

Review Article**Biosecurity: bioexclusion and biocontainment measures as effective poultry health management strategy**

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Abstract

Biosecurity is a tool used to alleviate the introduction, emergence and spread of diseases caused by infectious agents. It comprises different health-management activities that need to be followed to reduce the passage and dissemination of infectious agents within and among farms, poultry flocks, and humans, as well as within a country, among countries, or the whole globe. In terms of public health measures, biosecurity applies to practices that will reduce contact between poultry and humans and thereby reduce zoonotic disease transmission. Two of the common biosecurity measures are bioexclusion and biocontainment which themselves are further categorized as segregation/isolation, movement control and hygiene/sanitation/disinfection. Isolation is about putting poultry under an exclusively isolated environment where it lives alone without any interference from any source external to the poultry or at least under reduced and controlled interference. Movement/traffic control and sanitation measures are practices to follow the isolation of poultry or preparatory phase as in the case of sanitation of poultry houses before introduction of poultry. These techniques have been effective in controlling poultry diseases like avian influenza, exotic Newcastle, Marek's disease, and any other diseases. Depending upon the underlying situation either bioexclusion or biocontainment measure will be used to control these infectious diseases of poultry.

Keywords: Biocontainment; Bioexclusion; Biosecurity; Health-management; Poultry

INTRODUCTION

Disease control in general, and the control of poultry diseases in particular, is the priority to minimize unnecessary costs related to live animal losses and treatment of sick animals as well as losses to reduced productivity due to diseases. Among the most important options in the control of disease in poultry are maintaining high levels of biosecurity and husbandry practices, and, where possible and appropriate, also administration of suitable vaccines for populations at risk. Among these disease control measures, the biosecurity measure is a best alternative in the control of transmission of infectious agents within and among poultry flocks, farms, and countries of the globe [1].

Biosecurity as a disease control strategy refers to practices used to exclude or at least minimize the risk of diseases caused by infectious agents from entering, emerging, establishing, or spreading in a country, a particular area, or a farm and thereby potentially harming human population by affecting food security and economy. With regard to poultry operation, biosecurity involves various practices used to prevent birds from getting into contact with sources of disease agents like vectors and vehicles of infectious agents that ranges from people to other animals, feed, and farm equipment. Biosecurity is about creating an environment in which poultry enjoy their life to the fullest without being disturbed by any intruders that could disturb their health and productivity [1].

Biosecurity involves a set of practices that collectively and serially be used to create a pathogen free environment for poultry under which poultry performs well and could not be a problem to other birds of their type, other animals including human as well as the global environment. Biosecurity is primarily based on creating a big solid barrier between poultry and its environment, and the sources

of infectious disease agents. At least a barrier that could exclude pathogens from entering a secured population of birds should be instituted by the set of biosecurity measures. There are different ways of grouping biosecurity measures though all of them stand for the basic principles of bioexclusion and biocontainment measures. The term bioexclusion stands for biosecurity measure that involves measures to reduce the risk of the introduction and spread of infectious agents into a new area, farm, or country [2]. That means, it is a practice that is used to prevent the passage of infectious agents from infected to susceptible animals or prevents the introduction of infected animals into a flock, region, or country in which the infection has previously not presented. In short, bioexclusion is referred to preventing infectious agents from entering a particular farm, area, or country. Biocontainment is another biosecurity measure used to prevent the release of pathogens from an infected herd (i.e., preventing infectious agents from exiting a flock, farm, or country). Biocontainment stands for containing a problem that has occurred in a particular flock, farm, or country where it occurred to take measures to solve the problem before spreading out. The concept of biocontainment can also be extended to include the practices used to prevent the spread of a disease within a flock where the disease is already present (containing the disease at an individual animal level) [1]. Both the bioexclusion and biocontainment principles involve isolation of flocks through housing and construction of fences, traffic control to restrict the movement of products, stocks, and persons, and sanitation by maintaining disinfection and cleanliness in flocks and by the use of personal protection equipment [3].

