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Assessment of biosecurity practices of small-scale broiler producers in central Egypt

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ABSTRACT

In the current situation of endemicity of highly pathogenic avian influenza (HPAI) in Egypt, improving the biosecurity of poultry production has become essential to the progressive reduction the incidence of the disease. A significant proportion of the Egyptian commercial poultry system consists of small-scale poultry producers operating with low to minimal biosecurity measures. An investigation was conducted into the level of adoption of standard biosecurity measures of the small-scale commercial chicken growers, including both farm- and home-based commercial production, input suppliers and other actors along the meat chicken value chain in Fayoum, Egypt. The study which used direct observations and group discussions of nearly 160 participants and structured interviews with 463 respondents, assessed biosecurity implementation to improve management practices and ultimately to control and prevent highly pathogenic avian influenza (HPAI). The survey found that overall, biosecurity measures are rarely implemented in small-scale commercial poultry production units. Compliance with recommended biosecurity practices did not greatly vary from home-based to farm-based commercial production. Furthermore, serious risk practices were identified, such as unsafe disposal of poultry carcasses and potential disease spread posed by poor biosecurity measures implemented during vaccination. HPAI control measures have been ineffective due to limited cooperation between public and private sector, aggravated by the unpopular measures taken in the event of outbreaks and no compensation paid for incurred losses. Outreach and biosecurity awareness raising initiatives should be specifically developed for small-scale producers with the objective of improving general poultry management and thus preventing HPAI and other poultry diseases.

1. Introduction

Since February 2006, the Egyptian poultry production sector has been severely damaged by continuous outbreaks of highly pathogenic avian influenza (HPAI) caused by the Influenza A (subtype H5N1) virus (Kayali et al., 2011). Control efforts initially focused on extensive culling of infected birds, with compensation provided to commercial producers; however, compensation was stopped in September 2006 until the necessary funding could be secured (Albrechtsen et al., 2009). Currently there are no appropriate compensatory mechanisms to cushion poultry producers from losses in the event of an outbreak. Within the framework of the HPAI national strategic plan, mass household vaccination campaigns began in May 2007 and were suspended in July 2009. Additionally, various assessment studies have highlighted substantial weaknesses in the immunization program and a lack of positive impact on the spread of infection (Peyre et al., 2009; Poetri et al., 2011). Despite numerous efforts to control the

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disease, the virus has now become endemic. HPAI remains highly prevalent in poultry production systems throughout the country and human cases of avian Influenza A (subtype H5N1) continue to be reported, with 168 cases confirmed up to August 2012 of which 35.7% (60) have been fatal (WHO, 2012). Currently, the disease continues to have serious socioeconomic consequences, particularly on the livelihoods of rural households (Geerlings et al., 2007; Mack et al., 2005; Scanes, 2007).

Epidemiological and molecular biology studies suggest that while wild birds play a role in the spread of disease, this role is minimal in endemically infected countries (Beato and Capua, 2011; FAO, 2011). HPAI viruses are spread to domestic poultry primarily through direct or indirect contact with infected birds. Transmission also occurs through movement of infected poultry and contaminated organic material and fomites (Capua and Marangon, 2006). Thus, the application of consistent biosecurity practices along the marketing chain has become critically important in the prevention, control and eradication of HPAI (FAO, 2006a; Honhold et al., 2008). According to the Egyptian Integrated National Plan for Avian and Human Influenza (FAO, 2010), biosecurity is a key strategy to reduce the incidence of HPAI.

Biosecurity involves a comprehensive range of procedures to limit the introduction of infection into a poultry production unit by means of three major components: segregation, to keep contaminated people, animals and materials away from uninfected birds; cleaning, to remove most of the contaminating organic matter; and disinfection which, if properly implemented, destroys avian influenza viruses (DeBenedictis et al., 2007; Hsu et al., 2011; Wanaratana et al., 2010).

Many technical recommendations on biosecurity practices have been formulated for large-scale commercial producers (DAFF, 2009; Newell et al., 2011); however, not all measures are appropriate for poultry producers in resource limited circumstances (Guerne-Bleich et al., 2009). This is especially relevant since a vast majority of broiler production is carried-out at small-scale (Hosny, 2006). This paper outlines the biosecurity practices implemented on commercial small-scale poultry production and aims at contributing to improve poultry management practices in resource-limited situations, specifically in Egypt, where complex production and marketing chains are involved

2. Materials and methods

A semi-quantitative study was conducted in Fayoum, Egypt (Fig. 1) from July 2009 to January 2010 in order to describe the biosecurity practices being implemented in small-scale commercial chicken production. According to the Egyptian Ministry of Agriculture and Land Reclamation (MALR), Fayoum produces around 12 million chickens per annum, and to October 2012, 148 poultry outbreaks and 12 human cases infected with avian influenza A (H5N1) virus (WHO, 2011) have been reported.

The target population of the study was small-scale commercial producers, intermediaries and service providers of the meat chicken sector of all six districts of Fayoum (Youssef El-Sedeek, El Fayoum, Atasa, Abshoway, Senourass and Tamiya).

FAO divided the poultry chain in four sectors (FAO, 2004). Nevertheless, this classification does not reflect the Egyptian poultry sector. Poultry production systems in Egypt are quite diverse, ranging from rural very small-scale, extensive poultry production to highly intensive systems. Broiler production is by far the largest element of Egypt's poultry industry and the vast majority is rather small-scale production, accounting for more than 70% of total broiler production (Hosny, 2006).

Small-scale commercial poultry production varies in technology and size and usually strives with financial constraints. This study explores two different small-scale chicken production systems. A: farm-based systems which are simple small-scale production units operating in an enclosed building in similar way to the intensive sector but on a smaller scale. The premises are expanded vertically with one to four sheds of 5000 bird capacity per cycle, producing 4–5 cycles per year. B: home-based systems which use family labor and locally available inputs. This production has evolved from backyard poultry rearing due to the growing demand of poultry meat in rural and peri-urban areas and constitutes the sole means of livelihood for the family, while requiring low inputs (Ahmed and Schwabenbauer, 2009; Limon et al., 2009). Home-based commercial poultry production is generally conducted on the roof top of the family household and numbers range approximately from five hundred to 10–15 thousand birds per production cycle (Pagany and Hamdy Kilany, 2007).

