

## Biosecurity Strategies in Poultry Farms and their Impact on Health and Production: A Review

Mohammed hasib Mohamed <sup>1</sup>, Ruya. F. Jasim <sup>2</sup>

<sup>1</sup> Department of Animal Production, College of Agriculture, Kirkuk University, Kirkuk, Iraq.

<sup>2</sup> College of Nursing, Kirkuk University, Kirkuk, Iraq

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**Annotation:** His context: While poultry production is a fundamental source of global food security, the growth and sustainability of the industry is continuously challenged by infectious diseases. The importance of protecting the poultry industry led to the establishment of biosecurity as the best measure available to avoid devastating economic losses from farms and threats to food safety. The poultry biosecurity principles are illustrated with application at the external (external biosecurity – location, visitors control and quarantine) and internal (internal biosecurity – cleaning and disinfection, litter/processing, procedures for handling feed) levels as well as vaccination programs. At the holding level, biosecurity has a positive impact on poultry health and is associated with a decline of important diseases like Newcastle disease, avian influenza and salmonella, lower mortality rates, and improved immunity which in turn results in the reduction of the use of antimicrobials. Biosecurity speaks to the possibility of improved growth performance, improved feed conversion

ratio, and egg quality at the production level leading to economic profitability competences through reduced cost and enhanced productivity. This could access innovative solutions through the new technologies (sensors, artificial intelligence or automatic monitoring), but not all the problems related to the financial and knowledge gap in developing countries. However, future research should focus on biosecurity measures that are attentively tailored to suit local context, and integrated with the One Health approach, so as to enhance resilience of poultry systems in the long term.

**Keywords:** Biosecurity; Poultry health; Infectious diseases; Egg production.

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## Introduction

In terms of providing low-cost human food with high-quality proteins, poultry meat is one of the most rapidly expanding and fastest moving sectors of world agribusiness. The consumption of poultry meat and eggs is a global concern for food security and is expected to rise steadily for the following decades in both developed as well as developing countries (Mottet & Tempio, 2017). At the regional level, poultry is a basis of rural economic development in providing employment and household income which will impart the sustainable agricultural development (Sharma et al., 2020).

Nevertheless, intensified production systems have fundamentally increased how often we see outbreaks of infectious disease that frequently result in economic loss, welfare issues, and even public health emergencies. In light of these challenges, biosecurity is now at the centre of chicken production in the world as one of the key pillars of production today. Biosecurity is a management practice and physical barrier to disease agents between and/or within flocks (FAO, 2020). Strategies such as farm biosecurity, detergents and biocides, pest and vector control, vaccination schemes and hygiene status of feed or water (Dorea et al., 2020) are examples of this type of measures. This means biosecurity can save lives, and reduce disease and the need for antibiotics so flocks can be more productive, healthy and safer food.

However, biosecurity is not a homogeneous concept and would have the following broadly defined objectives: Increased productivity — that is, a reduced impact of economic losses from individual cases or outbreaks of disease. Safe food (these objectives would contribute towards improving zoonotic infections, e.g., avian influenza transmission mitigation, pathogenic *Salmonella* strains which could be a risk to consumers) (Ahmed et al., 2022) Studies in other production animals (eg, sheep) have additionally demonstrated the response of the animal to environmental interventions (either with hormonal treatment (Alwan et al. : 62 Palani & Al-Zubaidy) which predominantly influence reproductive performance, functional traits, and

oxidative status. The results highlight the importance of integrating nutrition with management practices such as biosecurity, in order to improve animal health and productivity.

The aim of this review is to summarize the current status of biosecurity measures implemented in poultry farms and its influence on the health status and production performance of birds. Here we have collated recent study data that illustrates what constitutes good biosecurity, how to best achieve it and a gap analysis of those activities currently practised on pigs (both high and low numbers) by producers, as well as means to improve adherence to such practices. But the long-term sustainability of poultry production for food security and public health will depend on the integration of these vaccines into the existing poultry production system.

