Jana Publication & Research

POULTRY FARMERSÃ¢Â Â KNOWLEDGE AND PREVALENCE OF SALMONELLA INFECTION IN RELATION TO HANDLING A…

VRC20

Document Details

Submission ID

trn:oid:::2945:312973362

Submission Date

Sep 18, 2025, 10:45 AM GMT+5:30

Download Date

Sep 18, 2025, 10:48 AM GMT+5:30

File Name

IJAR-53882.pdf

File Size

1.3 MB

29 Pages

9,841 Words

49,836 Characters

23% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

Filtered from the Report

▸ Bibliography

▸ Quoted Text

Match Groups

84 Not Cited or Quoted   11%
Matches with neither in-text citation nor quotation marks

38 Missing Quotations   12%
Matches that are still very similar to source material

0   Missing Citation   0%
Matches that have quotation marks, but no in-text citation

0   Cited and Quoted   0%
Matches with in-text citation present, but no quotation marks

Top Sources

22%   🌐 Internet sources

17%   📖 Publications

9%   👤 Submitted works (Student Papers)

Match Groups

🔴 **84** Not Cited or Quoted 11%
Matches with neither in-text citation nor quotation marks

🟠 **38** Missing Quotations 12%
Matches that are still very similar to source material

🟡 **0** Missing Citation 0%
Matches that have quotation marks, but no in-text citation

🟢 **0** Cited and Quoted 0%
Matches with in-text citation present, but no quotation marks

Top Sources

22% 🌐 Internet sources
17% 📖 Publications
9%   👤 Submitted works (Student Papers)

Top Sources

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1 Internet
scialert.net   **4%**

2 Internet
www.ncbi.nlm.nih.gov   **4%**

3 Internet
journalcra.com   **3%**

4 Internet
academicjournals.org   **2%**

5 Internet
www.scialert.net   **1%**

6 Internet
ageconsearch.umn.edu   **1%**

7 Internet
www.researchgate.net   **<1%**

8 Internet
iart.gov.ng   **<1%**

9 Internet
journals.plos.org   **<1%**

10 Internet
dergipark.org.tr   **<1%**

11 Publication

Ruyi Yu, Zongzheng Liang, Xiaoyan Su, Wenhua Yan. "An Assessment of Livelihoo... <1%

12 Internet

ijrrjournal.com <1%

13 Publication

Hamid Reza Sodagari, Ihab Habib, Scott Whiddon, Penghao Wang, Arkan Baraa M... <1%

