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# EFFECTS OF BIOSECURITY PRACTICES ON THE HEALTH MANAGEMENT SYSTEM OF POULTRY FARMS IN NIGERIA

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RESEARCH ARTICLE

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**ABSTRACT**: The purpose of the study was to determine how Oyo State, Nigerian biosecurity strategies, affected the poultry health management system. The regional data were collected through a planned investigation. The 120 respondents were selected using random and purposeful sampling approaches. The analysis revealed that 43.3% of poultry farmers were between the ages of 31 and 40; the majority were men; 72.5% were married; 37.5% had been in farming for between 11 and 20 years, and 95.5% had one to six children. Most farmers (75.8%) reported that raising poultry was their main source of income; 70.8% stated they got their information from the farmers' association; 95.0% stated burning birds reduced susceptibility to infectious diseases, and nearly all (99.2%) stated keeping foot dips in place stopped the spread of infectious diseases. According to the regression analysis, there is a strong correlation between respondents' age, sex, marital status, agricultural experience, family size, source of income, and adoption of biosecurity methods in the research region. The greatest and most affordable way of infection protection can be found in biosecurity. Without appropriate biosecurity measures, no single disease prevention program will succeed. It is can be concluded that the introduction of additional biosecurity measures could be a significant boost to the prevention and spread of poultry diseases in the study area.

**Keywords:** Biosecurity strategies, Commercial Farm, Health Management Practices, Infection protection, Poultry.

## INTRODUCTION

Poultry occupies a sizable portion of the creature kingdom, with little commerce and sometimes expansive legal frameworks that overwhelm the industry, especially in agricultural countries according to Conan et al. (2012). Adene and Oguntade (2006) reported that about 70% of grills cultivated globally are grown in indoor, severe cultivation frameworks that are extremely similar to one another, in poultry breeding. Furthermore, broilers and occasionally egg-laying birds are commonly raised using deep litter systems with wood shavings to contain the chicken excrement (Riber et al., 2018; Prasai et al., 2018). If not promptly and securely managed by the farmers, this typically results in respiratory illnesses in chickens, sores, and zoonotic diseases (Munir et al., 2019; Bello and Oriola, 2020)

Consequently, the measures taken to prevent the emergence and spread of disease-causing natural agents in flocks of poultry is refers to biosecurity. Poultry producers should practice daily biosecurity measures due to the concentration of poultry surges in energy business creation projects in terms of size and area as well as the typical disorder risks associated with this type of creation (Maduka et al., 2016). According to Cunningham and Fairchild (2020), routine biosecurity measures can reduce the likelihood of birds being exposed to transmissible diseases like Avian Flu and Colorful Newcastle on poultry farms as best management practices.

In addition, modern bird health programs include biosecurity measures to reduce the spread of infectious illnesses across farms and inside individual farms (Dorea et al., 2010). According to Abdelqader et al., (2007), weak biosecurity measures and poor disease control techniques lead to high baseline death rates from infectious illnesses. In addition to assisting in the elimination of management risks brought on by environmental factors like human and animal contact with the poultry environment, biosecurity can prevent financial losses in the poultry farm. Executing biosecurity involves planning, attention, resources, and a perspective of heightened risk and loss of reward (Conan et al., 2012).

However, preventing the spread of infectious illnesses also helps farmers make less money by lowering the expense of treating the infections and the losses brought on by bird death. Additionally, failure to get biosecurity estimates from small-business poultry boards will unquestionably jeopardize biosecurity standards in the modern poultry sector (Negro-calduch et al., 2013). Biosecurity measures are a combination of frameworks and procedures to lessen the presence of



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any disease-deliverers on ranches and so prevent the negative effects of diseases on farms according to Ajewole and Akinwumi (2014).

Despite the industry's strengths and prospects, issues that jeopardize the sustainability of the sector and continued expansion are encountered by poultry producers. It is impossible to ignore the connection between these difficulties and biosecurity measures, which endanger the viability of the poultry business. In light of this context, the following objectives of this study include identifying the personality traits of commercial poultry farmers, figuring out the respondents' sources of information regarding the use of biosecurity practices, determining the respondents' benefits derived from and effectiveness of biosecurity measures, and figuring out the variables influencing the respondents' use of biosecurity in the study area.