### **Key Components of Biosecurity in Poultry Farms**

External biosecurity is the means to keep infectious agents from being introduced to poultry premises. Farm siting plays a role in this; proximity to wetlands and live bird markets, and competitive biosecurity, result in reduced poultry disease entry into production systems (FAO, 2020). In addition to physical barriers, fencing and controlled access is employed to prevent contact with potential disease vectors such as wild birds and stray animals. This regulation (Dorea et al., 2020) is controlled by restricting visitors by registration and (or) restricted access and use of protective clothing to minimize (attenuate) the introduction of pathogens (Dorea et al., 2020). In addition, quarantine of new birds and birds returning to the flock to test for infections prior to mixing the 2 groups is suggested to minimize the potential for introduction and thus, outbreak (van Steenwinkel et al., 2018)

#### **Internal Biosecurity**

Internal biosecurity does not transmit pathogens to other species or foreign farms but spreads within the infected farm. They are able to establish high levels of contamination and that contamination is persistent between production rounds and these are identified as poultry houses that are well cleaned and disinfected. If there is good management of equipment, for instance, there should be independent implements for every home, which would help prevent the disease from spreading. Also, litter treatment, which is another big target in the war against disease, as wet contaminated litter will host pathogens such as *E. coli* and *Salmonella*. This systematic reduction and/or addition of litter decreases shed infection pressure and is beneficial to flock health status (Ssematimba et al., 2019). In case of more intensive production systems, also feed and water hygiene matters are important to prevent it from contamination.

#### **Vaccination and Preventive Health Programs**

Integrating vaccination programs with biosecurity strategies — the first line of defense — enhances flock immunological resistance to endemic and emerging pathogens and, as new frontiers in biosecurity, immunity-based intervention strategies are becoming crucial for SAC [18]. Morbidity and mortality can be dramatically reduced through high biosecurity and vaccination against the long term storage target diseases (Newcastle disease, avian influenza and infectious bronchitis) which would be inactivated in these eggs (Sajjadi et al., 2025). Inconsistency in vaccination program implementation and stiffness in biosecurity regulation lead farms to disease outbreaks (Zikibayeva et al 2025). For this reason, vaccination should not be understood as an alternative to biosecurity, but as part of an integrated health management strategy.

#### **Training and Awareness of Workers**

Biosecurity governance (Oct 2017) — toilet biosecurity compliance system a system is only as effective as the people who follow it. Maintain the staff education at full throttle about hygiene practices, animal handling and emergency response. Gelaude et al. According to Rahman et al. (2014), the ability to decrease the mortality as a result of the biosecurity practices at this level is dependent on the awareness and motivation of the staff, even though the farm having a formalized

training performed better in biosecurity and less mortality than others who did not have a formalized training.

### **Impact of Biosecurity on Poultry Health**

The effective implementation of biosecurity programs is what helps mitigate the risk of serious poultry infectious disease on farms. Newcastle disease (ND), avian influenza (AI) and Salmonella infection and other well known transboundary diseases lead to large-scale economic losses, threat to public health and turns into trade restrictions (Ak et al., 2019; Gerle et al., 2018). So far, it is true that some studies found differences between a group of farms with biosecurity measures, that are carefully managed (e.g. fully controlled access to the farms, disinfection, vaccination etc) and their poorly managed or non-compliance counterparts (Conan et al., 2012). High biosecurity on farms is associated with decreased risk of highly pathogenic avian influenza outbreaks at a farm level (Martin et al., 2018) and less human cases of infection from a flock, which indicates the necessity of sustainable measures which long stay protective to the health status of flocks over time.