14 Internet

agriculturalsocietynigeria.org <1%

15 Internet

pericles.pericles-prod.literatumonline.com <1%

16 Internet

krepublishers.com <1%

17 Internet

rusan.org.ng <1%

18 Internet

www.aitubd.org <1%

19 Internet

nomadseason.com <1%

20 Student papers

Auburn University - Agriculture on 2012-12-02 <1%

21 Student papers

Napier University on 2020-09-11 <1%

22 Student papers

University of Sunderland on 2024-01-07 <1%

23 Internet

journals.esciencepress.net <1%

24 Internet

journals.um.si <1%

25	Internet	
www.open-access.bcu.ac.uk		<1%

26	Internet	
arcnjournals.org		<1%

27	Internet	
ujseat.uniport.edu.ng		<1%

28	Internet	
www.sciencepub.net		<1%

29	Student papers	
CVC Nigeria Consortium on 2017-02-09		<1%

30	Student papers	
Universiti Putra Malaysia on 2018-04-10		<1%

31	Internet	
jageng.agrif.bg.ac.rs		<1%

32	Internet	
cdm15738.contentdm.oclc.org		<1%

33	Internet	
edepot.wur.nl		<1%

34	Internet	
pdffox.com		<1%

35	Internet	
www.biorxiv.org		<1%

36	Internet	
www.coursehero.com		<1%

37	Student papers	
Bournemouth University on 2022-05-26		<1%

38	Student papers	
Federal University of Technology on 2024-02-03		<1%

39	Publication
O.O. Oyedele, I.B. Adeoye, I.O. Amao, K.M. Bamimore, A. Ogundeyi. "Analysis of m...	<1%

40	Student papers
University of Technology, Sydney on 2020-06-14	<1%

41	Student papers
University of Ulster on 2022-04-03	<1%

42	Internet
archive.org	<1%

43	Internet
dspace.unza.zm	<1%

44	Internet
hydradoc.tips	<1%

45	Internet
wlv.openrepository.com	<1%

46	Internet
www.ajol.info	<1%

47	Publication
Sina Basil JOHNSON. "FACTORS AFFECTING THE PROFITABILITY OF POULTRY EGG ...	<1%

48	Student papers
DeVry, Inc. on 2023-04-17	<1%

49	Publication
Djim-adjim Tabo, Colette D. Diguimbaye, Sophie A. Granier, Frédérique Moury, An...	<1%

50	Publication
O.K. Akintunde, A.I. Adeoti, V.O. Okoruwa, B.T. Omonona, A.O. Abu. "Effect of Dise...	<1%

51	Publication
O.K. Akintunde, A.I. Adeoti. "Assessment of Factors Affecting the Level of Poultry ...	<1%

52	Publication
O.K. Akintunde. "Determinants of Poultry Farmers' Participation in Livestock Insu...	<1%

POULTRY FARMERS' KNOWLEDGE AND PREVALENCE OF SALMONELLAINFECTION IN RELATION TO HANDLING AND BIOSECURITY MEASURES IN OYO STATE, NIGERIA

Abstract

Poultry-related illnesses, such as Salmonellosis, continue to pose a significant threat to poultry farming in Oyo State, Nigeria. The expenses associated with treating and controlling these diseases tend to raise overall production costs, which in turn reduces the profit margins for poultry farmers.Against this background, this research was devised to identify understanding and incidence of Salmonella infection among poultry farmers as far as handling and bio-security control in Oyo State, Nigeria are concerned.Primary data were collected from 120 poultry farmers using a cross-sectional survey conducted through a multi-stage sampling method and a structured questionnaire. The data were analysed using descriptive statistics and multinomial logit regression. Most of the respondents (77.5%) were aged between 26 and 55 years, with 70.8% being male, 50.8% married, and 85.0% having received formal education.The average years of poultry farming was 15±7.57 years, and 59.2 % of the sample was Yoruba. The findings also demonstrated that all the poultry farmers knew about Salmonella, and over 78.6 % knew the source of Salmonella through seminars, extension workers, family/friends, and the Agricultural Development Programme (ADP) in Oyo State.The study revealed that disease prevention is very relevant in managing poultry diseases, comparable to the impact of medication and insurance. Notably, 62.5% of the poultry farmers were found to engage in low-level disease management practices. It was also demonstrated that key factors influencing the effectiveness of poultry disease control in the area included gender, educational attainment, household size, farming experience, marital status, nationality, ethnicity, and the scale of poultry operations. Based on these findings, the study recommends strengthening extension services and the roles of Agricultural Development Programme (ADP) officers. Additionally, it calls on the government to develop policies aimed at enhancing poultry disease management practices.

Keywords: Poultry; Knowledge; Prevalence; Awareness; Disease Management, *Salmonella*;

Introduction

The agricultural sector stands as the primary contributor to Nigeria's economy, accounting for over 38% of the nation's non-oil revenues. It also employs nearly 70% of the active working-age population.Furthermore, it has been proven that the poultry sub-sector is the

36 most commercialised of all sub-sectors of agriculture in Nigeria (Adene and Oguntade,

37 2008), and has reshaped the lives of the less privileged individuals of the society through

38 little investment as well as low cost of technology. Its average production is 454 billion

39 tonnes of meat and 3.8 million eggs each year, and the population primarily consists of

40 approximately 180 million birds (FAO, 2018). Animal protein sources in Nigeria, like in

41 most developing economies, are dominated by poultry meat and eggs due to their

42 affordability and acceptability (Bettridge *et al*., 2014; Fagbamila*et al*., 2017). Regrettably, a

43 series of infectious diseases, such as salmonellosis, threatened the sustainable growth of this

44 significant sub-sector. Thus, to the best of our knowledge, there are few published studies of

45 circulating strains of Salmonella in poultry production in Nigeria (Raufu*et al*., 2014;

46 Fagbamila*et al*., 2017), and the risk factors of different types of Salmonella spp. have barely

47 been studied. The populace depends on this industry as the source of nutritional benefits such