Isolation is the confinement of animals within a controlled environment where birds cannot be exposed to any external risk factor. This is important to keep out disease from the outside surrounding. If birds are kept under scavenging system, it is important to use fencing that can guarantee the isolation. In this case, be sure

that birds are securely fenced in. Fencing is important to enclose flock properly and to keep predators and rodents out. For the success of backyard and village poultry biosecurity, it is important to have an effective pest control program. Isolation also applies to the practice of isolating sick birds from the healthy ones to prevent further spreading of disease. Isolation can also be connected with separating birds by age groups which in this case is usually called segregation. Segregation is suitable for the application of all-in/all-out management in poultry operations, which allow simultaneous depopulation between flocks and thereby gives time for periodic clean-up and disinfection of facilities. Keeping birds separate by batch is also another isolation method. The new birds brought into an existing flock should be quarantined before mixing, to check if they haven't picked up any new disease. Keeping different species of birds separately is also another isolation technique which is paramount important [4].

Movement/traffic control is the control of the uncontrolled movement of birds, goods, and people to farm and the traffic patterns within the farm. Traffic control will restrict access to farm and flock. Not sharing tools or equipment, not accepting birds from neighbors, and not allowing visitors or allowing only limited number of visitors that are must to get access to the birds but with great care, would limit the chance of the passage of infectious agents from their source to other places and thereby secure poultry from any potential disease agents [4].

Sanitation is the other alternative and/or complementary biosecurity measure, that addresses the cleaning and disinfection of materials, equipment and people entering the farm, and the "clean" way of working on the farm. Cleanliness includes provision of clean feed and water for poultry, use of clean and disinfected equipment, cleaning poultry house regularly and removing wet bedding and replacing it with fresh dry one between batches of birds, hygienic

status of person working with and visiting poultry, and cleaning of the poultry premises, farm stead and the wider environment around poultry living area [4].

The biosecurity measures, isolation, movement control, and sanitation, involves only biological methods and does not use a chemical to control disease agents. Therefore, this approach to disease control is effective and it is effective usually in two regards. The first one is, it is chemical-free and thereby has no side effects and the other one is, it is relatively cost-effective. These make a biosecurity measure to be preferred over the other disease control options. If properly applied, biosecurity measure is efficient disease control option. Biosecurity measures such as isolation, traffic control and sanitation measures cannot be substituted by any disease control options that are based on provision of medicaments. If strictly followed, the biosecurity practices would totally exclude disease agents from any poultry environment. They can keep poultry environment free of any disease risk by putting potential disease agents at very far distance away from poultry. Biosecurity plays an important role in controlling infectious diseases by breaking the unwise connection between the sources of disease agents and poultry population that could bridge the transmission of infectious agents from one to the other. Biosecurity measure is usually seen as the first line of defense in the control of infectious poultry diseases. The other disease control measures will follow once the problem has precipitated by overcoming the instituted biosecurity measure in a particular area, or flock. The other thing is that, biosecurity measure doesn't need professionals to implement it, rather can be practiced by any concerned individuals. As a result of this, biosecurity is regarded as a cost-effective disease prevention strategy [3].

With the increasing production intensity of this days, the main emphasis of disease prevention should typically emphasize increasing bioexclusion and

biocontainment practices [1]. To minimize the risk of introduction of disease to a flock, farm, or country, the isolation, traffic control, and sanitation measures should be implemented in all poultry production systems [5]. But for the bioexclusion and biocontainment's practical implementation, infectious diseases' control practices should be directed to the pathogens involved, and to the at-risk farm's production practices. Furthermore, effective control of infectious diseases in poultry requires identification of the main transmission pathways of the pathogens, risk quantification, and assessment of efficacy and cost of the relatively preferred control measure of the risk. The biosecurity practices are basically well suited to control any infectious diseases of poultry. So far, it has been used to control viral diseases like Avian Influenza virus, exotic Newcastle disease and Marek's disease and other deadly diseases that are contact transmitted, easily disseminated among farms and also that can pass the species barriers and affect human [4]. What is not addressed by the current infectious disease control measures is the occupational and environmental pathways of pathogen transmission though these types of infectious disease transmission are aggravated by the industrial food animal production systems of the present days [1].