## MATERIALS AND METHODS

Registered poultry farmers made up the study's population in Nigeria, which was conducted in the state of Oyo. The farmers were contacted to seek their consent before going ahead with the administration of the questionnaire for ensuring ethical allowance of study.

Due to the significant number of commercial farmers in Oyo State's Ido, Oluyole, Akinyele, and Egbeda local governments who are registered with the Nigerian Poultry Association, a purposive sample of these four local governments was chosen. From among the Poultry Association of Nigeria members in each of the local government areas, thirty poultry producers were chosen at random, totaling one hundred and twenty responses. A structured interview schedule was used to gather data from the farmers. Both descriptive statistics (frequency counts, percentages, and averages) and inferential statistics were used to examine the acquired data (regression). Regression analysis is a statistical method used to estimate relationships between dependent variables and one or more independent variables. It can be used to evaluate the strength of the relationship between variables and for forecasting the future relationship between them.

The general equation of each type of regression model is:

Linear regression equation:

$Y=a+bX+bX1+bX2+bX3+ bX4+..... u$

Where,

a = constant; *u*= error term; Y= Biosecurity; X1 = AGE; X2 = Sex; X3 = Marital Status; X4 = Farming Experience; X5 = Size of family; X6 = Source of income; X7 = Membership of Association.

## RESULTS AND DISCUSSION

According to Table 1, 43.3% of respondents are between the ages of 31 and 40, 24.2% are between the ages of 41 and 50, and just 10.8% are between the ages of 51 and 60. The majority of responders (70.0%) were men, while just 30.0% were women. Additionally, 10.0% of respondents were divorced, 17.5% were single, and 72.5% of respondents were married. Only 3.3% of respondents had between 41 and 50 years of agricultural experience, compared to 59.2% who had between 1 and 10 years of farming experience and 37.5% who had between 11 and 20 years. Less than half (48%) of the respondents had families with 1-3 members, 47.5% had families with 4-6 members, and 6.7% had 7-9 members per home.

The respondents' age range is deemed to be young, and as a result, they still possess the strength to operate their farms successfully. Poultry farming is a serious endeavour that calls for young farmers to become accustomed to strict biosecurity procedures. This finding agrees with Akpan (2010) argument that youth participation in broiler production has to be increased. In the study area, men are more involved in commercial poultry production, and the majority of them are married, which comes with more responsibilities than being single. As a result, they need to diversify their sources of income to meet household expenses.

However, the average family size was just four people. As a consequence of their modest family sizes, the respondents entered the lucrative commercialized poultry farm production industry and improved their quality of life by providing a healthy diet for their families. This concurs with Arthur (2009) observation that smaller families have better economic and social circumstances, which has a significant impact on a better knowledge of farming. Table 1's data showed that 75.8% of the respondents exclusively farmed poultry as a source of income, whereas 24.2% of the respondents also earned a wage. While 6.7% of farmers and 15.0% of Nigerian Association of Animal Health and Husbandry Technologists members were members of the farmers' association, 23.3% of cooperative society members were (NAAHHT). This suggests that most responders could maximize their output since they were generally dependable.

According to Adene and Oguntade (2006) research, respondents' participation in one or more social organizations helped their farming businesses grow. Being a member of a cooperative or farmers' association gave farmers more access to training sessions offered by those organizations, a channel for requesting government assistance, and chances to raise their quality of life.



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**Table 1** - Distribution of respondents according to socio-economics characteristics of poultry farmers.