#### **Impact on Mortality and Morbidity**

Improved biosecurity results in less mortality and morbidity in commercial flocks. Farm-level practices such as clean outbreak management, movements of animals and people, biosecurity & disinfections, will minimize the birds exposure to pathogens, which lowers disease. A quantitative study showed a positive relationship between high biosecurity scores and low mortality rates and better performance in Belgian broiler farms (Gelaude et al., 2014). And, this once again reiterates the fact that biosecurity is not only a health issue but also an integral part of improving farm productivity.

#### **Improvement of Immune System Response**

Because chickens are not exposed to as much pathogens and/or they do not experience constant immune stimulation they have a more active immune response overall. The reduced load of environmental pathogens reduces immune system energy expenditure and leads to improved feed efficiency and growth. Furthermore, since birds are less immune suppressed by co-infections, the biosecurity mediated immune protection that is incorporated into vaccination programs is extremely advantageous (Abd El-Hack et al., 2021).

#### **Contribution to Antibiotic Reduction**

A further benefit of biosecurity is that it helps decrease antibiotic applications in poultry raising. Chronic bad hygiene and biosecurity causes heavy reliance on antimicrobials that cause resistance. The use of biosecurity measures to reduce incidence of disease outbreaks (Manyi-Loh et al. 2018). Substantial reduction of antimicrobial use in the EU was achieved through compliance with stringent biosecurity protocols at the farm level, limiting the contact of AMR pathogens with food-producing animals and, consequently, humans (Collineau et al., 2017).

### **Impact of Biosecurity on Poultry Production**

The fast growth and FCR of broilers maintained under stringent bio-security measures confirmed the role of bacterial sero-prevalence in poultry production. Reduced pathogen load and thus subclinical infection due to less-concentrated, more-natural dietary formulations liberated nutrients from the energy cost of immune defense and increased allocation of nutrients to growth. For example, in a European survey, low AB use was linked to high quantification of internal biosecurity scores (i.e., feed conversion ratio as a proxy of farm technical performance) and a good hygiene management (Mallioris et al., 2022). In comparison, the disease burden and growth and feed efficiency in farms with high compliance to biosecurity practices consisting of essential (proper biosecurity practices) and secondary (not directly related to biosecurity but influence a broader scope of risk mitigation) components of biosecurity are less than low compliance (Ziebe et al., 2025).

## Effects of Egg Production and Quality on Adjusted Egg Number and Performancea

In layer production, biosecurity reduces egg production variations and improves egg quality by reducing possibly respiratory, enteric and another infection. The lower antimicrobial use associated with higher biosecurity changed the balance for maintaining hen-day egg rate and increasing shell quality (EIP-AGRI Focus Group ( 2021 )). In contrast, at the time of avian influenza discovery these herds produced significantly higher egg production than low biosecurity level cohorts in years with no avian influenza outbreaks (Martin et al., 2018) vice versa in avian influenza- justified regions.

Enhances savings, efficiency, and sustainability without any new potentials for positive economic impacts.

From the economic perspective, it is profitable as biosecurity decreases mortality rate which in turn brings down veterinary costs and feed conversion inefficiency. Bao et al. Introduction Specific veterinary and biosecurity interventions Smallholder chicken farms (2024)The matching of targeted, cost-effective reductions in disease costs with income stability among smallholder chicken farms Cross-sectional studies<sup>463</sup> in non-European countries<sup>464–466</sup> have also shown lower use of antimicrobials as mandatory biosecurity plans have promoted harmonisation of sustainability targets, and influenced the long term competitiveness of the poultry markets<sup>464465</sup>,Mahmood et al. 2025). Adoption of biosecurity needs to be looked at from the economic perspectives, as the cost- benefit analysis and economic sustainability remain drivers of decision-making processes of farmers (Palani, 2025a) (Palani, 2025b)

