Food and Agriculture Organization of the United Nations

AFRICA SUSTAINABLE LIVESTOCK 2050

Improving broiler business and biosecurity A win–win?

Insights from producers in Menoufia and Qualiubia governorates in EGYPT

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Required citation:
FAO. 2023. *Improving broiler business and biosecurity – A win-win? Insights from producers in Menoufia and Qualiubia governorates in Egypt.* Rome. https://doi.org/10.4060/cc2947en

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978-92-5-137203-6
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Contents

Key highlights

- Commercial small- and medium-scale broiler production in and around cities in Egypt has increased greatly over the past decades and is predicted to further grow.
- This trend has public health implications as transforming poultry production systems in densely populated areas can drive the emergence of infectious diseases.
- Compliance with biosecurity practices is essential to ensure a sustainable transformation of the poultry sector while protecting public health.
- Producers are more likely to adopt biosecurity practices when they are convinced of their economic viability and positive impact on their business.
- A business perspective can help to identify biosecurity related opportunities but requires better accounting at the poultry farm level.
- This brief presents an approach to explore biosecurity related win-win solutions for both public and private sectors.

Workshop between FAO and poultry stakeholders in April 2021 – setting the foundation for partnership.

Acknowledgements:this brief has been drafted by Martin Heilmann, Amira Abdel Nabi, Lina Abdallah and Ugo Pica Ciamarra. Our heartfelt thanks go to the entire AERI team and everybody who helped in planning and carrying out this study. This includes in particular the veterinary services and producers in Qualiubia and Menoufia governorates as well as the producers that agreed to join the consultations – without their involvement, none of these insights would have been possible. We also kindly thank the ECTAD Egypt team leader Zelalem Tadesse for the careful review and support. We would finally like to acknowledge the financial contributions provided by the United States Agency for International Development (USAID).


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1. Introduction

The poultry sector is changing

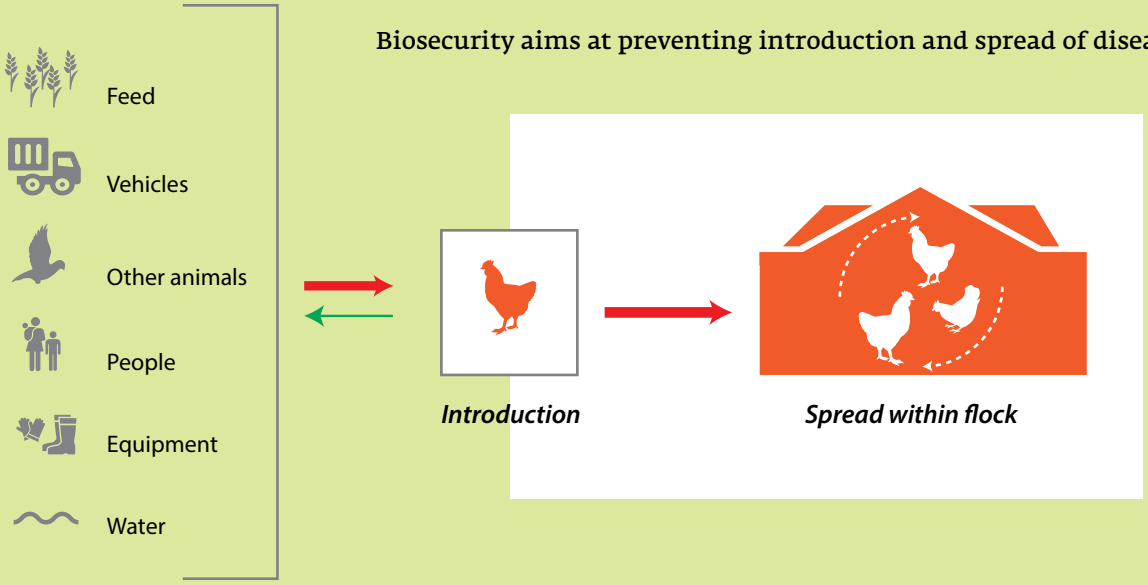
Egypt has a long history of poultry farming dating back to at least 3 500 years ago as domestic chicken have been recognized on the walls of the famous Karnak Temple near Luxor (Lawler, 2015). While the value of poultry to society remains unchanged ever since, poultry farming has changed significantly over the millennia. Poultry [1] meat production in Egypt has increased by a factor of seven over the past three decades (1989–2019) and the demand is predicted to grow to eleven million tons by 2050 (FAO, 2017). This trend is of particular importance for public health as closer contact between people and animals in densely populated areas provides favourable grounds for infectious diseases, including zoonoses and antimicrobial resistant microorganisms (Gibb *et al.*, 2020; Graham *et al.*, 2008; UNEP and ILRI, 2020). Biosecurity can play a major role in ensuring public health by limiting the introduction and spread of pathogens between and within animal and human populations.

Solutions must be business-compatible

Compliance with biosecurity practices depends on not only the laws and regulations in place but also the willingness of poultry actors to comply with them. Compliance is more likely when poultry producers are convinced of the economic viability of the practices, procedures or behaviours recommended by the legislation (Fasina *et al.*, 2012). This brief presents information on poultry producers' compliance with biosecurity practices in Egypt, and offers an approach for market-based solutions that could facilitate the wider adoption of biosecurity practices.