| Variables | | Frequency | Percentage | Mean |
|---|---|---|---|---|
| Age | Below 20 | 3 | 2.5 | 36 |
| | 21 – 30 | 23 | 19.2 | |
| | 31 – 40 | 52 | 43.3 | |
| | 41 – 50 | 29 | 24.2 | |
| | 51 – 60 | 13 | 10.8 | |
| | Above 60 | - | - | |
| Sex | Male | 84 | 70.0 | |
| | Female | 36 | 30.0 | |
| Religion | Christianity | 96 | 80.0 | |
| | Islam | 24 | 20.0 | |
| Marital status | Married | 87 | 72.5 | |
| | Single | 21 | 17.5 | |
| | Divorced | 12 | 10.0 | |
| | Widow | - | - | |
| Farming experience | 1 – 10 | 71 | 59.2 | 6 |
| | 11 – 20 | 45 | 37.5 | |
| | 21 – 30 | 0 | 0.0 | |
| | 31 – 40 | 0 | 0.0 | |
| | 41 – 50 | 4 | 3.3 | |
| Family size | 1 – 3 | 55 | 45.8 | 4 |
| | 4 – 6 | 47 | 47.5 | |
| | 7 – 9 | 8 | 6.7 | |
| Source of income | Salary | 91 | 24.2 | |
| | Self employed | 29 | 75.8 | |
| Member of association | Cooperative | 28 | 23.3 | |
| | Farmers' Association | 8 | 6.7 | |
| | NAAHHT | 18 | 15.0 | |
| | NIAS | 12 | 10.0 | |
| | Poultry Association of Nigeria | 14 | 11.7 | |

*NAAHHT- Nigerian Association of Animal Health and Husbandry Technologists- NIAS-Nigeria Institute of Animal Science

**Table 2** - Respondents' distribution according to sources of information of poultry farmers

| Variable | Yes (%) | Frequency of use | |
|---|---|---|---|
| | | Regular (%) | Occasional (%) |
| Veterinarian | 69.2 | 60.0 | 9.2 |
| Farmer's association | 70.8 | 65.0 | 5.8 |
| Friends and relatives | 59.2 | 56.2 | 3.0 |
| Internet | 58.3 | 43.3 | 15.0 |
| Research institutes/universities | 59.2 | 44.0 | 15.2 |
| Television | 58.3 | 40.0 | 18.8 |

**Source of Information**

Table 2 data shows that 69.2% of respondents and 70.8% of respondents, respectively, obtained their information from veterinarians and farmers' groups, respectively. Moreover half (59.2%) of the respondents stated that they acquired their knowledge from research institutions and friends/family, respectively. However, 58.3% stated they acquired their knowledge via the internet, while 58.3% watched television to get their information.

Given their proximity to and regular attendance at farmers' associations, where important information and concerns relevant to their poultry company are being addressed, it may be inferred that the majority of respondents obtained their knowledge from these organizations. This strengthens the rationale for why joining friendly organizations has a significant influence on how biosecurity is used. Maningas et al. (2005) contest the notion that having data in farmers' possession entails control over their resources and dynamic cycles.

Table 2 shows the respondents' distribution according to the source of information and its benefits derived from the use of biosecurity measures. Table 3 demonstrates that the majority of respondents adhered to nearly all biosecurity measures, including restricting access to the farm for people and equipment, using disinfectants, administering vaccinations when necessary, and fencing poultry farms among others. Burning dead birds lowers susceptibility to



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infectious diseases. Therefore, biosecurity measures enable farmer's easy-to-use, cost-effective ways to secure their farms, while extension services should be improved to provide enough training to promote output and increase food supply.

Additionally, the majority of respondents exercised biosecurity, such as burning dead birds to lower susceptibility to infectious illnesses and using disinfectants to lower the transmission of infections. Farmers are urged to check their flocks daily if they exhibit any of the following symptoms: a lack of appetite, green or yellow diarrhoea, and watery manure, birds who are struggling to breathe, coughing or sneezing, have decreased egg production.

In filthy conditions, parasitic, bacterial, and viral infections can persist for weeks or even months, but the application of disinfectants reduces mortality and increases the survival rate of the supplied birds. These steps will help to keep infections from spreading and to preserve a thriving and successful chicken industry. Cleanliness and effective biosecurity go hand in hand. This shows that more respondents believe using disinfectants to be extremely useful, which is consistent with Sharma (2010) results.

Table 3 shows the distribution of respondents' benefits derived from the use of biosecurity measures. According to Table 4, the majority of respondents (99.2%, 93.3%, 95%, 88.3%, 85%, 89.1%, and 94.1%, respectively) agreed that "maintenance of foot dip, provision of quality feed," "regular disinfection of poultry equipment and tools," "regular medication/vaccination of birds," and "quarantine of new stock" are efficient ways to ensure biosecurity measures and have reduced the spread of infectious diseases. Given the research conducted by Alhaji and Odetokun (2011) and Henning et al. (2011). According to Sharma (2010), visitors to poultry barns may exhibit severe diseases.

