecurity measures in the spread of diseases. Additionally, more research is needed to evaluate the cost-effectiveness of biosecurity measures, especially in the context of smallholder pig farmers. These measures should be tailored to the specific conditions of each farm to ensure their effectiveness and sustainability.
various pathogens from their farms of origin. Thus, according to ROSSEL, the multiplicity of animal origins could explain an increased risk of having Salmonella-positive pigs [24]. Similarly, LO FO WONG showed that the risk of seropositivity increases with the number of supplying farms [25].

4. 2 Internal Biosecurity Measures

➢ **Staff hygiene**

In 89% of the farms surveyed, staff had work clothes, but 57% of them also used them outside the farm. In addition, in 74% of the farms the movement between the livestock buildings was done without a specific order. According to FAO, the implementation of special clothing and shoes reserved for the farm is the most applied measure in confined pig farms [26]. In addition, the direction of movement of personnel within the buildings could be a significant risk factor for pig infection as noted by FABLET et al [27].

➢ **Cleaning-Disinfection**

The results of the survey showed that animal housing was cleaned preferably twice a day, and that this consisted of sweeping and rinsing with simple water.

Disinfection in most farms was done with bleach added to the water used to rinse the pens. For the equipment, 30% used a disinfectant solution, 25% cleaned with plain water and 12.5% never cleaned. These results show that the farms concerned are familiar with the concept of cleaning/disinfection. However, the protocol used was not always appropriate. The disinfectant solution should not be mixed with the detergent. This is the case in the farms surveyed, which could have a considerable influence on the technical and economic performance of the farms and be the reason for the high cost of treating pathologies. According to CORREGE et al, variables related to the cleaning-disinfection protocol explain good technical-economic performance [28]. These include systematic disinfection, pit washing, and cleaning and disinfection of the corridors and loading area.

➢ **Breeding management**

Only 48% of the farms surveyed had a banding system. However, the details of this system were not always given. This could encourage the mixing of animals of different ages during fattening. Multi-ageing can cause immune imbalances favorable to the multiplication of infectious agents. Hence the importance of the arrangement of the compartments during the construction of the buildings. The non-application of banding in all farms is due to a lack of knowledge on the more or less strict respect of this practice. In addition, some farmers claimed that the implementation of strip management would constitute an economic loss, insofar as the sanitary vacuum imposed by strip management would leave the boxes empty and therefore without production. Studies by HEBERT et al, rightly show that non-compliance with strip management is a factor in the degradation of animal health in livestock production [29]. This is particularly true of practices that may generate contact between animals in different groups, which increases the probability of transmission of pathogens.

➢ **Animal feeding**

The results of the survey show that only 18% of the farms use swill for feeding, compared to 91.7% in Bangui [30]. This low prevalence of swill use shows that in Côte d’Ivoire, and particularly in the peri-urban area of Abidjan, farmers are increasingly turning to appropriate raw materials for pig feed formulation. However, the high cost of locally available industrial feed or essential raw materials (corn, soybean meal, etc.) leads farmers to resort to less recommended feeds such as swill (which is also not sterilized). The use of feed of doubtful quality can have enormous sanitary consequences. The African Swine Fever epizootic that occurred in Côte d’Ivoire in 1996 illustrates this perfectly. According to EL HICHERI et al, the origin of the disease was linked to the distribution of food scraps containing meat, sausage products, and other products, most likely from an infected country [31].

The results of this study showed that the level of biosecurity on the pig farms visited in the urban and peri-urban areas of Abidjan is generally low. This corroborates the survey conducted by TONA TONA et al. in the peri-urban area of Kinshasa [5].

5. CONCLUSION

The application of biosecurity measures is important in the fight against diseases. Indeed, the absence of biosecurity measures can lead to heavy losses for farms in the event of an
outbreak of contagious diseases such as African swine fever. In sum, this survey allowed us to note that biosecurity measures are very poorly applied in pig farms. To remedy this, it will be necessary to train and sensitize confined pig farmers on the application of biosecurity measures and the numerous advantages that result from them, and to demonstrate to them the need to involve trained professionals in the sanitary management of their farms. Effective implementation of biosecurity requires a sustained investment to ensure farm safety and to limit the uncontrolled use of antimicrobials.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

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

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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