Details of Poultry Health Management Strategies

1. Biosecurity Measures

Biosecurity is not a single practice rather it is a set of practices used to prevent the introduction of infectious organisms into a flock free of the pathogens and their dissemination among different poultry farms of a specific locality or the globe. But once the disease has occurred in a particular individual animal, flock, farm, or country, biosecurity measure is targeted to contain the problem at its specific

initial situation and control it before spreading out wide. Practicing biosecurity in poultry farming systems is part of a solution to control specific diseases which can spread between poultry flocks such as Avian Influenza, Newcastle disease and Marek's disease. Generally, the agents that can be controlled by sound biosecurity practices include “bacteria, viruses, protozoa, fungi, parasites, and any other agents capable of introducing an infectious disease into a poultry flock [1].

Infectious diseases may enter and spread throughout a flock particularly as flock size increases and where poultry are placed in more confined situation in intensive housing. Therefore, strict biosecurity programs like all-in/all-out production, ‘downtime’ between broods, cleaning, and disinfection of the sites, buildings and equipment, and control of traffic of human and other animals are important for the control of poultry diseases. Furthermore, to have a greater outcome of biosecurity it is better to: regularly conduct risk analysis, have integrated surveillance or traceability systems, have improved emergency preparedness and response, know complete exposure pathways, give integrated responses to new and emerging diseases, rationalize control of diseases, and more. This is because without having a good biosecurity program to apply, it is difficult to lower the risk of pathogens' transfer from farm to farm. In general, biosecurity is a concern for poultry operations. These biosecurity measures are grouped into bioexclusion (preventing the disease from entering a facility) and biocontainment measures (managing a disease once it is on the premises) [1].

Bioexclusion and biocontainment measures

Bioexclusion and biocontainment are measures that if properly implemented in the farms are used to prevent the introduction to, persistence in, or dissemination among poultry farms of infectious agents. They can also be used to prevent the

human health risks of zoonotic infectious agents and economic losses they can cause. These bioexclusion and biocontainment measures can be put into practice by segregation of poultry based on relevant parameters to raise barriers to infectious diseases, traffic control, as well as by cleaning, and disinfection of poultry premises and equipment. Since disease causing viruses and bacteria can be transported from one flock to another on bird transporting equipment, trucks, tractors and other farm equipment as well as egg flats and cases, as well as on human's clothes, shoes, skin, and hair, developing and practicing daily biosecurity procedures as best management practices on poultry farms will reduce the possibility of introduction of infectious diseases such as Avian Influenza and Exotic Newcastle and many others [6]. By being careful not to bring disease home, limiting contact from visitors, and cleaning carefully and regularly, the health of flocks can be increased and the chance of disease occurrence can be decreased. Generally, isolation, movement control, and sanitation measures are used to implement both the bioexclusion and biocontainment on a farm, in a country, or all over the globe [3].

Isolation/Segregation

Isolation or segregation is a biosecurity measure and it stands for bringing in one flock and not adding other birds until that flock is taken out. It is not only concerned with the replacement and the added birds but also the founder flocks. At the very start of the farm, the establishment stock should be of the same type and be segregated based on different parameters like breed, age, health status and the like. Also, if birds are purchased or gifted from any other source they should be placed separately in quarantine for two weeks before mixing them with the host flock to observe the new birds for any signs of illness. Again, when there is an outbreak in the flock, birds with clinical sign should be separated and placed in isolation room as they may be a potential risk for the transmission of infectious

disease. Sick birds should be isolated in quarantine for about 30 days as some pathogens can be spread for up to four weeks after infection. The quarantine and isolation structures should be appropriately disinfected after use, and while birds are in quarantine, appropriate hygiene measures should be taken. Hands should be washed after handling sick birds in quarantine and isolation facilities. The routine tasks like feeding and cleaning should always be finished with the healthy flock before treating those in quarantine [5].