Management procedures, such as ventilation, feeding, brooding equipment, litter disposal system, staffing and infrastructure are different at household and farm-dedicated premises. Data from these two types of small-scale commercial production: farm-based and home-based, was therefore analyzed separately, in order to better characterize these systems. Intermediaries were selected due to their potential role in virus transmission into poultry production units, and included input suppliers (feed, equipment, chicks and drugs), veterinarians, vaccinators, haulers and traders.

A combination of two methodologies – participant observation and structured interviews – was used in order to increase confidence in the results and to clarify unclear findings. This combined methodology was conducted in 2 phases, combining quantitative and qualitative approaches in order to address the biases inherent in a single method. In addition, literature was reviewed from various sources (UNICEF, 2009; VSF-CICDA, 2005; FAO, 2006b, 2007; MALR, unpublished data).

2.1. Participant observation

First level of data was collected by participant observation of small-scale poultry growers, both farm- and home-based. It involved informal discussions and direct observation at 32 production units, totaling approximately 100 participants and two group discussions, consisting of about 30 participants each. Participatory methods were used to understand what farmers and other actors along the value chain think of currently available biosecurity

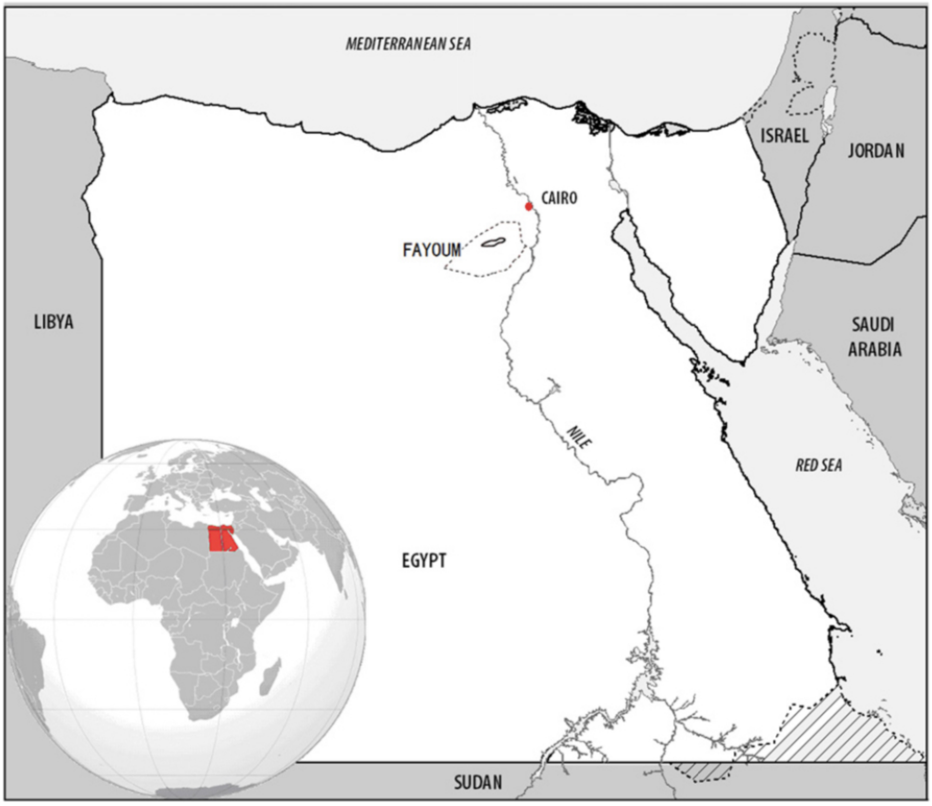

Fig. 1. Fayoum governorate, Egypt.

methods and the main factors that contribute to the adoption or failure of adoption of these measures. According to the MALR of Egypt, an estimated 70% of poultry producers are unlicensed and operate illegally. Considerable distrust has been generated throughout the poultry sector due to past policies to combat avian influenza such as banning of live bird markets and lack of compensation of culled poultry. When located, producers are often reluctant to being interviewed. Thus, snowball sampling was used to identify potential participants of the study due to the difficulties in reaching the target population.

2.2. Biosecurity survey

Following participant observation, quantitative data was collected through structured interviews from actors other than those who had participated in direct observation. Two tailor-made questionnaires, containing 40 questions for poultry growers and 20 questions for intermediaries, were used to gather information on operational biosecurity (Table 1). Structural biosecurity, such as location and layout of production area, was not taken into consideration given that the study focused on low-cost biosecurity enhancement. Questionnaires were pre-tested and administered face-to-face by three local veterinarians because of their accessibility to the target population. Sample size was calculated for each stratum of the target population using OpenEpi® software and a convenient sample within each category was selected. Anticipated relative frequency of the event was established at 50%. Sample sizes were calculated for confidence levels of 95%. An error of 10% was set due to time and logistic constraints. Official figures of registered commercial producers were obtained from Egyptian governmental databases. However, due to the fact that a high proportion of producers and intermediaries were not registered, only estimates were considered. Design effect established for a random sample was set at 1.0.

2.3. Data analysis

Absolute and relative frequencies of nominal variables were calculated for each type of stakeholder, while means and standard deviations were provided for quantitative variables. Contingency tables were elaborated to test for independence and statistical significance through the chi-square statistic and the unpaired *t*-test was performed for mean comparison. The significance level was established at 5%. The few missing data were completely at random and handled by list-wise deletion. Many of the biosecurity practices/attitudes were summarized on a 5-point ordinal rating scale. The response set for each question ranged from 0 (never), 1 (seldom), over 2 (sometimes), to 3 (often) and 4 (always). Ordinal measurement provided the relative ranking of the different categories and the prevalence of those biosecurity practices. The descriptive statistic calculated for ordinal measurement of the central tendency

Table 1
Summary of survey questions distributed to actors of the chicken value chain in Fayoum Egypt, to characterize the on-farm implementation of biosecurity measures.