[1] In the context of this brief, the term poultry refers to chicken specifically raised for meat production (broilers). Other poultry species include ducks, turkeys, geese and guinea fowls in the Egyptian context but are not considered.

BOX 1: What is biosecurity?



Many factors pose a risk to the health of animals. Biosecurity is a strategic and integrated approach to analyse and manage those risks to prevent pathogens' introduction and spread within the poultry flock. Given that many pathogens are zoonotic, i.e. shared between animals and humans, this is a two-way process where also poultry can infect farmers or other animals as illustrated with the green arrow in the Figure.

Disease outbreaks, such as avian influenza in animals or salmonellosis in humans, are signs of inadequate biosecurity along the food chain. In many cases, simple practices, such as changing boots when entering a farm or washing hands before slaughter, can prevent pathogens from reaching the animals.

2. Methodology

The Agricultural Economics Research Institute (AERI) as part of the Agricultural Research Center, and the Food and Agriculture Organization of the United Nations in Egypt (FAO Egypt) have joined forces to characterize the business models and compliance with biosecurity practices of commercial small and medium-scale poultry farmers in urban/peri-urban areas of Egypt. The specific objectives were to:

- Characterize poultry producers' business models.
- Assess the profitability of poultry farms.
- Assess the compliance with biosecurity-related practices among farmers.
- Describe the relation between biosecurity and business.
- Assess farmers' willingness in adopting specific biosecurity practices.
- Identify opportunities for win–win solutions in terms of business and biosecurity.

The point of departure for reaching those objectives was a series of participatory consultations with over 120 poultry producers in Ashmoun and Quesna districts, Menoufia governorate, and in Banha and Kafr Shokr districts, Qalyubia governorate. The consultations included interviews, focus-group discussions and field visits that took place throughout the years 2020–2021. Both governorates lie in peri-/urban areas and are traditional hubs for poultry production (FAO, 2018). The consultations covered specifically 48 farms to portray the business model canvass (Box 2) and estimate enterprise budgets (Table 1). The compliance with a set of biosecurity related practices among producers was then assessed (section 3.3) and compared to the economic performance of the farms (section 3.4). In order to find options to facilitate the adoption of specific biosecurity practices, an ad hoc workshop was organized for producers to specifically identify actions they are ready to take in order to improve biosecurity (section 3.5).

BOX 2 What's a business model canvas?

A strategic management template for documenting business models. As illustrated below, it includes a visual chart with elements describing an enterprise through different elements including value proposition, customers, finances, etc. Such canvas assists enterprises in aligning their activities or developing new ones. The figure below reflects the dynamic of elements for the livestock sector. The value proposition, for example, refers to what an enterprise offers to customers (or family members in case of home consumption) which, in the case of broiler producers, could refer to high quality chicken with the desired weight.

Examples of poultry shops in Cairo that serve as main retail channel for birds from commercial small and medium-scale poultry farms. Usually the customers choose the bird, which is then weighed, freshly slaughtered and handed over directly.

3. Key findings and implications

3.1 The business models rely on selling live birds through brokers

Most poultry producers sold live birds through brokers that serve as intermediaries between them and wholesalers, who in turn sold the birds to retailers. On the one hand, selling through brokers has advantages as brokers find buyers quickly, pay relatively high prices and in cash once a deal is made. On the other hand, however, brokers determine prices in their respective areas, thereby minimizing the mark-up for producers. In some cases, producers sold poultry directly to slaughterhouses but this was a less preferred option given lower prices and delayed payments. The business model canvas is illustrated in Figure 1 and revealed the presence of alternative customers, such as hotels, restaurants, fast food outlets or street sellers. In terms of revenue in Egyptian pound (EGP), the sale of live birds made up 99 percent while the sale of poultry litter[2] accounted for about 1 percent. "Key partners" are shown in Figure 1 and included inputs suppliers and actors downstream along the poultry value chain. It is noteworthy that veterinarians are not considered among the key partners since many producers considered them poorly trained and lacking in technical experience. Also financial institutions are missing as key partners, although they have programmes to support small and medium-scale poultry producers. However, common conditions to access those programmes include technical and economic feasibility studies, closed farming systems as well as an insurance against animal disease outbreaks. The latter is unlikely to be available since insurance companies are unlikely to provide their service in the absence of quantified disease risks and sufficient collaterals.

[2] Poultry litter is a mixture of poultry excreta, spilled feed, feathers, and material used as bedding.

FIGURE 1: Visualization of the business model canvas for broiler producers in Egypt

Key partners

Hatcheries
For day old chicks (DOCs).

Feed companies
For chicken feed incl. yellow corn and soya beans.

District pharmacies or feed companies
For veterinary products (e.g. antibiotics and vaccination) and disinfectants.

Carpenters or wood companies
For sawdust used as litter.

Local brokers
For mediating btw. producers and wholesalers.

In some cases: government veterinary services
For testing for Avian Flu before sale of birds.

In some cases: Banks
For providing capital (e.g. loans, deposits, credits, etc.).

Key activities

Cleaning & disinfection of housing and equipment
7d prior to production cycle.

Purchase of production inputs to start production cycle of 35–40d
DOCs, feed, sawdust, etc.

Designation of one worker per chicken house
For providing feed and water; regulating temperature; monitoring health; waste disposal; overall recording.

Vaccination and medication
During production cycle.

Sell live birds to wholesaler through broker
Towards the end of production cycle. In some cases, producers sell directly to hotels or restaurants.