Movement Control

Movement control is another biosecurity measure and it includes control of traffic of human, animals as well as vehicle or farm equipment. The traffic onto a farm and the traffic patterns within a farm should be controlled. Poultry buildings and the farm premises should not be stuffed by visitors and their vehicles. Since frequent visits of a farm by individuals from another farms and exchange of equipment could cause a potential danger and could allow the dissemination of any communicable diseases, they should be controlled. Restricting people's movement and exchange of equipment can limit the risk of introduction of infectious agents into flocks, or farm. Restriction of unnecessary human traffic is a major component of a sound biosecurity program. Visitors should be restricted and only those with a good reason to be there should be allowed to enter the farm. For those who are allowed to enter, protective covering such as boots, coveralls, and headgear should be provided and they should wash and disinfect their hands and use foot bath at the gate [1].

The unlimited access to a poultry farm must always be controlled. It is important to restrict contacts between backyard poultry and commercial farms particularly where intensive farms are well-developed [3]. There should be strict restrictions of contact of poultry with wild birds, other animals, and humans. Equipment

should be cleaned and disinfected first before being moved from one poultry building to another [7].

Sanitation/hygiene/ Cleaning and disinfection

Sanitation and hygiene are also biosecurity measures that play a key role in effective disease control program in any poultry farms. Cleaning and disinfecting the surroundings of poultry farms proves particularly effective in interrupting potential poultry diseases from gaining access to the farm. Disinfecting buildings, materials, people's wears, and hands is important as a barrier in interrupting passage of disease agent from infected poultry, or poultry premises to another [3]. After depopulation of the previous and at the entry of each new batch, poultry site must be prepared by removing the previous bird stocks, their litter, and manure. There should be a physical and chemical cleaning of houses and equipment to limit the passage of an infectious agent from one batch to another. Disinfection and fumigation of the premises as well as designing for control of vector and rodents are also important in limiting between batch transmission of disease agents. Particularly, once a disease outbreak will occur specific care should be taken in the sanitary activities [8].

Sometimes, even if both bioexclusion and biocontainment measures will be applied, “zero” risk of pathogen introduction and release is practically impossible to achieve for a variety of reasons even in highly developed control settings. The reason is that a particular disease that may occur in some farms can transmit in the presence of even a slight breach of biosecurity, and occur in another area which is free of that particular disease. Therefore, the successful control of disease in poultry needs to bring together the different control options like management, animal welfare and vaccination, in addition to biosecurity, rather than control through a single measure [1].

2. Husbandry practices/animal welfare

Implementing a good husbandry practices is one among the different disease control strategies in poultry. Husbandry measures are usually further classified into management of flock, feed and water management, management of poultry trade and stock change, and poultry health management, as well as the management of the risks of poultry production to humans and vice versa. Poultry health management by itself includes the management of disease outbreaks and the use of litter. Any of these management factors can significantly affect the clinical outcomes of infection in poultry. Good flock management and feed and water hygiene, adequate stocking density, and effective control of environmental conditions can significantly affect disease and their economic outcomes [3].

The recommended management measure to maintain the health of poultry is therefore, to separate poultry by their species and age, to adjust stocking density with the type and size of the premises, to keep poultry on balanced ration, to avoid any stressful condition to poultry, to confine poultry in a controlled area, to inspect flocks daily and report sick animals, to stamp out the whole poultry during a contagious disease outbreak, to have a control over poultry trade, to provide clean feed and portable water using clean and disinfected equipment, and to manage the poultry farm stead and the whole immediate environment and of the globe. As mixing species increases disease agent transmission, it is better to raise one species at a time instead of different species mixed together as a single flock. Age separation is important to practice the all-in-all-out strategy in a farm. The all-in/all-out management is recommended in poultry operations to allow simultaneous depopulation of facilities between flocks. This would further allow sanitary cleaning between the complete exit and renewal of flocks. Because, it

allows time for periodic clean-up and disinfection. Keeping poultry indoor is also a recommended management practice and where it is difficult to apply as the case in scavenging production system, it is recommended to keep poultry indoors at least at night time. Limiting free-ranging and building fences to separate species are important management practices to be used in case indoor management is difficult to apply [3].

Supplementing food and providing clean containers for food and water are also recommended. This is because evidences show that there is an association between providing an untreated water for poultry and outbreaks of some poultry diseases. Thus, it needs to account for feed and water sources and the containers by which they are served, as contaminated food and water and their containers are recognized as risk factors for disease transmission to poultry [3].