Therefore, a foot dip should be available. In order to eliminate disease specialists from chicken buildings, Mccrea and Bradley (2008) argue that disinfection is essential. Sanitizer footbaths could help reduce the amount of life on boots, but to maintain effectiveness, the sanitizer has to be changed on a regular basis. These have significant effects on reducing the spread of contagious poultry diseases by humans and are important for general health in relation to a few poultry diseases. However, Fasina et al. (2012) observed that failure to implement these biosecurity measures may be due to ignorance, exposure, lack of knowledge, and a lack of equipment.

Table 4 shows the effectiveness of biosecurity measures employed by the respondents. Table 5 shows the outcome demonstrates the importance of age ($P<0.000$), sex ($P<0.013$), married status ($P<0.042$), farming experience ($P<0.000$), family size ($P<0.001$), and financial source ($P<0.032$) to biosecurity measures in chicken production. Farmers of a certain age will benefit more from biosecurity, and Langy and Mekura (2005) found that older farmers had larger wealth accumulation. Additionally, it is believed that older farmers are superior to younger ones since they have more knowledge and experience.

Farmer's experience gained through learning by doing among farmers themselves or by observation or training from different organizations is essential because it will make farmers more effective and efficient because they will have a better understanding of biosecurity practices (Oluwatayo et al., 2008). In this regard, Table 5 shows the factors influencing the use of biosecurity among poultry farmers. Furthermore, financial accessibility ensures that poultry producers have access to practice the majority of these biosecurity measures.

**Table 3 -** Distribution of respondents' benefits derived from the use of biosecurity measures among farmers

| Benefits | Yes | Highly Beneficial | Beneficial | Not Beneficial |
|---|---|---|---|---|
| Burning of dead birds reduce susceptibility to infectious disease | 114 (95%) | 98 (81.7%) | 10 (8.3%) | 6 (5.0%) |
| Use of disinfectants reduces the spread of infectious diseases | 108 (90.0%) | 90 (75.0%) | 18(15.0%) | - |
| Regular washing of overalls and boot for field workers and visitors reduced susceptibility to infectious diseases | 98 (81.7%) | 91(75.8 %) | 7(5.8%) | - |
| Regular cleaning and draining of slaughter house limits the spread of disease | 112 (93.3%) | 97 (80.8%) | 15(12.5%) | - |
| Fenced poultry farm limits entrance of pests reduces evasion of poultry farm | 109 (90.8%) | 92 (76.7%) | 17(14.2%) | - |
| Provision of quarantine pen reduces the spread of diseases | 103 (85.8%) | 91 (75.8%) | 8(6.7%) | 4 (3.3%) |
| Use of disinfectants suppress mortality | 108 (90%) | 105 (87.5%) | 3(2.5%) | |
| Burying of dead animals reduce the spread of infectious diseases | 76 (63.3%) | 56(46.7%) | 8 (6.7%) | 12 (10.0%) |



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**Table 4 -** The effectiveness of biosecurity measures employed by the respondents

| Biosecurity | Yes (%) | Very effective | Not effective |
|---|---|---|---|
| Maintenance of foot dip | 119 (99.2%) | 119 (99.2%) | - |
| Provision of good quality water | 75 (62.5) | 75 (62.5) | - |
| Provision of quality feed | 112 (93.3%) | 112 (93.3%) | - |
| Regular disinfection of poultry equipment and tools | 114 (95.0%) | 112 (93.3) | 2 (1.7) |
| Distance disposal lacking of litter/poultry waste. | 87 (72.5%) | 85(70.8) | - |
| Regular medication/Vaccination of birds | 106 (88.3%) | 106 (88.3%) | - |
| Restriction of movement of customer's vehicles. | 98 (81.7%) | 91 (75.8%) | 7(5.8) |
| Regular culling of sick birds | 106 (88.3%) | 106 (88.3%) | - |
| Regular washing of disinfection of protective clothing's | 85 (70.8%) | 75 (62.5%) | 10.0 (8.3%) |
| Regular sanitation of the pen. | 102(85.0%) | 98 (81.7%) | 4 (3.3) |
| Quarantine of new stock | 107 (89.1%) | 105 (87.5%) | 2 (1.7) |
| Physical examination of birds against deformities | 113 (94.1%) | 111 (92.5%) | 2 (1.7) |