Sell poultry manure to local fruit tree farmers
Often farms belong to friends or relatives of the farm owner.

Value propositions

Healthy live chicken of desired weight at an affordable price
Based primarily on a wholesale business model.

Poultry manure as fertilizer to local fruit tree farms

Customer relationships

For birds: Phone contact with broker who identifies a willing wholesaler
Producer and wholesaler are usually not in direct contact.

For manure: Direct contact with farmers
(commonly part of social network of friends or relatives).

In some cases: Slaughterhouses
In case of disease outbreaks, some producers sell birds to slaughterhouse or slaughter on-farm before birds die.

Customer segments

Brokers that mediate btw. producers and wholesalers
To sell live chicken.

Fruit tree farmers
To sell poultry manure as fertilizer.

In some cases: Hotels and restaurants
To sell chicken directly without brokers.

Shops
To sell small-sized chicken (<1kg) for grilling.

Key resources

Experience in broiler farming

Sufficient number of skilled workers for routine work

Capital for initial investment
Most producers have enough capital to cover essential expenses without external support (e.g. bank loan).

Channels

Information on daily poultry prices accessed through internet/social media, mainly Facebook
No influence from state in prices.

Communication between producers, brokers and wholesalers by mobile phone.

Cost structure

Variable cost: feed (60 percent), DOCs (20 percent), medicine and disinfection (10 percent), labour (<2 percent)
Fixed cost: Ca. 2 percent of total cost.

REVENUE STREAMS

>95 percent of revenue from sale of live chickens
Followed by the revenue received from the sale of the manure (details in the enterprise budget section)

3.2 Poultry meat production is profitable but there is room for improvement

All broiler farms were profitable with a net margin ratio, i.e. the ratio of net margin (profit) to total revenue or output value, ranging from 4 to 25 percent. Table 1 provides an enterprise budget comprised of inputs and outputs based on farm averages. Averages were used since the poultry farms shared common production characteristics that are described in more detail in Box 3. The enterprise budget reveals that fixed cost were rather minor, accounting for about 2.2 percent of the total input cost. The major cost items included feed (64 percent of total cost), day-old chicks (17 percent), medication (6 percent) and vaccines (5 percent). It is noteworthy that those costs reflect a single point in time estimate and can change rapidly due to price fluctuations, which explain profit variability across production cycles.

BOX 3 Characteristics of the selected poultry farms

The average broiler farm had a flock size of 5 000 birds and five cycles per year. The mortality rate lied at 7.8 percent, with a rather high variation (standard deviation: 2.96). Producers followed a three to four weeks downtime, i.e. time not being productive between production cycles that is commonly used for cleaning and disinfection. Most of the farms were not fenced. Heating and ventilations were mainly manually controlled through windows or open sided curtains. A litter system was based on wood shavings (sawdust) that are commonly bought from carpenters and replaced and sold after each cycle. Feeding relied on manual hanging feeders and bell drinkers. Day-old chicks (DOCs) were bought and fattened over a production cycle of 35 to 40 days on average until they reach a slaughter weight of around 2.1 kilogram. Vaccination programmes exist and cover major endemic diseases including Newcastle disease, Avian Influenza and infectious bronchitis. However, producers do not follow a systematic vaccination scheme and often vaccinate birds only when outbreaks are reported in nearby farms. Among the interviewed poultry farmers were only one female; the large majority (90 %) were renting the poultry farms from a landowner and hired at least one full-time worker.

TABLE 1: Enterprise budget of poultry farms[a]

ITEM	UNIT OF OUTPUT/INPUT	OUTPUT/INPUT PER CYCLE	OUTPUT/INPUT PER ANNUM	UNIT VALUE (EGP)	TOTAL VALUE (EGP)
OUTPUT					
Broilers	Kilogram	9 851	49 255	23.6	1 162 418
Sarda and Farza	Kilogram	98	488	15.7	7 654
Litter	Cubic metre	15	75	164.1	12 225
TOTAL OUTPUT					**1 182 297**
OUTPUT PER HEAD					**47**
INPUT					
VARIABLE INPUTS					
Day old chicks	Head	5 000	25 000	6.8	170 000
Feed	Kilogram	175 000	87 500	7.2	630 000
Labour	Lump sum / cycle	2 844	14 220	2 844.1	14 220
Vaccines	Lump sum / cycle	9 681	48 406	9 681.3	48 406
Other medication	Lump sum / cycle	12 188	60 938	12 187.5	60 938
Disinfectants	Lump sum / cycle	738	3 691	738.1	3 691
Detergent	Lump sum / cycle	293	1 466	293.1	1 466
Lime	Lump sum / cycle	322	1 611	322.3	1 611
Sawdust	Lump sum / cycle	3 358	16 792	3 358.3	16 792
Electricity	Lump sum / cycle	694	3 468	693.6	3 468
Gas (heating)	Lump sum / cycle	1 314	6 570	1313.9	6 570
Gasoline	Lump sum / cycle	182	910	182.0	910
Water	Lump sum / cycle	265	1 323	264.6	1 323
Maintenance (equipment)	Lump sum / cycle	567	2 834	566.7	2 834
Brokerage	Lump sum / cycle	358	1 792	358.3	1 792
Dead bird disposal	Lump sum / cycle	155	777	155.4	777
Veterinary care	Lump sum / cycle	831	4 157	831.4	4 157
PPE for visitors	Lump sum / cycle	175	875	175.0	875
PPE for workers	Lump sum / cycle	236	1 181	236.2	1 181
Total variable input					**971 009**
Gross margin before feed cost					**841 288**
Gross margin					**211 288**
FIXED INPUTS					
Taxes	Lump sum / cycle	652	3 261	652.1	3261
Farm rent	Lump sum / cycle	2 589	12 946	2 589.2	12 946
Total fixed input					**16 207**
Total input					**987 216**
Net margin					**195 082**
Net margin per head					**7.8**
Net margin ratio					**16,50%**