3. Vaccination

Vaccination is a disease control strategy that depends on immunity and is preferred to be used where appropriate and applicable to supplement other disease control alternatives. It is an immunological control and is a practical alternative to chemotherapy. Though vaccination is not the only component of the disease control strategy to be used in poultry operation, it is a preferred option in disease control on most farms, once the disease is suspected to exist in the nearby area, and there is a higher probability of introduction of the disease to an area or country free of that particular problem. Vaccination is an effective way to control disease in poultry when appropriately used. The vaccines' success in fighting poultry diseases depends mainly on the choice of the appropriate type of vaccines, right time of their usage, and administration method used [1].

The Major Biosecurity Breaches in Poultry Operations

1. Lack of Test and Quarantine/isolation facilities

The breaches of biosecurity sometimes start from the very beginning at the importation or introduction of founder stock to a country or farm. There may be cases in which very strong tests do not conducted to assure the certifications that testify freedom from major diseases for importation or introduction into a country or farm. The quarantine, inspection, follow-up, and isolation activities may not be in place even at large-scale commercial poultry farms in some countries either at border gates or the importing farm level. The quarantine posts for poultry and poultry products may be unavailable at the entrance points in some countries or farms even though it is stated in the bio-security policy that day-old chicks and other poultry be quarantined for at least 7 days and also suggested by the standard operating procedure (SOP) that incoming birds be kept in a separate house for three weeks [9]. Even in those farms and poultry houses that have isolation areas for sick birds usually at one corner of the house, the isolation space may not provide real physical isolation as it is the case in most developing countries. On top of these, may be, there are no effective veterinary services and verification mechanisms to detect the disease situation to safeguard the poultry, other animals and whole public society. Though things are in this situation, authority to import day-old and other parent stock and poultry products from countries in connection with the potential infectious diseases is given for different importers that do not well informed about the diseases and their risks. Due to these, the exotic disease problem remains a threat of poultry rearing all over the globe particularly in some developing countries [10].

2. Uncontrolled movement of poultry, human, and equipment

Backyard poultry usually moves freely between households in some poultry rearing communities. These poultry also move from their dwelling area to local market for sale, from market back home in case of unsold chicken, or move in the form of gifts from a household to another. Thus, the rural community and their birds can be exposed to communicable diseases through these practices of the rural farmers. Selling chickens and their eggs at public market days in nearby towns or roadsides and bring birds unsold back home is a routine practice of rural farmers that can potentially aggravate disease transmission [10].

There are also uncontrolled importation and movement of poultry particularly day-old chicks from abroad as well as from farm to farm. Government-owned poultry multiplication centers, non-governmental organizations, and private individuals distribute intensively reared chickens to smallholders which is the case throughout some developing countries. These and the close links between intensive and smallholder farms facilitate disease spread and could pose a potential threat to poultry production, exacerbated by low biosecurity, and poor access to veterinary inputs and expertise particularly among smaller producers. There are also human traffic onto farm including their vehicles and different farm equipments. Unlimited type and number of visitors, movement of vehicles onto farm, and sharing of farm equipments among farms, can expose poultry and their environment to communicable diseases [11].

3. Human sharing the same house or environment with Poultry

In the backyard poultry production system, there is a case in which humans share the same house with their poultry or live in a close association where there is no

barrier between them. In most of the backyard poultry farms, poultry are not housed in a separate and well-protected room. On the other hand, poultry reared under extensive backyard conditions live on scavenging and not live in an isolated environment from other livestock and people who share their living quarters with poultry [10].

Like backyard poultry, most small-scale commercial poultry farms are located in residential areas where there is no tight barrier or separation from the public. In the small-scale commercial poultry farms, the birds are kept in crowded conditions with no ventilation. In these settings, the chance for becoming in contact with infected poultry discharges and bodies is very high [10].