**Table 5 -** The factors influencing the use of biosecurity among poultry farmers

| Variable | Coefficient | Std. Error | T-value | Significant |
|---|---|---|---|---|
| (Constant) | 1.697 | 0.174 | 9.761 | 0.0001 |
| Age | -0.126 | 0.034 | -3.688 | 0.0001[a] |
| Sex | -0.136 | 0.054 | -2.538 | 0.013[a] |
| Marital status | -0.148 | 0.072 | -2.071 | 0.042[a] |
| Farming experience | 0.040 | 0.006 | 6.784 | 0.000[a] |
| Size of family | -0.061 | 0.017 | -3.646 | 0.001[a] |
| Source of income | 0.207 | 0.094 | 2.193 | 0.032[a] |
| Membership of association | -0.018 | 0.014 | -1.266 | 0.210 |
| Adjusted $R^2$ | 0.557 | | | |
| P-Value | 0.000 | | | |

*Note $x^a$ – superscript a means significant

## CONCLUSION

According to the study's conclusions, the majority of respondents were married (72.2%), young men (43.3%), with an average family size of four, and had an average amount of agricultural experience of six years. They were also self-employed. The findings imply that most farmers do follow biosecurity regulations which assisted them to prevent and combat the spread of diseases, however, it is still important to take the required procedures to manage arriving animals and people on and around the farm. Because any biosecurity flaw will be disastrous, it is important to promote ongoing training in current biosecurity practices. Therefore, provincial collaboration may streamline the feasibility of a biosecurity program. Any level of biosecurity is beneficial, but the program will be more effective overall if optimal management practices are used by all poultry producers in a particular area. Thus, consistently practicing strong biosecurity measures as part of the best management program can help to reduce the likelihood of contracting a disease, slow the spread of infection in the event of an epidemic, and inevitably boost farmer profits.

## DECLARATIONS

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**Author's contribution**
This work is a project work by G.O. Adeleke supervised by Prof. F.A. Aderemi, co supervised by Dr. Adebamiji Ayandiji. Adebamiji Ayandiji drafted the manuscript while Prof. Aderemi proofed read it.

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## REFERENCES


Abdelqader A, Wollny C, Gauly M (2007) Characterization of local chicken production systems and their potential under different levels of management practice in Jordan. Tropical Animal Health Production, 39: 155-164. Doi: https://doi.org/10.1007/s111250–007-9000x

Adene DF and AE Oguntade (2006) The structure and importance of the commercial and village based poultry industry in Nigeria. Poultry Production Systems, FAO, Rome, Italy, pp: 1-102. https://www.inter-reseaux.org/wp-content/uploads/pdf_poultrysector_nga_en.pdf

Adeosun KP, Ume CO, and Ezugwu RU (2019) Analysis of socio-economic factors of fish pond production in Enugu State, Nigeria. Journal of Tropical Agriculture, 57(1): 27-34. http://www.jtropag.kau.in/index.php/ojs2/article/view/654

Ajewole OC and Akinwumi, AA (2014) Awareness and Practice of Biosecurity Measures in Small Scale Poultry Production in Ekiti State, Nigeria. IOSR Journal of Agriculture and Veterinary Science, 7(11):24-29. https://www.iosrjournals.org/iosr-javs/papers/vol7-issue11/Version-1/D071112429.pdf

Akpan SB (2010) Encouraging Youth Involvement in Agricultural Production and Processing in Nigeria. Policy Note, 29, International Food Policy Research Institute, Washington DC. Article link

Alhaji NB, and Odetokun IA (2011) Assessment of biosecurity measures against Highly Pathogenic Avian Influenza risks in small-scale commercial farms and free-range poultry flocks in the North central Nigeria. Transboundary Emerging Diseases, 58(2):157–161. https://doi.org/10.1111/j.1865-1682.2010.01195.x

Arthur ED (2009) Food Security Initiatives in Nigeria: Prospects and Challenges. Journal of Sustainable Development Africa, 11(1): 186-202. https://dx.doi.org/10.2139/ssrn.3584225

Bello RO, and Oriola KO (2020) Level of health risk among poultry workers in Nigeria. Journal of Research in Forestry, Wildlife and Environment, 12(4):10-18. https://www.ajol.info/index.php/jrfwe/article/view/204316