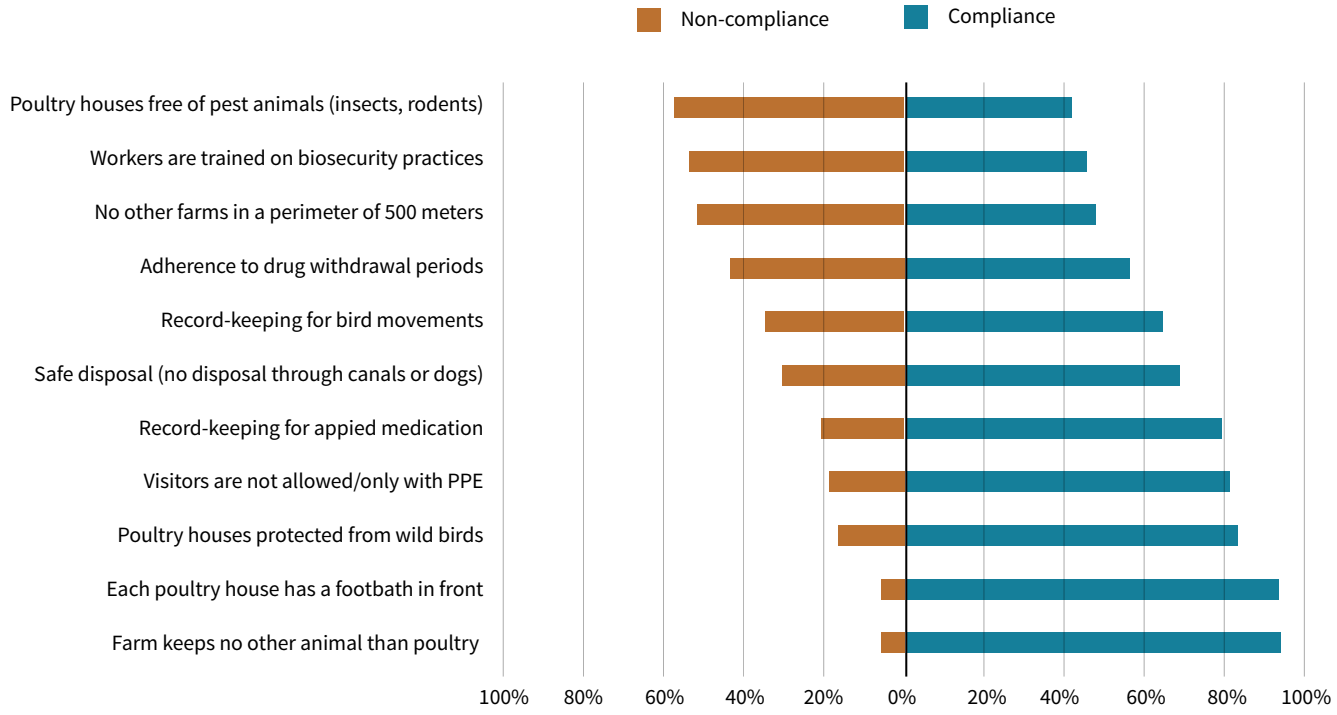
[a] All cost-related calculations are built on farm averages and were performed using the Egyptian pound (EGP) with an exchange rate of 1 USD = EGP 15.7 at the time of analysis (August 2021).

3.3 Compliance with biosecurity

Most of the surveyed poultry farms were neither registered nor licensed and had inadequate infrastructure to maintain a minimum level of biosecurity, i.e. they lacked fences and gates as critical first barrier, often called segregation, to keep pathogens out of the farm (bioexclusion) as illustrated in Box 1. The compliance levels were particularly low regarding the prudent use of antimicrobials, which can drive the development of antimicrobial resistant pathogens (O'Neill, 2015).

Interviewers noted that producers commonly used antibiotics without specific consideration of the disease in question. When asked about 'compliance with withdrawal periods', many producers replied to respect withdrawal period assuming a default duration of 3–5 days irrespective of the drug used. In addition, more than half of the producers did not comply with practices related to the safe disposal of dead birds and a majority of them did not consult veterinarians in the case of animal disease, treatment or ante-mortem inspection before slaughtering.

FIGURE 2: Compliance with selected biosecurity criteria among farmers (%) (n=48)



Typical examples of poultry farms involved in the study from the out- and inside.