### Case report and literature review (2020–2025)

These case studies focus on recent experiences related to the value of biosecurity. More generally, there was ten times more likely that farms with poor compliance to biosecurity will experience outbreaks with caused a mild or moderate loss of productivity than those biosecured farms, revealing a broader stratified approach to upgrade is needed across the country (Akter et al., 2025). However, it should be noted that on the farm level studies among small scale broiler producers in Cameroon, farmers in some cases perceived better performance (lower mortality and higher weight gain), higher compliance to recommendations, and higher advisor knowledge with higher compliance to recommendations (Ngom et al., 2025). Biosecurity of US poultry billion\$ 2025 whilst HP AI hyper-constrains the egg market b/c HP egg production support (The Washington Post, 2025; The Guardian, 2025)—On the flip of such societal interests to biosecurity)

## Challenges and Future Perspectives in Poultry Biosecurity

While there is a clear advantage to the implementation of biosecurity, formal biosecurity management in commercial poultry in the developing world is essentially non-existent. Important constraints include financial difficulty, ignorance of farmers, lack of veterinary services and weak enforcement of regulations (Conan et al., 2012).

Smallholder and village chickens produce a high proportion of the poultry meat and the eggs in those areas however, limited access to resources to invest in infrastructure, for example fencing, quarantine unit or disinfection unit has been reported (Akter et al. 2005). These voids are created by a very high sensitivity to epizootic events in areas in which both avian influenza and Newcastle disease are enzootic.

### Cost–Benefit Considerations

Although biodetection & biosecurity needs to be taken seriously, and supported by facilities, personnel and training and monitoring, a multitude of studies show that long-term benefits of investments heavily outweigh any costs (Cutting et al. 2021). Bao et al. (2024) delivered through well organised veterinary and biosecurity measures reduced disease loss and increased profit for smallholders.

Similarly, Mahmood et al. Policy framework reform to align with Europe biosecurity enforcement led economies supported through decreased consumption of antimicrobials and stabilized production (2025). But in terms of cost–benefit outcomes, scale matters: biosecurity has a more potent positive effect on gross margins in large, commercial enterprises, whereas smallscale farms require high levels of subsidy or cooperation models to share costs among farms.

### Integration with Modern Technology

Biosecurity improvements and the evolution of digital farming solutions. Moreover, early indications of livestock flock health and farm environmental conditions, e.g. farm level visitor management, can also be monitored using sensors, automated data loggers, and artificial intelligence (AI)(Rothwell et al., 2021).

In this project, ML technologies use movement and biosecurity compliance data, model disease risk, and inform interventions before disease is established Github CCTV, smart doors and other in-farm technologies will reduce human error and improve accountability for biosecurity.

The protective effect and in vivo pharmacological role of natural antioxidants (e.g. crocin) have been reviewed in recent years (Mhamad & Palani, 2025; (10) Mhamad, Palani & AL-Zubaidy, 2025) and the antioxidant compound crocin has been suggested as an ideal candidate for enhancing gut health in birds reared under intensive production systems (10, 11).

Previous studies in ruminants have demonstrated the effects of dietary manipulations such as plant (supplements) and trace element supplementation on animal health, oxidative stress and reproductive performance, suggesting a broader benefit of nutritional strategies targeting resilience to reduce susceptibility to disease (Palani et al., 2024; Palani, Ameen & Shekhani, 2025; Palani et al., 2025a; Palani et al., 2025b; Palani et al., 2014).

### Implications for Research and Practice

It is therefore necessary to explore in more depth contextualized responses that adapt the biosecurity concept to the specific requirements of smallholder livestock owners under resource-poor conditions. Including inexpensive methods of disinfection, home-quarantine, as well as health communication using mobile devices for animals [25]

Furthermore, there are challenges to determining the combination of precision farming technologies which are biosecurity feasible, and practical, and cost-effective data-driven interventions to curb disease. At the policy level, for example, enabling uptake calls for design of incentive-based structures by government and international organizations while research need to be targeted on a systems basis in the scope of One Health where poultry biosecurity aspects are embedded within food safety, overall public health, and antimicrobial resistance mitigation approaches.