No.	Survey items
General information	
1	District
2	Name of vendor and full address
3	Type of production
4	Commercial farm (farm premises up to 15 000 birds)
5	Commercial household rearing (in house, rooftop, up to 5000 birds)
6	Type of bird species
7	Rent or ownership status
8	Number of birds reared per cycle by type of production
9	Cycle duration
10	Mortality rate per cycle
Biosecurity items	
11	Visitors access to poultry sheds
12	Visitors contact with poultry
13	Presence of fence around premises
14	Sheds lock/gate presence
15	Permit visitors to enter sheds or contact with birds
16	Hand hygiene before and after handling poultry
17	Utilization of on-farm cloths and footwear
18	Cleaning and disinfection of footwear before and after visits
19	Availability of biosecurity plan
20	Record keeping
21	Availability of sanitation station
22	Isolation of new/sick birds in separated areas
23	Mixing of species
24	Time-interval for total sell out
25	Removal of dead birds
26	Carcass disposal options
27	Producers utilization of specific cloths
28	Utilization and maintenance of footbath
29	Utilization of borrowed equipment/sprayers
30	Utilization of high-pressure sprayers
31	Poultry house cleaning and disinfection
32	Duration of the time-interval between production cycles
33	Cleaning and disinfection of equipment by producers and intermediaries
34	Cleaning and disinfection of vehicles by producers and intermediaries
35	Maintenance of windows mesh and surroundings
36	Storage of poultry feed
37	Control of animals and wild birds
38	Pest control (rodents and insects)
39	Manure and litter management
40	Self-perception of contributing to disease spread

was the median. Statistical analyses were performed using SPSS V.15 (SPSS, Inc., Chicago, IL).

3. Results

3.1. Participant observation

3.1.1. Segregation

Traffic control. Through participatory methods, producers indicated that the fencing off of farms was hindered by laws prohibiting construction on agricultural lands, physical restrictions due to the close proximity of other buildings and associated costs which were to be borne by the tenant farmer. Overall, due to a continuous period of losses, growers were reluctant to make any investments in biosecurity. Generally, the access of visitors to poultry sheds was restricted, except for vaccinators and animal health workers.

Children usually helped to restrain birds at vaccination, accompanying vaccinators from farm to farm without any personal cleaning and disinfecting between farm visits. Shoes or clothes were not changed either. Small-scale farmers reported that veterinarians rarely inspected their premises and most commonly, farmers took diseased birds to the veterinary clinics. Growers reported that cleaning and disinfection of vehicles was not conducted due to time and space constraints and because they were not perceived as a means for disease transmission. Furthermore, there was no record keeping of visitor entries.

Poultry management. Farmers understood the importance of downtime between depopulation and restocking as a way to reduce virus persistence in the environment. An interval of up to 10 days between production cycles was usually allowed. However, downtime length depended mostly on the market price of day-old-chicks. If the price was attractive, a new production cycle would start regardless of the need for downtime.

On farms, each shed houses birds of the same age and these are treated according to the ‘all-in, all-out’ principle whereas in households small batches of birds of different ages, species or breeds for self-consumption were sometimes mixed with the rest of the flock which was being reared for commercial purposes.

There were no facilities available for proper isolation of sick and runt birds in separated areas, away from healthy flocks. Nevertheless, most farmers reported that it was common practice to segregate sick birds in a designated area within the same shed as the rest of the flock.

Some producers indicated that sick birds were slaughtered and disposed of immediately after showing the first signs of disease. However, other poultry growers admitted selling sick birds and runts for human consumption to slaughterhouses which bought them at a lower price or to “special traders” who collected them from door-to-door. According to the participants, new marketing formulas for these runt birds had been promoted lately, for instance, trays with various different runt birds were sold by weight or the selling of small broilers as pigeons.

Common methods for the disposal of dead birds in small-scale production included throwing them into watercourses and feeding them to stray dogs and cats. Participants reported lack of resources and sufficient space for implementing disposal measures such as burning or burial. Furthermore, producers were unaware of the benefits of composting as a biosecure method to dispose of poultry mortalities.

Pest control. To an extent, producers perceived risks for disease transmission through humans and equipment, but paid less attention to animals and insects. Overall, insects and rodents were not perceived as a major threat in transmitting disease, thus, insecticides and rodent baits were rarely used. Most producers had installed wire mesh on shed windows to isolate poultry houses from rodents, wild birds and pests, but mesh maintenance was generally poor,

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reducing its usefulness. Litter and diverse debris were frequently observed around poultry premises.

3.1.2. Cleaning and disinfection

Personnel hygiene. Most farm workers admitted for neglecting hand-washing, even after handling daily mortalities. Sanitation stations were rarely present and there were neither on-farm biosecurity plans nor continuing training on biosecurity implementation.

Larger farms might allocate special workers for each shed and provide special clothing/footwear for each poultry house, but the majority of producers usually used the same garments to enter all poultry houses indifferently. Although most participants reported using specific on-farm clothing and footwear, these did not necessarily meet biosecurity standards. Most participants reported using plastic basins for footbaths. If present, cement basins were poorly maintained, rarely used and inappropriately located for regular use. Producers indicated that footbaths tended to dry up quickly through leakages and evaporation.

Cleaning and disinfection of housing and equipment. Most farmers indicated that proper sanitation of poultry sheds – dry cleaning followed by wet cleaning and disinfection – was performed after each production cycle. Phenol-based products were the most commonly used disinfectants, followed by lime. A few farmers indicated that wet cleaning was not performed and after dry cleaning, disinfectants were applied directly.

Litter was removed in baskets and emptied in trucks after each production cycle. The litter's surface layer was sold as crop fertilizer and the deep layer as fish feed supplement. Participants were unaware of the importance of separating clean and dirty areas. Generally, poultry producers did not borrow materials or equipment. They indicated that equipment entering their premises was cleaned and disinfected. Nevertheless, sanitation facilities for proper cleaning and disinfection of equipment were not found. Furthermore, the cleanliness of drinkers and other equipment was clearly poor. However, a few participants did report occasional rental of high-pressure washers for vehicle and equipment cleaning and disinfection.