48 as animal protein, vitamins, minerals and fats and oils, raw materials to produce organic

49 fertilisers and animal feeds, among others, may be because of low or no distinction against

50 poultry and poultry products and availability and low cost (Fagbamila*et al*., 2010; Bettridge

51 *et al*., 2014). Therefore, the poultry industry has remained pertinent to Nigeria'seconomic

52 development. Poultry-linkedsalmonellosis is widespread throughout the globe, resulting in

53 morbidity and mortality and, hence, financial losses (Akter *et al.*2007; Kwon *et al.*2010;

54 Abiodun *et al.*2014; Ahmed *et al*., 2017).

55 Salmonella,like most *Enterobacteriaceae*, are motile by peritrichous flagella except

56 *Salmonella pullorum* and *Salmonella gallinarum*, which lack flagella (Bhunia,

57 2008).Salmonella is categorised into two primary species: *Salmonella enterica* and

58 *Salmonella bongori*.The vast majority of all pathogenic species of Salmonella that affect

59 people encompass the species of *S. enterica*. Over 2,500 serotypes have been reported due to

60 differences in the somatic (O) and flagella (H) antigens (Solari *et al.,* 2003; Barde *et al.,*

61 2017). However, a recent report from the Centre for Infectious Disease Research and Policy

62 classifies members of the Salmonella species into more than 2541 serotypes (serovars)

63 according to their somatic (O) and flagellar (H) antigens (CIDRAP, 2006). The pathogen

64 lives primarily in the intestinal tract of animals, birds, mice, farm animals, and sometimes in

65 eggs (Ellermeier and Slauch, 2006). The Salmonella-caused disease is significant becauseit is

66 capable of being transmitted to offspringperiodically. The control of salmonellosis in the

67 poultry industry is complex because, in addition to perpendicular transmission from parent

68 stock to offspring, horizontal transmission on farms is also standard; this makes its control a

2

69 challenge (Dawoud *et al.*2011; Hannah *et al.*2011; Abiodun *et al.*2014). This is possible via

70 infected litter, water, dust, fluff, insects, faeces, feed, equipment, fomites, diseased chicks and

71 rodents, contaminated with Salmonella (Poppe 2000). Other animals, wild birds, and

72 personnel may also transmit them. However, it has been reported that poultry farms and

73 poultry products are the primary sources ofSalmonella contamination (Hussein*et al.*, 2009).

74 Studies on numerous poultry diseases occurring in certain parts of the country have shown

75 that salmonellosis is the major threat facing poultry production (Mamman et al., 2014).

76 Additionally, animal droppings have been identified as a potential reservoir for many enteric

77 organisms (Raufu et al.,2013). Hence, consumers of poultry and poultry products are at risk

78 of contracting salmonellosis via consumption of contaminated products (Adesiyun*et al.*2005;

79 Mughini-Gras *et al.*2014).Salmonellasppinfectivity in poultry farms is a common problem of

80 great interest to both the health of the population and the socio-economic life of the country it

81 attacks due to the destruction it can inflict on it.

82 Furthermore, it has been estimated that the total costs for medical care and lost productivity

83 resulting from food-borne Salmonella infections in humans were between \$ 0.6 and \$ 3.5

84 billion annually (CDC, 2009; Majowicz*et al.*, 2010). The other costs linked with Salmonella

85 are factors ranging from direct expenses incurred by producers because ofSalmonella

86 infection in chicken stocks. Preventive measures such as bio-security procedures, facility

87 cleaning and disinfection, rodent management programmes, vaccination, and testing can all

88 significantly add to the cost of production. Moreover, Salmonella contamination of food

89 products can significantly reduce consumer demand and affect producer profits (Namata *et*

90 *al.,* 2008). One of the biggest and most significant sources of paratyphoid

91 (PT)Salmonellainthe human food supply is through commercial poultry. Controlling

92 paratyphoid (PT) infections has thus become an essential objective for the poultry industry

93 from both public health and economic perspectives (Gast, 2003). In addition, food safety has

94 been studied in depth with everyone's concern of production, transportation, processing, food

95 storage,and food preparation. Nevertheless, despite the amount of knowledge we have, there

96 is still more to unravel about food safety and the complete control of salmonellosis within the