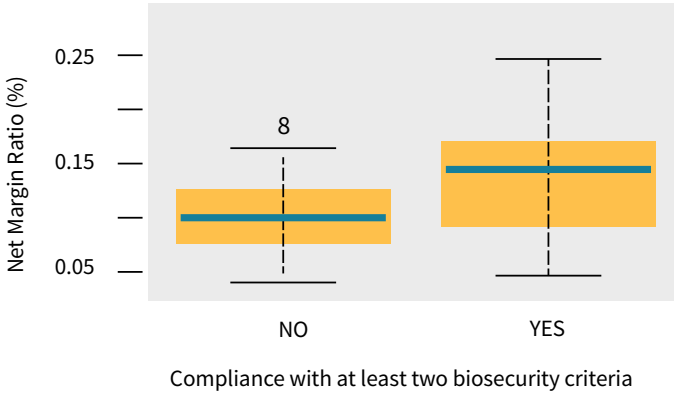
3.4 Biosecurity improvements require better book-keeping

During the interviews with producers, we noted that proper recording of biosecurity related cost was not in place. When recorded, biosecurity cost items were commonly lumped together with one budget line covering, for example, medication, vaccination and purchase of detergents, disinfectants and protective equipment. These cost items refer, however, to different dimensions of biosecurity and lumping them together provides little guidance to improve business profitability. Cost for detergents or disinfectants, for example, represents a regular variable cost aimed at the prevention of disease and improving general hygiene. Cost of medication, instead, refer to costs related to medicine to treat an infection in the flock and, therefore, could reflect a leak of biosecurity in the first place. Clearly, lumping these cost items together makes it impossible for farmer to appreciate whether, as one could expect, there is a negative correlation between preventive vs curative biosecurity costs and thus to better allocate his/her scarce resources. Other cost, such as on infrastructural biosecurity (e.g. fences, gates, etc.), were not even made since most poultry producers rent farms and thus refrain from making fixed long-term investments that they may 'lose' when the contracts expires.

TABLE 2: Biosecurity related criteria with mortality rates by non-compliant and compliant farms (n=48)

VARIABLES	MORTALITY RATE (%)	
	NON-COMPLIANT FARMS	COMPLIANT FARMS
1. No other farms in a perimeter of 500 meters	8.0%	6.0%
2. Workers are trained on biosecurity practices	8.5%	6.0%
3. Poultry houses free of pest animals (insects, rodents)	9.0%	6.0%

FIGURE 3: Boxplot of the net margin ratio by farms complying or not complying with at least two of the three biosecurity related criteria



In the attempt to order to disentangle the relation between biosecurity and profit, we looked at how the compliance or non-compliance with selected biosecurity criteria, notably distance from other poultry farms, training in biosecurity and measures in place to prevent bird contacts with wild animals (e.g. wire mesh), correlates with mortality rate in flocks[3] (see Figure 2). Table 2 shows that farms complying with the selected criteria have lower mortality rates of 2–3 percent.

Odds ratios have been generated to quantify the strength of the association between compliance with selected criteria and flock mortality variables. Mortality was considered low when below the average of all farms, which was at 7.5 percent per cycle. The results show that the odds for having low mortality were 1.18 times higher in farms complying with criterion 1 (OR = 1.18; 95% CI =0.38, 3.67). The other two criteria have also shown a positive association including criterion 2 on biosecurity training (OR = 1.4; 95% CI = 0.34, 4.38) and criterion 3 on freedom of pest animals (OR= 2; 95 % CI = 0.62, 6.42). As illustrated in Figure 3, we also found that those farms that comply with at least two of the three biosecurity criteria also had a five percent higher net margin ratio (p = 0.073). We must note, however, that these results point to a correlation that does not necessarily imply a causality.

[3] Only the first three criteria were chosen as explanatory variables to ensure a minimum of 20 observations for both categories (compliance and non-compliance). Mortality rate has been chosen as outcome or dependant variable given that biosecurity is commonly associated with animal health (Dewulf and Van Immerseel, 2019).

3.5. Poultry producers are willing to improve adoption of good biosecurity practices

We discussed with producers about the advantages and disadvantages of biosecurity. Most of them (92 percent) agreed that biosecurity positively contributes to productivity and profitability and four out of five (83 percent) indicated to be willing to strengthen biosecurity on their farm. In particular, producers noted that biosecurity may result in higher quality products and market prices (e.g. for residue-free meat), improved business reputation and larger customer base (e.g. through better food safety). The also indicated that biosecurity could help to make use of current waste products (e.g. litter and dead birds) into products that can provide an additional source of income (e.g. fertilizer). Commonly mentioned disadvantages included the cost associated with the adoption of biosecurity practices, such as the purchase of disinfectants and personal protecting equipment. Producers also stressed that some practices, such as laboratory testing for diseases such as avian influenza and respecting drug withdrawal periods, are not only costly but also not rewarded by the market, i.e. they do not result in higher market price for birds.

After an open discussion on the advantages and disadvantages of biosecurity, we asked producers in each governorate to prioritize two biosecurity practices they would favourably consider adopting.