Conan A, Goutard F, Sorn S and Vong, S (2012) Biosecurity measures for backyard poultry in developing countries: A systematic review. BMC Veterinary Research, 8 (1): 240-250. DOI: https://doi.org/10.1186/1746-6148-8-240

Cunningham DL and Fairchild BD (2020) Biosecurity basics for poultry growers Extension Bulletin, no. 1306. https://extension.uga.edu/publications/detail.html?number=B1306

Dorea, FC, R Berghaus, C Hofacre and DJ Cole (2010) Survey of biosecurity protocols and practices adopted by growers on commercial poultry farms in Georgia, U.S.A. Avian Disease, 54: 1007-1015. DOI: https://doi.org/10.1637/9233-011210-reg.1

Fasina FO, Ali AM, Yilma JM, Thieme O and Ankers P (2012) The cost-benefit of biosecurity measures on infectious diseases in the Egyptian household poultry. Preventive Veterinary Medicine. 103 (2–3): 178-191 DOI: https://doi.org/10.1016/j.prevetmed.2011.09.016

Henning, KA, Henning J, Morton J, Long NT, Ha NT, Meers, J (2011) Farmand flock-level risk factors associated with Highly Pathogenic Avian Influenza outbreaks on smallholder duck and chicken farms in the Mekong Delta of Viet Nam. Prevention Veterinary Medicine, 91(2–4):179–188. DOI: https://doi.org/10.1016/j.prevetmed.2010.05.016

Langy A and Mekura M (2005) Modelling agricultural technology adoption using the software STAT. A paper presented at a training course organized by CIMMUT-ALP for its NARS partners in Southern Africa on the econometric application of modelling technologies. No. 378-2016-21410). - References - Scientific Research Publishing (scirp.org)

Maningas, RV, Perez, VO, Macaraig, AJ, Alesna WT, and Villagonzalo, J (2005) Electronic information dissemination through the farmers' information and technology services (FITS)/Techno Pinoy Program. Bringing Information and Technology within the Reach of the Farmers. from http://jsai.or.jp/afita/afitaconf/2000/part08/p231.pdf,2000

Maduka CV, Igbokwe IO, Atsanda NN (2016) Appraisal of chicken production with associated biosecurity practices in commercial poultry farms located in Jos, Nigeria. Scientifica, 2016: Article ID 1914692. https://doi.org/10.1155/2016/1914692

Munir MT, Belloncle C, Irle M, Federighi M (2019) Wood-based litter in poultry production: a review. World's Poultry Science Journal, 75(1): 5-16. https://doi.org/10.1017/S0043933918000909

Mccrea, BA and Bradley F A (2008) Biosecurity for poultry at community farms. University of California Division of Agriculture and Natural Resources Publication 8280. ANR CS Web site, https://escholarship.org/uc/item/0714x41v

Negro-calduch E, Elfadaly S, Tibbo M, Ankers P, and Bailey E (2013) Assessment of biosecurity practices of small-scale broiler producers in central Egypt. Preventive Veterinary Medicine, 110: 253-262. DOI: https://doi.org/10.1016/j.prevetmed.2012.11.014

Oluwatayo, IB, Sekumade, AB, Adesoji, SA (2008) Resource use efficiency of maize farmers in rural Nigeria, Evidence from Ekiti State. World Journal of Agricultural Science, 4(1): 91-99. https://www.adscientificindex.com/scientist/isaac-oluwatayo/99667

Prasai TP, Walsh KB, Midmore DJ, Jones BE, and Bhattarai SP (2018) Manure from biochar, bentonite and zeolite feed supplemented poultry: Moisture retention and granulation properties. Journal of environmental management, 216:82-88. https://doi.org/10.1016/j.jenvman.2017.08.040

Riber AB, Van de Weerd HA, De Jong IC, and Steenfeldt S (2018) Review of environmental enrichment for broiler chickens. Poultry science, 97(2):378-396. https://doi.org/10.3382/ps/pex344

Sharma B (2010) Poultry production management and bio-security measures. Journal of Agriculture and Environment, 11:120-125. DOI: https://doi.org/10.3126/aej.v11i0.3659