97 poultry industry, with greater structural focus on Oyo State, Nigeria, within the whole farm-

98 to-fork production model. Moreover, Oyo State has also been referred to as an example of a

99 civil servant state due to the large number of civil servants and the existence of thousands of

100 unemployed graduates who find ways to supplement their income. This singular factor has

101 triggered the boom in poultry keeping in Oyo State. The poultry industry in Oyo State,

3

Nigeria, is substantially being impeded by salmonellosis in its pursuit of a private sector facilitated economy and micro stability. Against this, the disease outbreak in the poultry industry is not given a lot of consideration in the team of foresight and preventive measures. Therefore, to prevent Salmonella contamination of broiler/layers, one must be well aware of the most critical risk factors involved in the existence of Salmonella within the poultry production system. Thus, we aim to investigate the knowledge and prevalence of Salmonella spp. infection among poultry farmers in Oyo State, Nigeria, in relation to its handling and biosecurity control.

Materials and Methods

Study area

The research was conducted in Oyo State, Nigeria, situated between latitudes 7°03′ and 9°12′ North of the equator and approximately 2°47′ East of the prime meridian. The region experiences two main climatic seasons. The state is made up of 33 local government areas in four agricultural zones (Ogbomosho zone, Ibadan/Ibarapa zone, Oyo zone, and Oke Ogun zone) and three senatorial districts (Oyo North, Oyo Central, and Oyo South senatorial districts) with a population of 5,591,585 people (National Population Commission, 2006). Oyo State shares its northern border with Kwara State, its southern border with Ogun State, its eastern border with Kwara and Osun States, and its western border with the Republic of Benin. The region's favourable climate has encouraged about 70% of residents to engage in agriculture, cultivating both permanent and food crops. Small-scale farmers make up the majority of the farming population in the state. The population is predominantly Yoruba, speaking the Yoruba language, with a rich cultural heritage and strong kinship ties that unify the community. Climatically, Oyo State experiences a moist equatorial climate characterised by hot, dry, and wet seasons with moderate humidity. The dry season lasts from November to January, while the wet season spans from April to October. Temperatures typically range between 25°C (77°F) and 35°C (95°F) throughout the year. These favourable weather conditions have contributed to the popularity of poultry farming among local farmers (Adeyonu, 2015). Vegetation-wise, the southern part of Oyo State is covered by rainforest, while the northern part features guinea savannah. The south is dominated by dense forests, whereas the north consists mainly of grasslands interspersed with trees.

132

Figure 1: Map showing the thirty-three Local Governments in Oyo State.

Poultry and poultry farm handler sampling

The study, spanning 5 months (July 2021 - November 2021), was conducted on 18 commercial poultry farms. All the farms were sampled twice, and 10 respondents were sampled on each farm, with different respondents per farm comprising attendants, supervisors, security, managers, etc. The participants were requested to read the questionnaire attentively, considering the study topic upon due introduction. A total of one hundred and twenty (120) questionnaires were received at the end of the study and analysed accordingly, as they were found to provide useful data towards the study.

Farm description

Poultry production systems could be categorised into five intermediate categories from the four operational classes of the Food and AgricultureOrganisation (FAO), based on the number of chickensraised in a farm (FAO, 2018). The poultry farms were classified based on size as backyard farms (under 200 birds), semi-commercial farms (200 to 999 birds), small-scale farms (1,000 to 4,999 birds), medium-scale farms (5,000 to 9,999 birds), and large-scale farms (over 10,000 birds). Most of the farms included in this study fell into the medium-scale or large-scale categories. Although grandparent breeds are mainly imported to Europe, well-

5

150 established breeding farms exist in the Oyo State study area in Nigeria.Day-old chicks are
151 likewise mostly produced in the area sampled by the big and small hatcheries and transported
152 by road to different parts of the country in Nigeria (Adene and Oguntade, 2008).

Administration of a structured questionnaire

154 Study participants and poultry owners were given a structured questionnaire with the required
155 information, which included voluntary and informed consent. The level of poultry disease
156 management was derived from the poultry disease management index as earlier
157 categorisedby Lestari *et al*. (2011) as (1) Low level (0 up to 0.33), (2) Moderate level (0.34-
158 0.66), and (3) High level (0.67-1.0). The three dimensions (Biosecurity practices,
159 Medications, and Insurance) and attributes, as shown in Table 6, were selected using the
160 approach outlined byRitz (2011).