Moreover, participants were asked to identity actions they can take to facilitate the adoption and score them against a ranking framework that we developed specifically for this purpose. Participants could rank each action on a scale from 1 (very low) to 4 (very high) based on the following criteria:

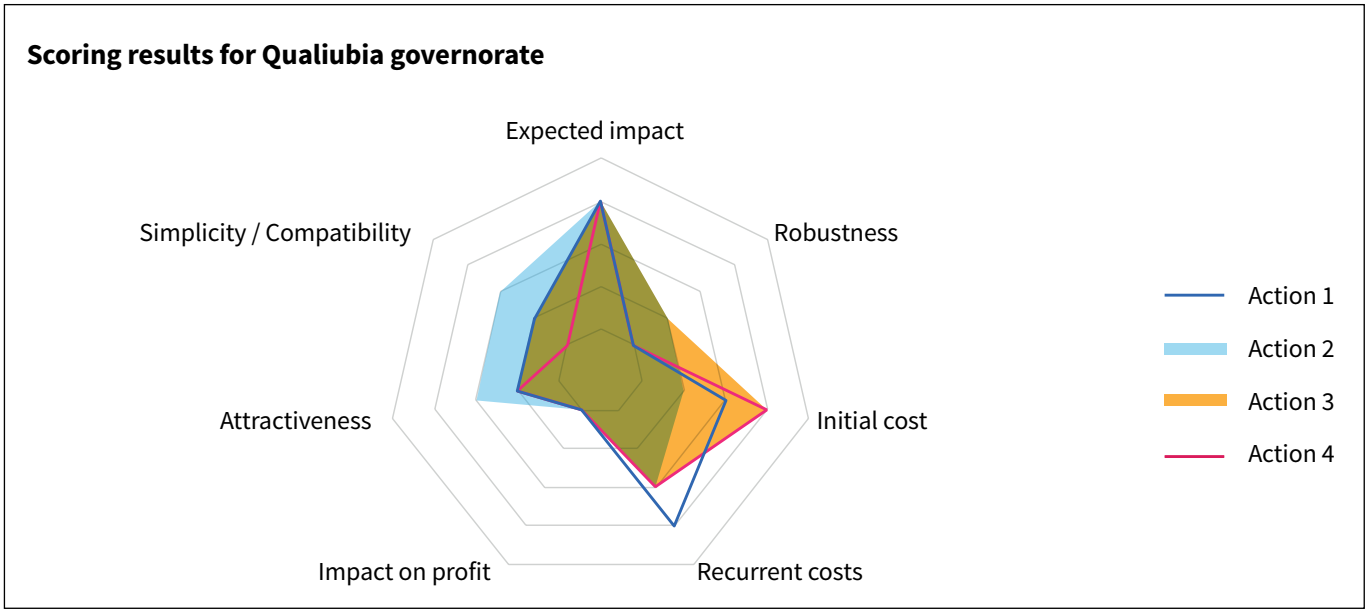
1. Expected impact: Does this action result in the adoption of the good practice?
2. Robustness: Does the implementation of this action depend on the existence of other conditions?
3. Initial cost: Are there any initial financial investments required to implement this action?
4. Recurrent costs: Are there any recurrent financial inputs required to continue implementing this action?
5. Impact on profit: How does this action impact on profit?
6. Attractiveness: Are there any incentives to implement this action?
7. Simplicity/compatibility: Is this action easy to implement and fits into existing business practices?

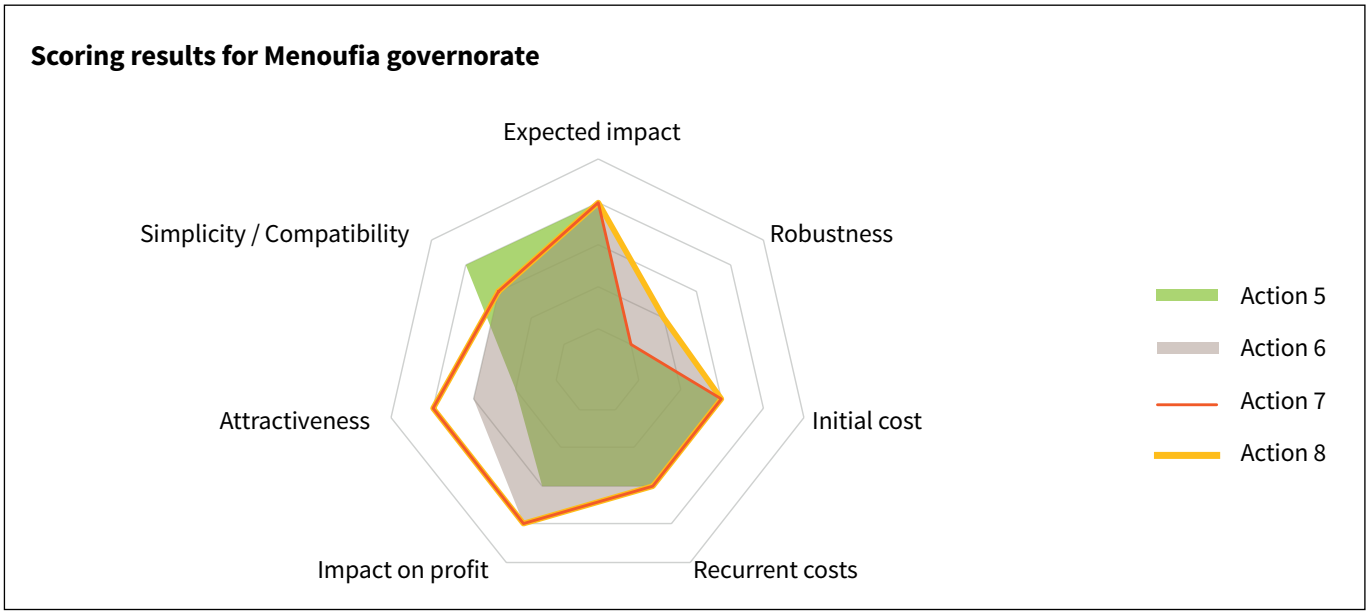
Table 3 provides a summary of the prioritized biosecurity practices and two actions that producers indicated to be willing to take in order to facilitate their adoption. The overall score for each action was based on the ranking framework and is provided in the right column of Table 3 and illustrated specifically for each action and criteria in Figures 4a and 4b.