3.2. Biosecurity survey

3.2.1. Characteristics of the sample

The survey captured feedback on biosecurity practices from a broad range of respondents across the small-scale chicken production for commercial purposes sector. The sample group ($n = 463$) included 226 poultry producers and 237 intermediaries. Seven layer farms were excluded. Mean number of birds per cycle and standard deviation were 7676.1 ± 4280.4 for farms and 2296.1 ± 1813.5 for households (Table 2). Three nurseries in home-based farms reached as high as 10 000 birds per cycle.

Mortality rates reported by the producers were significantly greater ($p = 0.000$) in farms ($6.08 \pm 1.91\%$) than in home-based production ($5.03 \pm 1.58\%$). Mortality was also higher ($p = 0.028$) in foreign breeds ($5.80 \pm 1.71\%$) than in indigenous breeds ($5.12 \pm 2.09\%$) which are usually kept in house-farms. 73.9% (167) of poultry producers reared foreign breeds whereas 26.1% (59) kept indigenous breeds. The duration of the cycle was shorter for foreign breeds (a mean of 40.3 ± 1.77 days) than for indigenous breeds (60.07 ± 7.35), and was 46.5 ± 10.4 and 45.1 ± 9.1 days for home and farm-based production respectively. There were no significant differences between the two types of commercial production (home and farm-based) regarding chicken breeds and duration of the cycle ($p > 0.05$).

3.2.2. Segregation

Traffic control. A total of 89 poultry growers (39.4%) reported that they had fenced off poultry areas in order to isolate their premises for disease control (Table 2). A high percentage of producers (92%; $n = 208$) reported that they always kept farm premises locked with a controlled entry gate. Generally, visitors were not allowed to enter poultry sheds (median = 0; Q25–Q75: 0–2) (Fig. 2); however, 22.5% of home-based producers allowed essential visitors to sometimes enter sheds and 12.1% of farm-based producers always permitted entry.

As shown in Fig. 3, self-perception of the role of intermediaries, input sellers and animal health workers in disease spread was low. Only 18.6% declared to play a potential role in disease transmission. Another 12.7% believed that they played a minor role and 68.8% did not consider that they contributed to disease spread at all; however, 27.3% of government veterinarians and 27.5% of input providers admitted that disease transmission could be linked to them.

Poultry management. The downtime between production cycles was found to be associated with the type of production (home-based or farm-based) and to ownership of the premises. A significant percentage of farms were rented (61.3%; $n = 76$) versus only 7.8% ($n = 8$) of the households rearing poultry. Producers renting farms aimed at optimizing the rental period by increasing the number of cycles per year, thus reducing downtime between cycles whereas longer downtime periods were observed more often among owned premises and home-based production (Fig. 4).

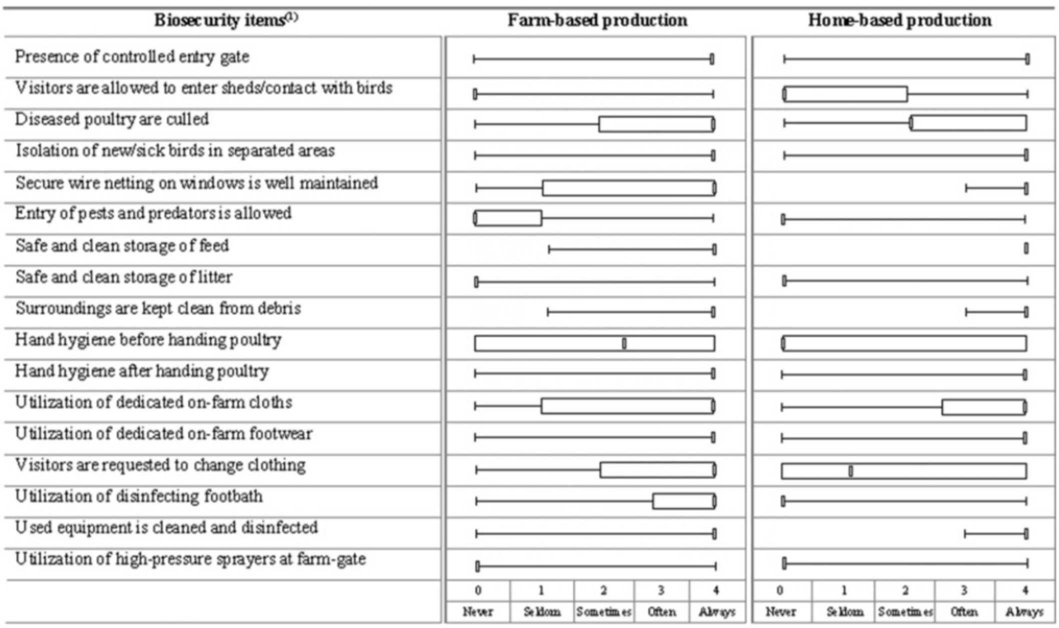
We have found that 10.5% of farm-based producers and 20.6% of home-based growers add new birds to their flocks during the production cycle, increasing the risk of introducing H5N1 HPAI and other microorganisms and many of these producers (73.5%) reported quarantining new birds in an area separated from the main flock. In addition, 24.8% of poultry growers thinned out their sheds in different lots. The interval used for selling out the totality of the birds is shown in Table 2. On the other hand, 13.9% of the home-based producers who responded to the field survey admitted mixing birds of different ages and/or species versus only 1.6% of the farm-based producers.

According to the survey, culling is the preferred method for managing diseased poultry on farms (median = 4; Q25–Q75: 2–4), whereas home-based growers slaughtered sick poultry only sometimes (median = 2; Q25–Q75: 2–4). Overall, producers reported that they always separate sick birds from the healthy flock (Fig. 2). In addition, 77% of the growers admitted to selling sick birds and runts to "special traders".

As shown in Table 2, the methods most used for disposal of daily mortalities were: on landfills, especially

Table 2
Responses to the structured questionnaire on the implementation of biosecurity practices in home and farm-based poultry production, Fayoum, Egypt.