Multinomial logit model

162 The factors influencing the level of poultry disease management among egg farmers in Oyo
163 State, Nigeria, were analysed using multinomial logistic regression. The dependent variable
164 was the level of poultry disease management, categorised as low, moderate, or high. To
165 estimate the model, one category had to be set as the reference group, which in this case was
166 the least desirable option (low). The model predicts the probabilities of each management
167 level based on the individual characteristics of the poultry egg farmers (Maddala, 1983).With
168 three possible choices ($s = 1, 2, 3$), the multinomial logit model calculates the probability P_{is}
169 that the i-th poultry egg farmer falls into category$s$. The farmers' characteristics are
170 represented by the vector z. The likelihood of selecting a particular option is determined by
171 the utility of that choice being greater than or equal to the utility of the other alternatives.
172 Following Babcock *et al*. (1995), the multinomial logit model for the three poultry farm
173 categories ($s = 1, 2, 3$) can be defined as:

$$P(Y = s) = \frac{e^{\beta_j z}}{1 + \sum_{j=2}^{s} e^{\beta_j z}} \text{ for s not equal to 1} \tag{1}$$

$$P(Y = 1) = \frac{e^{\beta_j z}}{1 + \sum_{j=2}^{s} e^{\beta_j z}} \tag{2}$$

174 X_1 to X_{13} represent the independent variables in this study that influenced the level of poultry
175 disease management among poultry egg farmers in Oyo State, Nigeria.The explanatory

6

176 variables included in the model are similar to those used in previous related studies as earlier
177 outlined by Ojo (2003),Oladeebo and Ambe-Lamidi (2007),Adepoju (2008),Olagunju and
178 Babatunde (2011),Isiorhovoja(2013), Akintunde and Adeoti (2014).

179 **Statistical analysis**

180 Epi Info (version 7.0) was used for data management, Microsoft® Office Excel 2010
181 Professional Edition for data entry, and SPSS (version 21.0) for data analysis. The data were
182 analysed through descriptive statistics, fuzzy set analysis, and multinomial logit regression.

183 **Result**

184 **Socio-demographic characteristics of poultry farmers**

185 Table 1 shows social-demographic indicators of poultry farmers in Oyo State. As a finding,
186 the majority (77.5 %) of the poultry farmers sampled were 26 – 55years of age during the
187 study, and 13.3% of respondents were aged 15-25 years, with a few (9.2 %) above 55years of
188 age. The number of male and female respondents was 70.8 % and 28.2 %, respectively. In
189 addition, just over half (50.8 %) of the poultry farmers were married, 35.8% were single,
190 6.7% were divorced, and 85.0% of the respondents were of between primary to tertiary level
191 education, with above 59.2 % of poultry farmers practising the Islamic religion or 39.2 % of
192 the poultry farmers practising Christianity with mean years of experience of 15 ± 7.57 years. A
193 total of 50.0 % of the respondents included 6 to 20staff/workers, 31.7 % included 1 to 5
194 staff/workers, and 18.3 % included more than 20 personnel. Regarding farm capacity, over
195 half (59.2%) of the sampled respondents had a population of less than 25,000 poultry birds,
196 and 29.2% had 25,000-50,000 bird populations at the time of this study.

197

198

199

200

201

202 **Table 1:** Socio-economic characteristics of the respondents (n = 120).

Variables	Frequency	Percentages (%)
Age		
15-25	16	13.3
26-35	39	32.5
36-45	33	27.5
46-55	21	17.5
Above 55	11	9.2
Sex		
Male	85	70.8
Female	35	29.2
Marital Status		
Single	43	35.8
Married	61	50.8
Divorced	8	6.7
Widowed	3	2.5
Separated	5	4.2
Educational qualification		
No formal education	18	15.0
Primary education	22	18.3
Secondary education	50	41.7
Tertiary education	30	25.0
Religion		
Islam	71	59.2
Christianity	47	39.2
Traditional	2	1.7
Tribe		
Yoruba	71	59.2
Igbo	30	25.0
Hausa/Fulani	13	10.8
Igede	6	5.0
Nationality		
Nigerian	93	77.5