TABLE 3: Prioritized biosecurity practices in each governorate with the corresponding actions and their score.

	PRIORITIZED PRACTICES	ACTIONS	SCORE
QUALIUBIA	**Follow the recommendations of withdrawal period for veterinary medicines.**	Action 1: Hire a veterinarian for supervision of flock health and medication.	17
		Action 2: Consult professionals to support selection and type of proper medicine.	18
	Do not sell sick birds for human consumption.	Action 3: Reporting of sick birds to authority.	18
		Action 4: Consult a veterinarian in case of sick animals.	16
MENOUFIA	**Dispose dead birds safely.**	Action 5: Engage processing companies to collect dead birds.	20
		Action 6: Process dead animals into compost.	22
	Test birds before transportation from the farm.	Action 7: Obtain insurance for animals to limit losses in case of disease outbreaks.	21
		Action 8. Engage governmental veterinarian to supervise the farm.	23

FIGURE 4a and b: Prioritized actions and their scoring by producers in Qualiubia and Menoufia governorates





4. Opportunities

Based on the information gathered and consultation with broiler farmers, we identified three win-win solutions that can potentially improve the profitability of the poultry producers while improving biosecurity.

4.1. Long-term contracts between producers and public veterinarians

Currently veterinarians play a minor role in poultry meat production. However, poultry farmers have shown willingness to cooperate with veterinarians and, in particular, to contract them on a long-term basis to assist in farm management so as to become more efficient and profitable. The ranking exercise presented in the earlier section has revealed that this solution was ranked the highest among producers with a total score of 23 and thus represents an opportunity for a constructive public-private partnership, which can not only assist producers in improving their profitability but also facilitate the early identification and reporting of diseases. The business model canvas suggests that internet and social media may be tapped into to facilitate an effective partnership between public veterinarian and poultry producers. Indeed, a number of services could be potentially provided remotely, such as generic veterinary advice, virtual animal inspection, dissemination of information on disease risks or new laws and regulations, etc.

Broadly speaking, the effective engagement of public veterinarians at production level may represent a starting point for assisting broiler producers in complying with existing rules and regulations and formalizing so as to facilitate their integration with other market actors, such as processors, wholesalers and retailers as well as financial and government institutions.

4.2. On-farm composting system for dead birds and litter

As shown in Figure 1, many producers do not dispose mortalities safely. Dead birds are commonly burned (42 %), dumped into canals (31 %), buried (19 %) or disposed of in another way such as through composting or sale to recycling companies. The dumping into canals poses a particular risk to public health risks, as dead birds are a perfect medium for bacterial growth and a source of infection.[4] Producers, however, agreed that composting has major potential as compared to other disposal methods and ranked it as the second easier action to implement in order to enhance biosecurity (Table 3). Indeed, most producers have sufficient space on their farm for composting sites (40 %) though, they lack knowledge about its proper implementation of this method (85 %).

Compositing is a natural process of 'rotting' or decomposition of organic matter by microorganisms under controlled conditions (FAO, 2003). It is an attractive proposition for turning on-farm organic waste material, such as litter or dead birds, into a farm resource while reducing pathogens at the same time (Wilkinson, 2007).
According to the farmers, the investment cost for a composter were estimated at around 1 500–1 800 EGP while the running cost were about EGP 50 per cycle. The resulting fertilizer could be sold to crop, fruit tree or fish farmers with an estimate prices ranging from 18 to 22 EGP per kilogram.

BOX 4 What do poultry producers say about compost?

"Compost is my preferred way to get rid of the daily mortality. It does not cost much, and I can add layers of straw, chickens and litter as much as I need. I use the product in my own land for fertilization. I am ready to train others how to do it. It is easy and very profitable."
Eid Elsayad- Qewesna, Menofia, Egypt. May 2021

@Mohamed Moussa, Assiut governorate

[4] Various research has confirmed the potential of carcasses as source of infection (Meroz and Samberg, 1995; Nespeca, Vaillancourt and Morrow, 1997) that can be further spread in the case of unsafe disposal by animals including mice and rats (Backhans and Fellström, 2012; Liljebjelke *et al.*, 2005; Meerburg and Kijlstra, 2007; Robyn *et al.*, 2015), dogs (Moran *et al.*, 2018) or flies (Bestman and Ruis, 2012).

4.3. Investing in basic biosecurity to improve animal health

The application of basic biosecurity practices, such as cleaning and disinfection as well as personal protective equipment for farm workers, was not widespread even though their cost is often marginal. Even though basic biosecurity may not have been comprehensive in the selected farms, the associated cost represented less than one percent of the total cost in the enterprise budget.[5] An investment in clean environment could pay off twice as pathogens in the environment are reduced and poultry health improves, which strengthens the animals' resilience to diseases and thus lowers the likelihood of disease or death. In fact, research and field experiments show that improvements in biosecurity can be beneficial for farm performance (Dewulf and Van Immerseel, 2019).[6] To demonstrate this point in the case of Egypt broiler producers, we calculated the financial losses due to mortality using the following formula:

Foregone revenue due to bird mortality =
(mortality rate x flock size) ×
(DOC purchase price + broiler sale price)[7]

Assuming a reduction in mortality from 8.5 to 6 percent due to adopting basic biosecurity practices as in Table 2 and using data from the enterprise budget, the foregone revenue due to mortality would reduce from 13 005 to 9 180 EGP per cycle.