4. Absence of protective equipment, disinfection/sanitation facilities

The other breaches of biosecurity measures in poultry farms, particularly in some government and private-owned poultry farms of developing countries are the absence of disinfection and/or sanitation facilities like foot bath, washing facility, etc. The regular practice of footbath is almost absent in most of the commercial farms in developing countries. These farms lack appropriate sanitary and washing rooms, working clothes and enough boots. In these farms boots or protective clothes are not provided for the workers or the supply of protective clothing and boots is not sufficient. It is common to see poultry attendants and health assistants working with their clothes and using the same gown and boot while visiting different houses. Workers of some farms manage many different poultry houses without any restriction. On top of these, hygienic facilities for workers are absent [9].

5. Other poor practices

Failure to regularly clean chicken shelters and replacing litter could expose birds to pathogens. The sweeping of the litter from the shelters and improperly disposing it in the compound is a poor practice practiced by some farmers in developing countries. The backyard poultry farms of some developing countries may also practice poor practices like improper disposal of dead birds or feeding of carcasses to pet animals [5]. Some farmers in developing countries may sell birds whenever there is suspicion of infectious diseases in the flock due to failure of culling the entire sick flock of birds, as they cannot afford to lose the entire flock. These different poor practices may lead to the spread of diseases [3].

There is a big gap of awareness regarding bio-security and its importance to poultry farming. The attention given to biosecurity practices in both private commercial farms and government-owned poultry multiplication and distribution centers (PMDCs) in developing countries is very low. The potential role of the various poultry breed improving and distributing centers, so-called PMDCs in the dissemination of communicable diseases to the vast majority of backyard poultry and the rural population is underestimated. Therefore, they have continued to disseminate infectious agents to poultry farms and the wider public [9].

Generally, the uncontrolled importation and distribution as well as movement of poultry, the living together in close association of poultry and human, the keeping of all birds together without prior quarantine of incoming birds and isolation of sick ones, the free movement of backyard poultry within household as scavenging and between households as gifts and the poor practices by some farmers in developing countries like selling of birds while there is suspicion of infectious disease within the flock, or farm, and the poor disposal systems in a farm are all

the breaches of biosecurity and could contribute to the transmission of many infectious diseases. These breaches of biosecurity could create a high chance of the introduction of exotic diseases and increased distribution of the existing ones among different poultry farms and areas. These were how an opportunity for the introduction of exotic poultry diseases into a country and for their transmission from farm to farm as well as for the passage of the endemic diseases in one area to move to another area has been created. The intensification and dissemination of the exotic breeds and their crosses to villages have also created the chicken population, which is susceptible to major poultry diseases [12].

Measures to be taken to reduce Disease Risks in Poultry Operations

Before proceeding to implementing measures to be used to reduce risks due to diseases in poultry farms, it is better to have a useful poultry disease control plan in advance that should be based on knowledge of the prevalence of diseases that can affect the flock, how each disease is transmitted, how to prevent each disease from entering the farm/flock, how each disease can be controlled, and the potential cost of an introduction and outbreak of disease, and the costs of the different intervention measures [1].

1. Ensuring the poultry supply source is disease-free (Test and quarantine/isolation)

Poultry trading is usually a risk factor for introduction in to a country and dissemination among farms in a country of infectious poultry diseases. Therefore, poultry farmers are advised to ensure that their poultry supply source is disease-free. This practice is particularly suitable for the maintenance of the health of the founder, replacement, and additional stock. Poultry farmers should avoid practices

like visiting live bird markets or other trading places and buying birds from uncertified sources, selling birds at open markets and returning unsold birds back home, exchanging birds as gifts and incorporating additional birds to the already available stock without being preceded by test and quarantine. Farmers better purchase birds from a known and regular stock source such as their neighbors provided that the flock is disease-free, rather than from live bird markets. The risk of disease transmission particularly in a backyard poultry stock is higher when birds are brought in from another backyard flock. Therefore, backyard poultry owners should either hatch their eggs or buy chicks or same-age young adult birds from one or a small number of the same commercial sources [1].