Biosecurity item	Farm-based	Home-based	Total	*p*-Value
Presence of fence around premises	41.1% (51)	37.3% (38)	39.4% (89)	0.553
Presence of sanitation station	93.5% (116)	96.1% (98)	94.7% (214)	0.399
Availability of written biosecurity plan	2.4% (3)	2.1% (2)	2.2% (5)	0.816
Different species/ages are mixed	1.6% (2)	13.9% (14)	7.1% (16)	**0.000**
Sale of runts/sick birds	80.6% (100)	72.5% (74)	77.0% (174)	0.150
Wet cleaning of poultry house	87.9% (109)	95.1% (97)	91.2% (206)	0.058
Disinfection/chlorination of drinking water	7.3% (9)	5.9% (6)	6.6% (15)	0.679
Utilization of poison/traps for rodents	44.4% (55)	25.5% (26)	35.8% (81)	**0.003**
Utilization of insecticides/insect traps	4.0% (5)	7.8% (8)	5.8% (13)	0.221
Cleaning and disinfection of vehicles	6.5% (8)	1.0% (1)	4.0% (9)	**0.036**
Poultry premises are rented	61.3% (76)	7.8% (8)	37.2% (84)	**0.000**
Carcass disposal options				
Disposal on landfills	44.4% (55)	59.8% (61)	51.3% (116)	**0.021**
Dogs/cats feeding	20.2% (25)	30.4% (31)	24.7% (56)	0.076
Incineration	29.8% (37)	6.9% (7)	19.4% (44)	**0.000**
Burial	13.7% (17)	18.6% (19)	15.9% (36)	0.315
Disposal into water canals	16.9% (21)	9.8% (10)	13.7% (31)	0.121
In plastic bags into waste bins	10.5% (13)	16.7% (17)	13.2% (30)	0.173
Sale for fertilizers use	1.6% (2)	1.9% (2)	1.7% (4)	0.269
Rendering plants	0.0% (0)	0.0% (0)	0.0% (0)	–
Partial sale of flock	23.4% (29)	26.5% (27)	24.8% (56)	0.593
Time-interval for total sell out				0.329
Before 72 h	34.5% (10)	29.6% (8)	32.1% (18)	
3–5 days	51.7% (15)	66.7% (18)	58.9% (33)	
6 days or more	13.8% (4)	3.7% (1)	8.9% (5)	
Total	100.0% (29)	100.0% (27)	100.0% (56)	
Visitors are allowed to enter sheds and/or contact with poultry				**0.000**
Always	12.1% (15)	1.9% (2)	7.5% (17)	
Frequently	1.6% (2)	2.9% (3)	2.2% (5)	
Sometimes	7.3% (9)	22.5% (23)	14.2% (32)	
Seldom	0.8% (1)	6.9% (7)	3.5% (8)	
Never	78.2% (97)	65.7% (67)	72.6% (164)	
Total	100.0% (124)	100.0% (102)	100.0% (226)	



1. The rectangle represents the median, the larger box the interquartile range, the wiskers the max and minimum values.

Fig. 2. Scores of each biosecurity item by type of small-scale broiler production (farm- and home-based).

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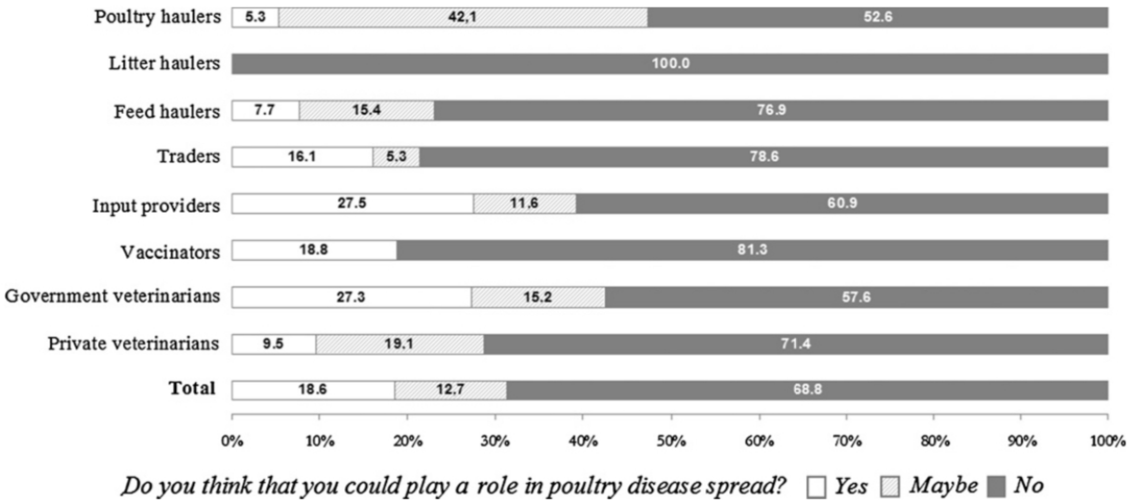

Fig. 3. Self-perception of intermediaries' role in disease transmission.

among home-based producers (59.8%); feeding to dogs and cats (24.7%); burning, 29.8% on farms versus only 6.9% at households; burial (15.9%); and disposal in water canals (13.7%). All home-based producers and most poultry farms (85.5%; $n = 106$) declared using municipal water supplies.

Pest control. Poultry growers reported to always keeping secure wire netting on windows (median = 4; Q25–Q75: 4) in order to protect the sheds from the entry of predators and pest birds. Access of animals into the poultry shed is restricted in households whereas some farmers (14.5%; $n = 18$) declared that they seldom allowed pets and wild birds to enter (Fig. 2). On the other hand 44.4% of farm-based producers and 25.5% of home-based producers used traps or poison baits to catch rodents and 5.8% of all producers reported using insecticides or insect traps.

Poultry producers reported that they always stored feed in such a way that it would be kept clean and protected from pests and birds (median = 4; Q25–Q75: 4) but they did not take the same measures for litter stockpiled on the farm (median = 0; Q25–Q75: 0).

Poultry producers also reported that elements which might attract pests and rodents – such as water, vegetation, rubbish and other debris – were always removed from the surroundings of their farms (median = 4; Q25–Q75: 4).

3.2.3. Cleaning and disinfection

Personnel hygiene. Nearly all (94.7%) of the poultry producers declared that there were sanitation stations at their entry gates (Table 2). All growers and most intermediaries said that they always washed their hands after handling poultry (median = 4). In addition, both farm- and home-based producers reported always using specific on-farm clothing and footwear (median = 4; Q25–Q75: 2–4).