This reduction corresponds to a cost saving of 3 825 EGP per cycle and 19 125 EGP per year, respectively.

Note that these calculations are based on data from a small sample of farms and rely on strong assumptions on the association between the selected of biosecurity criteria and profitability. Nevertheless, we contend that proper book-keeping cost breakdowns for biosecurity items in the enterprise budgets are needed to start better tapping into their profit-enhancing effects. Currently, most producers lump together all biosecurity related costs, which makes it difficult to identify causal relationships between the adoption of biosecurity practices, production and productivity levels and profitability. As a yard stick, we propose to use add simple biosecurity items in the enterprise budget, as listed in Table 2, that could be interpreted in relation to the total variable cost (e.g. biosecurity: variable cost ratio) to allow for comparison and potentially benchmarking.

A poultry farm owner demonstrates good basic biosecurity, i.e. protective clothes, boots, a water access with a basin to clean (right-hand side) and a footbath to disinfect boots when entering or leaving the poultry house.

[5] No including "vaccination", "other medication" or "veterinary care" as those costs are not exclusive of biosecurity but can cover also curative costs related to disease outbreaks. Note also that this formula does not specifically take into account the cost of feed, vaccines and other drugs applied as there was not information as to whether birds died at the beginning or the end of the production cycle. We thus assumed death takes place in the middle of the production cycle, which roughly equals associated costs and saving for those items.

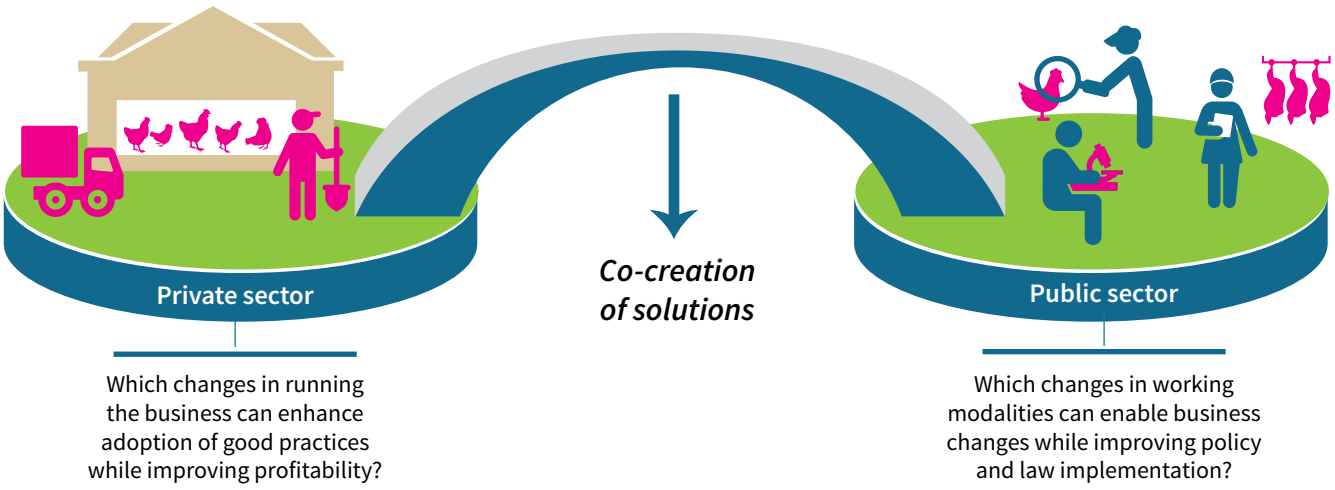
[6] Research has shown a positive correlation between biosecurity and health in different livestock production systems (Postma *et al.*, 2016; Zhang *et al.*, 2013) and specific pathogens (Gibbens *et al.*, 2001; Sandberg *et al.*, 2017) as well as in terms of economic returns (Corrégé *et al.*, undated; Fasina *et al.*, 2012; Postma and Dewulf, 2019). It must be noted however that gaps remain in the economic evaluation of biosecurity with respect to specific systems and practices.

[7] Since no death records are available by production day, we assumed that death of birds took place at the middle of the production cycle. This implies that feed costs can be ignored as the cost imposed during the first half would be approximately offset by the cost saved during the second half of the cycle.

5. Way forward

The results and opportunities identified during the participatory consultations with broiler farmers provide indications of potential interventions to improve business along with biosecurity. To that end, FAO plans to organize participatory workshops that aim further working out the proposed solutions in consultation public and private sectors stakeholders. This complementarity between both sectors and disciplines (health/biosecurity and business/economics) is a key element in the wider ASL2050 approach that is aiming at co-creating solutions to public health challenges through better dialogue across public and private sectors (Figure 2). The ultimate goal is to identify solutions to public health challenges that can be scaled up and translate into policies and regulations that are fit-for purpose at local level.

FIGURE 5: Improving biosecurity through better dialogue between private and public sectors



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CC2947EN/1/02.23