### Conclusion

Thus, we can conclude, biosecurity, a constant pillar of poultry health. Well-implemented inside and outside biosecurity reduces the rate of large bacterial diseases, protects chickens from critical production and health losses, and strengthens the flock's immune response according to research. Just like vaccination programs that have initiated simultaneous with modern technology that is expected to support clear disease prevention and therefore expected to reduce dependence on antibiotic. Economically, biosecurity promotes better feeding efficiency, regular egg production, and long-term sustainability of the poultry industry. While this will be very hard to implement (especially in developing countries that are currently poorly served by these strategies), efficient biosecurity investment that can pinpoint novel avenues such as AI and precision agriculture methods must take place in the coming decades.

## References

1. Abd El-Hack, M. E., El-Saadony, M. T., Shafi, M. E., Zaberemawi, N. M., Arif, M., Batiha, G. E., Khafaga, A. F., Abd El-Hakim, Y. M., & Alagawany, M. (2021). Probiotics in poultry feed: A comprehensive review. *Journal of Animal Physiology and Animal Nutrition*, 105(2), 769–784. <https://doi.org/10.1111/jpn.13574>
2. Ahmed, I., Khan, A., & Jamil, T. (2022). Assessment of biosecurity practices in commercial poultry farms: Implications for disease control and productivity. *Veterinary Medicine and Science*, 8(5), 2097–2106. <https://doi.org/10.1002/vms3.864>
3. Akter, S., Rahman, M., Sultana, R., & Kabir, M. H. (2025). Biosecurity practices in commercial chicken farms in Bangladesh: A nationwide assessment. *International Journal of Infectious Diseases: One Health*, 35, 112–120. <https://doi.org/10.1016/j.onehlt.2025.100635>
4. Alwan, A. S., Majid, A. F., & Ismail, H. I. (2018a). The effect of using some hormonal treatments on some reproductive performance traits in Awassi ewes. *Kirkuk University Journal for Agricultural Sciences*, 9(4), 17–23.
5. Alwan, A. S., Majid, A. F., & Ismail, H. I. (2018b). The effect of a hormonal program on some physiological and biochemical blood traits in Awassi ewes. *Kirkuk University Journal for Agricultural Sciences*, 9(4), 52–59.
6. Bao, T. D., Bui, V. N., Tran, P. V., & Pham, H. T. (2024). Economic assessment of an intervention strategy to reduce disease costs in small-scale chicken farms. *One Health*, 17, 100579. <https://doi.org/10.1016/j.onehlt.2024.100579>
7. Collineau, L., Belloc, C., Stärk, K. D. C., Häslér, B., Rushton, J., & Rüegg, S. R. (2017). Guidance on the definition of antimicrobial use indicators for monitoring AMU in animals. *Epidemiology & Infection*, 145(8), 1513–1523. <https://doi.org/10.1017/S095026881700018X>
8. Conan, A., Goutard, F. L., Sorn, S., & Vong, S. (2012). Biosecurity measures for backyard poultry in developing countries: A review. *BMC Veterinary Research*, 8(240), 1–10. <https://doi.org/10.1186/1746-6148-8-240>
9. Dorea, F. C., Berghaus, R. D., Hofacre, C. L., & Cole, D. J. (2020). Survey of biosecurity protocols and practices adopted by commercial poultry farms. *Avian Diseases*, 64(3), 350–358. <https://doi.org/10.1637/aviandiseases-D-20-00023>
10. EIP-AGRI Focus Group. (2021). Reducing antimicrobial use in poultry farming: Final report. European Commission. <https://ec.europa.eu/eip/agriculture/en/publications>
11. FAO. (2020). Biosecurity guide for live poultry markets. Food and Agriculture Organization of the United Nations. <http://www.fao.org/3/ca7612en/ca7612en.pdf>
12. Gelaude, P., Schlepers, M., Verlinden, M., Laanen, M., & Dewulf, J. (2014). Biocheck.UGent: A quantitative tool to measure biosecurity at broiler farms and the relationship with technical performances and antimicrobial use. *Poultry Science*, 93(11), 2740–2751. <https://doi.org/10.3382/ps.2014-04002>
13. Mahmood, Q., Hassan, M., & Petrovic, M. (2025). Mapping biosecurity mandates across 22 EU and non-EU countries: Policy implications for poultry farming. *Preventive Veterinary Medicine*, 223, 105954. <https://doi.org/10.1016/j.prevetmed.2025.105954>
14. Mallioris, P., Ge, L., Garcia, S., & Dewulf, J. (2022). Biosecurity and antimicrobial use in broiler farms across Europe: Drivers and statistical modeling. *One Health*, 15, 100443. <https://doi.org/10.1016/j.onehlt.2022.100443>
15. Manyi-Loh, C., Mamphweli, S., Meyer, E., & Okoh, A. (2018). Antibiotic use in agriculture and its consequential resistance in environmental sources: Potential public health implications. *Molecules*, 23(4), 795. <https://doi.org/10.3390/molecules23040795>