Home-based producers seldom required visitors to change clothing prior to entering poultry sheds (median = 1; Q25–Q75: 0–4), whereas, this practice appeared to be more common on farms (median = 4; Q25–Q75: 2–4). Disinfectant footbaths were not available in households (median = 0; Q25–Q75: 0) while farm workers reported to always use them (median = 4; Q25–Q75: 3–4).

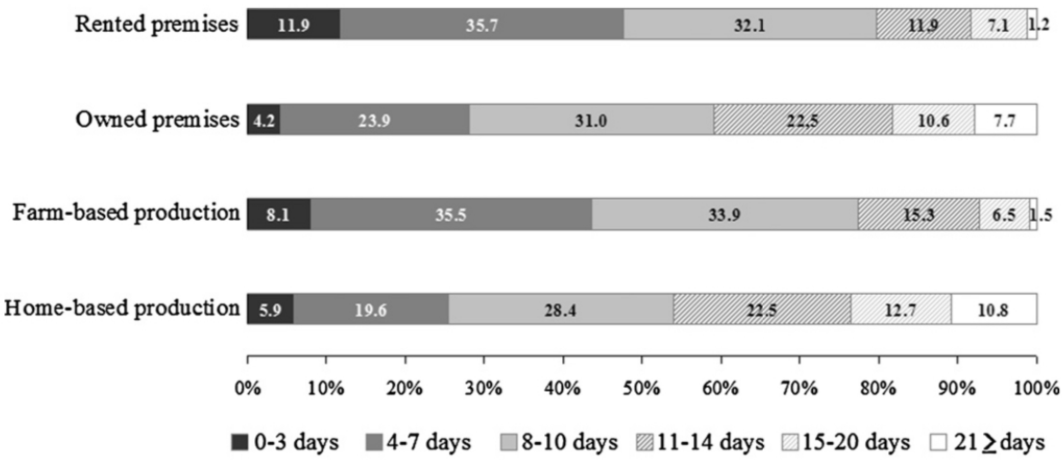

Fig. 4. Duration of the time-interval between cycles per type of small-scale broiler production and ownership of the premises.

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Only 2.2% small-scale commercial poultry producers had a written protocol related to hygienic practices and operational procedures at their premises/house-farms.

Cleaning and disinfection of housing and equipment. About 12% of farms and 5% of households reported refraining from using water to clean poultry sheds. Producers said that they never borrowed equipment from neighbors or from other farms (median = 0; Q25–Q75: 0) and declared that equipment/materials entering the premises, such as crates and feeders, were always cleaned and disinfected (median = 4; Q25–Q75: 4) although they did not use high-pressure sprayers (median = 0; Q25–Q75: 0). A small percentage of farm producers (6.5%), and only 1 home-based producer reported to clean and disinfect vehicles.

4. Discussion

This study assessed the status of information and the implementation of biosecurity among the actors of the small-scale chicken value chain by using different instruments to collect evidence: questionnaires, group interviews and field observations. Discrepancies were observed between the survey and validation data obtained through participatory methods. For example, in the survey, producers responded to always wash their hands, while at informal individual and group discussions they admitted to neglecting this practice. The discrepancies observed between survey results and data collected through direct observation indicate that producers have some basic knowledge of biosecurity standards but there exists a significant gap between knowledge of biosecurity and the reality of its implementation. Similarly, another study found differences between biosecurity knowledge and action among backyard poultry breeders of Fayoum (Radwan et al., 2011). Thus, a response bias was identified in the survey, thanks to the triangulation of observations obtained through participatory methodology. The survey respondents answered positively to behavioral questions associated with compliant practices, which could have lead to overestimation of the level of implementation of biosecurity measures according to the results of the survey which do not always match the outcome of the participant observation. Response bias in biosecurity surveys have been reported elsewhere (Nespeca et al., 1997). Particularly, this bias might also be explained by the mistrust generated by previous unpopular regulations, namely, the ban on live bird markets and the issuance of a governmental decree in July 2009 closing down all unlicensed premises (Mansour, 2009). Nevertheless, our fieldwork permitted to triangulate observations, facilitating cross-checking for internal reliability. The study also found that traditional surveys might not suit this type of target population and that participatory methodologies are recommended instead for hard-to-reach groups.

Once validated, data identified serious biosecurity flaws regarding pest control, traffic control, cleaning and disinfection and waste disposal. Usual means for carcass disposal included feeding to dogs and throwing dead birds into watercourses contributing to the risk of environmental contamination and disease transmission. On-site composting has been shown to be a successful practice based on its effectiveness by inactivating the H5N1 virus (US EPA, 2006); however, in the absence of supporting legislation and appropriate means, currently it is not feasible for this type of production. Moreover, some growers reported that the selling of diseased poultry for human consumption was a common practice. Although human infection with avian influenza A (H5N1) virus remains rare, the association between contact with diseased poultry and H5N1 human cases has been demonstrated (Kandeel et al., 2010; VanKerkhove et al., 2011) and handling sick birds for consumption provides additional opportunities for human infection.

Only in-general biosecurity parameters and allied deficiencies were explored and not exclusively those associated with the biosecurity risks for highly pathogenic avian influenza. The authors decided to conduct an assessment of operational biosecurity practices because of the significant HPAI underreporting at commercial poultry units due to lack of compensation mechanisms and other restrictive measures and the difficulties in reaching the target population. From 2007 to 2011, out of 1559 HPAI outbreaks notified in Egypt, only 198(12.7%) of them were reported in commercial farms (MARL, unpublished data). However, the possibility of conducting a case–control study in order to identify the biosecurity risk factors for highly pathogenic avian influenza (HPAI) should be considered in the future.