The all-in and all-out management strategy should be used during replacement of stocks. But in case this may not be practiced and few replacement birds have to be added to the existing flock, the newly introduced birds should be quarantined for two weeks before joining the existing flock to allow a time lag for any disease to reveal itself. Again, in case birds are purchased or gifted from an outside source, it is important to quarantine them in a room/shed or cage for two weeks so that they do not mix with the host flock. This practice helps to observe the new birds for any signs of sickness and to take an appropriate control measure in case they are found sick before being mixed with the existing flock. One can use the quarantine room or cage for isolation of sick birds rather than having a different isolation pen, if quarantined chicks do not occupy it [3].

It should be ensured that the isolation/quarantine room is appropriately disinfected after use and close regular follow up is a must whilst birds are in quarantine or during isolation period. To ensure that appropriate measures are put in place for the future to reduce the chance of further outbreaks, the cause of the current

disease problem that results in sickness of many birds must be established before introducing new birds or vaccinating surviving chickens [5].

2. Maintaining good Biosecurity Practices (Bioexclusion)

The bioexclusion practices to control poultry diseases involve flock management through species and age separation (avoid mixing), cleaning, disinfection, and visitor control. It is recommended to separate poultry by species and age to maintain biosecurity within poultry farms. Raising one species instead of several ones is recommended because disease agent introduction and transmission increases by mixing different species together. While a farm prefers to keep different species of poultry at once, building fences to separate species and limiting free-ranging is recommended. Farmers can use local materials to construct fences used to separate flocks by species and age. Age separation is important to practice the all-in-all-out strategy whereby sanitary cleaning can be carried out between the complete exit and renewal of flocks. But in case where free-ranging system is used to raise poultry, age separation is not feasible. Therefore, where indoor raising is difficult to apply like in some developing countries, keeping poultry indoors at least at night is recommended [3].

Contaminated food and water are biosecurity hazards to poultry; hence it needs to account for it. There is evidence of an association between a contaminated food and an untreated water source for poultry and outbreaks of some poultry diseases. Therefore, providing supplemented food (if possible) or ensuring clean containers for food and water is important to control poultry diseases. For backyard poultry it is difficult to propose a practical solution to solve the hazards associated with drinking contaminated water. Because, farmers who keep backyard poultry often

use water from ponds or rivers for their poultry, where it is practically impossible to address the issue of the associated hazards [3].

Controlling the flow of traffic on a farm also supports the prevention efforts by keeping carriers of infectious agents away from flock areas. Restricting human, equipment, and animal movement onto the farm, and controlling their movement patterns on the farm is an important measure in the control of poultry diseases [3].

Other biosecurity measure involves cleaning and disinfecting the surroundings, premises and equipment that proves particularly effective in interrupting potential infectious poultry diseases. Disinfection would also include people; their footwear, and hand-washing [3]. As a bioexclusion measure, hygiene and sanitation play a major role in effectively controlling infectious poultry diseases from entering poultry premises. A poultry farm site must be selected methodically and be prepared for the entry of a founder stock. Totally removing all the previous birds, and their litter and manure before entry of the next batch (all-in all-out) is mandatory. Cleaning, disinfecting, and fumigating the poultry premises is important in between every exit and entry of batches. It is important to design for the control of vector and rodent as well. A particular care should be given to the sanitary procedures after a disease outbreak. Regular visual inspection, together with routine testing by microbiological monitoring methods, is very effective in checking the efficacy of cleaning and disinfection practices exercised in a farm and to make amendments for the future [8].

Keeping a good record of flock history is also important for follow up and early intervention measures to be taken. This animal observation allows the farmer to detect any changes in the flocks. Moreover, in the case of an investigation, events would be easier to interpret if the flock history is known [3]. Management of

poultry requires detailed records on a daily or weekly basis. It is important to spend some time each day observing flocks. In this way, early signs of disease, or other problems may be detected and the necessary action be taken to exclude disease or if it may occur to control it [13].