16. Martin, V., Sims, L., Lubroth, J., & Domenech, J. (2018). Prevention and control of avian influenza in poultry. *World's Poultry Science Journal*, 74(2), 149–164. <https://doi.org/10.1017/S0043933918000250>
17. Mhamad, H. J., & Palani, Z. M. R. (2025). Pharmacological active crocin (antioxidant) in saffron: A review. *Spanish Journal of Innovation and Integrity*, 38, 8–17. Retrieved from <https://sjii.es/index.php/journal/article/view/169>
18. Mhamad, H. J., & Palani, Z. M. R. . (2025). Pharmacological Active Crocin (Antioxidant) in Saffron: A Review. *Spanish Journal of Innovation and Integrity*, 38, 8–17. Retrieved from <https://sjii.es/index.php/journal/article/view/169>
19. Mhamad, H. J., Palani, Z. M. R., & Al-Zubaidy, A. (2025). Investigation of the chemical compounds, antioxidant effect and therapeutic properties of *Crocus sativus* L. (Iridaceae): A review. *Indonesian Journal of Innovation and Applied Sciences (IJIAS)*, 5(1), 89–98. <https://doi.org/10.47540/ijias.v5i1.1829>
20. Mhamad, H. J., Palani, Z. M. R., & AL-Zubaidy, A. . (2025). Investigation of the Chemical Compounds, Antioxidant Effect and Therapeutic Properties of *Crocus sativus* L. (Iridaceae): A Review. *Indonesian Journal of Innovation and Applied Sciences (IJIAS)*, 5(1), 89-98. <https://doi.org/10.47540/ijias.v5i1.1829>
21. Mottet, A., & Tempio, G. (2017). Global poultry production: Current state and future outlook and challenges. *World's Poultry Science Journal*, 73(2), 245–256. <https://doi.org/10.1017/S0043933917000071>
22. Ngom, R. V., Ayebare, D., & Kouame, A. (2025). Relation between farm biosecurity compliance and poultry production performance: Evidence from broiler farms in Cameroon. *Poultry Science*, 104(6), 2219–2230. <https://doi.org/10.3382/ps/peae107>
23. Palani, P. M. R. . (2025). Residential Crisis in Iraq: The Current Trends and Future Prospectus: A Review. *Spanish Journal of Innovation and Integrity*, 38, 121–128. Retrieved from <https://sjii.es/index.php/journal/article/view/185>
24. Palani, P. M. R. . (2025). The Relationship of International Loans to Credit Wall (Worthiness): A Review. *Spanish Journal of Innovation and Integrity*, 38, 1–7. Retrieved from <https://sjii.es/index.php/journal/article/view/168>
25. Palani, Z. M. R., Ameen, G. W., & Shekhani, D. N. M. (2025). The Role of Lead and Molybdenum and Their Effects on Oxidative Stress in Ruminant Animals: Subject Review. *Nabatia*, 13(2), 104–115. <https://doi.org/10.21070/nabatia.v13i2.1665>
26. Palani, Z. M. R., Hamasalim, H. J. ., Abdualmajeed, O. M. ., Baqer, J. M. ., Omer, M. E. A. ., Mohammed, H. N. ., & Bchkol, D. H. K. . (2024). Biochemical Changes in Blood Serum after Selenium and Zinc Doses and their Effect on the Health and Environment of Kurdi Sheep in Kurdistan Region. *Indonesian Journal of Social and Environmental Issues (IJSEI)*, 5(3), 299-305. <https://doi.org/10.47540/ijsei.v5i3.1674>.
27. Rothwell, C. J., Stephenson, R., & Bracewell, L. (2021). Emerging technologies in poultry production: Applications for biosecurity and disease control. *Veterinary Research*, 52(1), 95. <https://doi.org/10.1186/s13567-021-00978-5>
28. Sajjadi, N. C., [et al.] (2025). Vaccination and surveillance for high pathogenicity avian influenza: A comprehensive evaluation. *Preventive Veterinary Medicine*, 224, 105987. <https://doi.org/10.1016/j.prevetmed.2025.105987>
29. Sharma, P. K., Chatterjee, R. N., & Rajkumar, U. (2020). An overview of poultry production in developing countries. *Journal of Applied Animal Research*, 48(1), 126–133. <https://doi.org/10.1080/09712119.2020.1733892>