Compliance with recommended biosecurity practices did not greatly vary from home-based to farm-based commercial production. At present, there is a growing body of evidence that suggests that the implementation of biosecurity measures is the cheapest and most effective means of disease prevention and can realize significant financial benefits (Fasina et al., 2007; Gifford et al., 1987; Sen et al., 1998). A recent study conducted in Egypt has illustrated that there is an 8.45 benefit–cost ratio for the implementation of desirable biosecurity for HPAI in home-based production (Fasina et al., 2012). Nevertheless, improving biosecurity in the thousands of small-scale poultry production units of Egypt represents a great challenge in the current situation. Small-scale farmers have been badly hurt by HPAI, a restrictive legislation, global food price increases and inflation (Ibrahim et al., 2006; Soliman, 1990). Most small commercial producers strive with financial constraints. The lack of proper technology and biosecurity leads to low feed conversion rates, poor poultry health, high losses and waste of feed. More than half of the respondents rent farm premises and are not willing to invest on structural biosecurity measures such as fencing or sanitation facilities due to difficulties in establishing the liability related to building and maintenance costs. Furthermore, small-scale commercial poultry growers are not associated under a registered entity and according to MALR, 70% of them are unlicensed, which makes them hard-to-reach, increasing both their vulnerability and their potential for maintenance and dissemination of H5N1 viruses. Small-scale commercial poultry growers may choose not to implement biosecurity measures also because of lack of awareness of the potential risks or a belief that the benefits do not outweigh the costs.

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Future interventions need to consider cost-effective alternatives under resource-limited circumstances. The findings of this report intend to assist policy-makers in advanced planning, in coordination with the private sector, for promoting socially equitable HPAI control and prevention strategies for resource-limited circumstances. Partnership between the public and private sector is essential to implementing cost-effective biosecurity measures. Initiatives should be developed, including the establishment of associations in which small-scale producers could share information, improve cooperation with government veterinary services and be engaged in decision-making. In addition, outreach and biosecurity awareness raising initiatives should be specifically developed for small-scale producers with the objective of improving general poultry management and thus preventing HPAI and other poultry diseases.

Conflict of interest

None disclosed.

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References

Agronomes et Vétérinaires Sans Frontières (VSF-CICDA), 2005. Prevention and Control of Avian Flu in Small Scale Poultry. A Guide for Veterinary Paraprofessionals in Vietnam, available at: http://www.fao.org/ag/againfo/subjects/documents/ai/AIManual_VN2005(en).pdf (accessed 22.09.05).

Ahmed, Z.S., Schwabenbauer, K., 2009. Highly pathogenic avian influenza (HPAI): An added risk to sustainable livelihoods, food security and nutrition in Egypt. In: FAO ed. 5th International Poultry Conference. Taba, Egypt. Rome, FAO.

Albrechtsen, L., Saade, M., Riviere, A., Rushton, J., 2009. Pro-active engagement in compensation and rehabilitation policy formulation and implementation: the case of HPAI in Egypt. Worlds Poult. Sci. J. 65, 225–230, http://dx.doi.org/10.1017/S0043933909000178.

Beato, M.S., Capua, I., 2011. Transboundary spread of highly pathogenic avian influenza through poultry commodities and wild birds: a review. Rev. Sci. Tech. 30 (1), 51–61.

Capua, I., Marangon, S., 2006. Control of avian influenza in poultry. Emerg. Infect. Dis. 12 (9), 1319–1324.

DAFF, 2009. National Farm Biosecurity Manual – Poultry Production. Department of Agriculture, Fisheries and Forestry, Australia, ISBN 978-1-921575-01-3, available at: http://www.daff.gov.au/__data/assets/pdf_file/0009/1147554/poultry-biosecurity-manual.pdf

DeBenedictis, P., Beato, M.S., Capua, I., 2007. Inactivation of avian influenza viruses by chemical agents and physical conditions: a review. Zoonoses Public Health 54 (2), 51–68.

FAO, 2011. Approaches to controlling, preventing and eliminating H5N1 highly pathogenic avian influenza in endemic countries. Animal Production and Health Paper No. 171, FAO, Rome.

FAO, 2010. Integrated National Plan for Avian and Human Influenza, Animal Health and Livelihood Sustainability Strategy, Arab Republic of Egypt.

FAO, 2007. Good Biosecurity Practices in Small Scale Commercial and Scavenging Production Systems in Kenya by Nyaga, P. FAO Report, available at: http://www.fao.org/docrep/013/al838e/al838e00.pdf

FAO, 2006a. Highly Pathogenic Avian Influenza in Africa. A Strategy and Proposed Programme to Limit Spread and Build Capacity for Epizootic Disease Control for Epizootic Disease Control. ECTAD Report, available at: http://www.fao.org/docs/eims/upload//217651/hpai_strategy_africa_en.pdf

FAO, 2006b. Latin America & Caribbean Guide for the Prevention and Control of Avian Flu in Small-scale Poultry, available at: ftp://ftp.fao.org/docrep/fao/010/ai005e/ai005e00.pdf

FAO, 2004. Poultry Production Sectors, available at: www.fao.org/docs/eims/upload/214190/ProductionSystemsCharacteristics.pdf

Fasina, F.O., Ali, A.M., Yilma, J.M., Thieme, O., Ankers, P., 2012. The cost–benefit of biosecurity measures on infectious diseases in the Egyptian household poultry. Prev. Vet. Med. 103, 178–191.

Fasina, F.O., Meseko, A.C., Joannis, T.M., Shittu, A.I., Ularamu, H.G., Egbuji, A.N., Sulaiman, L.K., Onyekonwu, N.O., 2007. Control versus no control: options for avian influenza H5N1 in Nigeria. Zoonoses Public Health 54, 173–176.

Geerlings, E., Albrechtsen, L., Rushton, J., 2007. Highly pathogenic avian influenza: a rapid assessment of socio-economic impact on vulnerable households in Egypt. In: FAO (Ed.), Report for FAO/WFP. FAO/WFP, Rome, p. 70.

Guerne-Bleich, E., Pagani, P., Honhold, N., 2009. Progress towards practical options for improving biosecurity of small-scale poultry producers. Worlds Poult. Sci. J. 65 (02), 211–216.

Gifford, D.H., Shane, S.M., Hugh-Jones, M., Weigler, B.J., 1987. Evaluation of biosecurity in broiler breeders. Avian Dis. 31 (2), 339–344.