3. Implementing Biocontainment Measures

The biocontainment measure is an appropriate method used for maintenance of health within a flock, in a farm and/or among farms in a country by containing the disease that has occurred to be localized to its origin where it occurred in a specific area, farm, flock, or individual bird than spreading out wide. Whenever there is an outbreak in the flock, sick birds should be separated as they may be a potential risk for the transmission of infectious disease to other non-infected birds or area. In serious disease conditions, affected bird(s) should be isolated or killed and poultry farmers and farm owners should immediately consult the veterinarian, development agents (DAs), and other experts in the locality on what to do next. Chicken shelters should regularly be cleaned and their litter should be swept off the shelters and be properly disposed of from the compound. It is recommended that poultry farm owners and household farmers should refrain from practices that increase the spread of disease within and beyond the farm or household. For the benefit of all chicken keepers in a particular community, poultry producers must refrain from dangerous practices like selling of birds whenever there is suspicion of disease in the flock. The risk of disease transmission can also be increased by inappropriate implementation of the disposal of sick animals and their carcasses. Improper disposal of dead birds, or the feeding of carcasses to pet animals could exaggerate the transmission of infectious agents. Thus, dead birds or parts from dead birds should be burned or buried deep enough (about one meter) to prevent dogs and other animals from digging them up and spread the disease [5].

Immediate disposal of dead and diseased birds is an important and effective tool in preventing the dissemination of any disease. Disposal methods include the use of burial pits, tanks, burial in trenches, burning, rendering, and composting [8].

The use of untreated poultry manure as fertilizer can also pose a serious risk of infection spread. This can be controlled by composting manure outside the flocked area. Composting the manure is a measure that is efficient but not well known among village farmers of many developing countries [3].

4. Maintaining human health

The last important measure to be taken to reduce disease risk, particularly of zoonotic ones, in both poultry operations and the associated human population is to maintain human health. This includes separating children from poultry and taking personal hygiene measures like hand washing or wearing gloves when handling poultry. Because, most zoonotic infection is caused by handling infected birds, their droppings or eating contaminated meat or eggs. Measures used to reduce the risk of people becoming infected by zoonotic pathogens includes: always washing hands after handling poultry, their droppings, and raw poultry meat; incinerating the carcasses and droppings of diseased animals; avoiding birds entering kitchen or food preparation areas; ideally, housing birds outside the house where people live, in separate accommodation; and making sure that chicken meat and eggs are cooked thoroughly before eating. The person in charge of taking after the sick or quarantined birds should take appropriate hygiene measures. This includes washing hands after handling sick and quarantined birds, and always finishing the performance of routine tasks such as feeding or cleaning with the healthy flock before treating those in quarantine or isolated birds [5].

CONCLUSION

Many risk factors for infection are related to the farm, movement of birds on and off the farm, and general management practices. Biosecurity measures are the solution to prevent, avoid, or reduce these risk factors from occurring, or once they have occurred. Biosecurity measures include procedures and practices which when applied prevent the entry of disease agents into a farm, or a country or the exit of the disease agents from the infected individual animal, flock, or premises. This may involve plans, protocols, and practices to ensure that healthy flocks, farms, and countries remain free from an entry of disease agents and that disease agents remain contained in infected individual animal, flocks, farms, and countries and do not spread to other birds, flocks, premises, farms, and countries. This need controlling movement of stock, persons, equipment, and products into the disease-free farm, or country and out of infected flocks, premises, farms, and countries. These also need the farm to remain in a state of sustained cleanliness, called sanitation and immediate isolation of birds whenever there is suspicion of infection or quarantine of the incoming birds for some days before introduction. Prior test to ensure certification of free of any disease before importation and introduction of founder stock, or replacement and additional stock and placing the then certified and accepted birds in quarantine before introducing in to a country, or farm or before mixing the new comers with the existing stock is mandatory [14].

Biosecurity is the outcome of all these activities that need to be undertaken by an entity to prevent the introduction of disease agents that one is trying to protect from entry into a country, or a particular farm (bioexclusion), or to contain the disease agents within its initial origin (biocontainment). Biosecurity measure is the usual way used to avoid unnecessary contact between animals and microbes,

and between infected animals and healthy ones. It includes the use of isolation/ segregation, traffic/movement control, and cleanliness/ hygiene/ sanitation/disinfection measures. Biosecurity measures were so far used in the control of transmissible diseases of poultry like avian influenza, Newcastle disease, and marek's disease, but it is logically well suited to control any infectious diseases as it is cost effective and doesn't need professionals to implement.

Conflict of Interest

The author declares that there is no conflict of interest.

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