30. Ssematimba, A., Hagenaars, T. J., & de Jong, M. C. (2019). Modelling the effectiveness of biosecurity measures in preventing between-farm transmission of avian influenza. *Preventive Veterinary Medicine*, 168, 41–50. <https://doi.org/10.1016/j.prevetmed.2019.04.001>
31. The Guardian. (2025, February 13). US pledges \$1 billion to bolster poultry biosecurity amid bird flu crisis. Retrieved from <https://www.theguardian.com>
32. The Washington Post. (2025, February 14). Bird flu prompts \$1 billion US response to secure poultry farms. Retrieved from <https://www.washingtonpost.com>
33. van Steenwinkel, S., Ribbens, S., Ducheyne, E., Goossens, E., & Dewulf, J. (2018). Assessing biosecurity practices, movements and density of poultry sites across Belgium, resulting in different farm risk scores for epidemic diseases. *Preventive Veterinary Medicine*, 153, 45–55. <https://doi.org/10.1016/j.prevetmed.2018.02.014>
34. Ziebe, S. D., Larsen, P., & Jensen, H. (2025). Impact of biosecurity on poultry production performance and antimicrobial use: A systematic review. *Veterinary Research*, 56(1), 77. <https://doi.org/10.1186/s13567-025-01054-8>
35. Zikibayeva, K. B., Svanbayev, Z., Akhmetsadykov, J., Kudaibergenova, N., Akhmetsadykova, A., Nurola, A., & Kydyrmanov, T. (2025). Epidemiological investigation of poultry infectious diseases in Kazakhstan: Outbreak patterns and implications for vaccination and biosecurity. *Veterinary World*, 18(2), 295–303. <https://doi.org/10.14202/vetworld.2025.295-303>
36. Palani, P. M. R. . (2025). Residential Crisis in Iraq: The Current Trends and Future Prospectus: A Review. *Spanish Journal of Innovation and Integrity*, 38, 121–128. Retrieved from <https://sjii.es/index.php/journal/article/view/185>
37. Palani, P. M. R. . (2025). The Relationship of International Loans to Credit Wall (Worthiness): A Review. *Spanish Journal of Innovation and Integrity*, 38, 1–7. Retrieved from <https://sjii.es/index.php/journal/article/view/168>