Honhold, N., McLeod, A., Satyajit, S., 2008. Biosecurity for Highly Pathogenic Avian Influenza. Issues and Options. FAO, Rome, available at: http://www.fao.org/ag/againfo/subjects/documents/ai/AIManual_VN2005(en).pdf

Hosny, F., 2006. Poultry Sector Country Review, Egypt. FAO-ECTAD Report, available at: ftp://ftp.fao.org/docrep/fao/011/ai355e/ai355e00.pdf

Hsu, B.B., Yinn Wong, S., Hammond, P.T., Chen, J., Klibanov, A.M., 2011. Mechanism of inactivation of influenza viruses by immobilized hydrophobic polycations. Proc. Natl. Acad. Sci. U.S.A. 108 (1), 61–66.

Ibrahim, A.A., Albrechtsen, L., Upton, M., Morgan, N., Rushton, J., 2006. Market impacts of HPAI outbreaks: a rapid appraisal process – Egypt. In: Symposium on the Market and Trade Dimensions of Avian Influenza, available at: http://www.fao.org/docs/eims/upload//234379/ah674e00.pdf

Kandeel, A., Manoncourt, S., Abd el Kareem, E., Mohamed Ahmed, A.N., El-Refaie, S., Essmat, H., Tjaden, J., de Mattos, C.C., Earhart, K.C., Marfin, A.A., El-Sayed, N., 2010. Zoonotic transmission of avian influenza virus (H5N1), Egypt, 2006–2009. Emerg. Infect. Dis. 16 (7), 1101–1107.

Kayali, G., El-Shesheny, R., Kutkat, M.A., Kandeil, A.M., Mostafa, A., Ducatez, M.F., McKenzie, P.P., Govorkova, E.A., Nasraa, M.H., Webster, R.G., Webby, R.J., Ali, M.A., 2011. Continuing threat of influenza (H5N1) virus circulation in Egypt. Emerg. Infect. Dis. 17 (12), 2306–2308.

Limon, G., DeHaan, N., Schwabenbauer, K., Ahmed, Z., Rushton, J., 2009. Highly pathogenic avian influenza: A rapid assessment of socio-economic impact on vulnerable households in Egypt. Ed. FAO Report. Rome, Italy, p. 32, available at: http://www.fao.org/docrep/013/al686e/al686e00.pdf)

Mack, S., Hoffmann, D., Otte, J., 2005. The contribution of poultry to rural development. Worlds Poult. Sci. J. 61 (3).

Mansour, F., 2009. Food and Agricultural Import Regulations and Standards – FAIRS Country Report. GAIN Report Number: EG9014. USDA Foreign Agricultural Service.

Nespeca, R., Vaillancourt, J.P., Morrow, W.E., 1997. Validation of a poultry biosecurity survey. Prev. Vet. Med. 31 (1–2), 73–86.

Newell, D.G., Elvers, K.T., Dopfer, D., Hansson, I., Jones, P., James, S., Gittins, J., Stern, N.J., Davies, R., Connerton, I., Pearson, D., Salvat, G., Allen, V.M., 2011. Biosecurity-based interventions and strategies to reduce *Campylobacter* spp. on poultry farms. Appl. Environ. Microbiol. 77 (24), 8605–8614.

Pagany, P., Hamdy Kilany, W., 2007. Interventions for Improving Biosecurity of Small-scale Poultry Producers in Egypt. FAO.

Poetri, O., Bouma, A., Claasen, I., Koch, G., Retno, S., Stegeman, A., Van-Boven, M., 2011. A single vaccination of commercial broilers does not

reduce transmission of H5N1 highly pathogenic avian influenza. BMC Vet. Res. 42, 74, http://dx.doi.org/10.1186/1297-9716-42-74.
Peyre, M., Samaha, H., Makonnen, Y.J., Saad, A., Abd-Elnabi, A., Galal, S., Ettel, T., Dauphin, G., Lubroth, J., Roger, F., Domenech, J., 2009. Avian influenza vaccination in Egypt: limitations of the current strategy. J. Mol. Genet. Med. 3 (2), 198–204.
Radwan, G.N., Wahid, W.Y., El-Derwy, D., El-Rabat, M., 2011. Knowledge, attitudes and practices of avian influenza among backyard poultry breeders in Fayoum Governorate, Egypt. J Egypt Public Health Assoc. 86 (5–6), 104–110.
Scanes, C.G., 2007. Contribution of poultry to quality of life and economic development in the developing world. Poult. Sci. 86 (11), 2289–2290.
Sen, S., Shane, S.M., Scholl, D.T., Hugh-Jones, M.E., Gillespie, J.M., 1998. Evaluation of alternative strategies to prevent Newcastle disease in Cambodia. Prev. Vet. Med. 35, 283–295.
Soliman, I., 1990. Economic Problems of Poultry Production in Egypt. Options Méditerranéennes, Series A, No. 7, available at: http://ressources.ciheam.org/om/pdf/a07/CI901603.pdf
UNICEF, 2009. Communication Strategy and Work Plan for Avian Influenza, available at: http://www.unicef.org/influenzaresources/files/ECO_Comm_07.pdf
U.S. Environmental Protection Agency, 2006. Disposal of Domestic Birds Infected by Avian Influenza – An Overview of Considerations and Options, available at: http://www.epa.gov/osw/inforesources/pubs/flu.pdf
VanKerkhove, M.D., Mumford, E., Mounts, A.W., Bresee, J., Ly, S., Bridges, C., Otte, J., 2011. Highly pathogenic avian influenza (H5N1): pathways of exposure at the animal–human interface, a systematic review. PLoS ONE 6 (1), e14582, http://dx.doi.org/10.1371/journal.pone.0014582.
Wanaratana, S., Tantilertcharoen, R., Sasipreeyajan, J., Pakpinyo, S., 2010. The inactivation of avian influenza virus subtype H5N1 isolated from chickens in Thailand by chemical and physical treatments. Vet. Microbiol. 140 (1–2), 43–48.
WHO, 2011. Situation Updates – Avian Influenza Global Alert and Response (GAR), available at http://www.who.int/influenza/human_animal_interface/avian_influenza/archive/en/index.html
WHO, 2012. Avian influenza – Situation in Egypt – Global Alert and Response (GAR), available at http://www.who.int/influenza/human_animal_interface/EN_GIP_20120810CumulativeNumber-H5N1cases.pdf