8

Foreigners	27	22.5
Years of poultry farming experience		
1 – 9	53	44.2
10 – 17	47	39.2
18 – 25	14	11.7
26 – 33	6	5.0
Number of staff/workers		
1 – 5	38	31.7
6 – 10	24	20.0
11 – 15	20	16.7
16 – 20	16	13.3
Above 20	22	18.3
Farm capacity		
Less than 25000	71	59.2
25001 – 50000	35	29.2
50001 – 75000	10	8.3
75001 – 100000	4	3.3

203 Furthermore, in Table 2, the summary statistics of the respondents show that the mean age
204 was 38.05 years with a standard deviation of 11.66, indicating that the majority were middle-
205 aged with some spread across younger and older groups. The mean sex score was 1.29 (SD =
206 0.45), which, based on coding, indicates that most of the respondents were male. The average
207 marital status was 1.96 (SD = 0.94), showing that the majority were married, although singles
208 were also represented. For educational qualification, the mean of 2.43 (SD = 1.00) suggests
209 that respondents on average had secondary education, with variations ranging from no formal
210 education to tertiary level. Religion had a mean score of 1.41 (SD = 0.54), indicating that
211 most respondents were Muslims, while a considerable proportion were Christians. The mean
212 tribal code was 1.28 (SD = 0.81), pointing to Yoruba as the predominant ethnic group. The
213 nationality mean of 1.23 (SD = 0.43) reflects that the majority were Nigerians, with
214 foreigners forming a minority. In terms of years of poultry farming experience, the mean was
215 11.48 years with a standard deviation of 7.05, suggesting substantial experience with wide
216 variation across respondents. The average number of staff employed was 11.24 (SD = 6.64),
217 indicating small to medium farm sizes with variability in workforce. Finally, the mean farm
218 capacity was 26,458 birds with a standard deviation of 18,920, reflecting moderate

9

219 production capacity overall but with large variation across farms, ranging from small to much
220 larger operations.

221 **Table 2:** Summary statistics of continuous variables of respondents (n = 120).

Variable	N	Mean	Std. deviation
Age (years)	120	38.05	11.66
Sex	120	1.29	0.45
Marital status	120	1.96	0.94
Educational qualification	120	2.43	1.00
Religion	120	1.41	0.54
Tribe	120	1.28	0.81
Nationality	120	1.23	0.43
Years of poultry farming experience	120	11.48	7.05
Number of staff/workers	120	11.24	6.64
Farm capacity (birds)	120	26,458	18,920

222 **Awareness and source of information about Salmonellosisinfection.**

223 Table 3 reveals the awareness about Salmonella in Oyo State. Findingsshow that all (100.0%)
224 of the respondents have had Salmonellosis. Majority (90.0%) of the respondents reveals that
225 their staff were observing all necessary protocol against the incidence ofSalmonella
226 infections, while majority (78.6%) of the respondent were aware of Salmonellafrom someone
227 else farm within Oyo State, also, majority (75.0%) of the respondents indicates they have
228 notice sign of Salmonellaspread in their farms and 65.0% of them indicate the incidence of
229 Salmonella in their poultry farms and above half (55.0%) of the respondents were aware of
230 Salmonella disease in the farms.

231

232

233

234

235

10

236   **Table 3:** Awareness of Salmonella

Awareness of Salmonella	Yes (%)	No (%)
Have you heard of a disease called Salmonellosis	120 (100.0)	0(0.0)
Have you noticedanysigns of Salmonellainfection in your farm?	90(75.0)	30(25.0)
Are you aware of the incidence of Salmonellain your farm?	78(65.0)	42(35.0)
If No, are you aware of it in someone else's farms before? **(n = 42)**	33(78.6)	9 (21.4)
Are your farm workers/attendants aware of Salmonella?	66(55.0)	54(45.0)
If yes? Are they observing all necessary protocols against Salmonella? **(n = 66)**	60(90.9)	6(9.1)

237   **Source(s) of information about Salmonellainfection**

238   Figure 2 reveals the source(s) of information about Salmonellainfection, which is based on
239   multiple responses from the respondents sampled. Findings show that the majority (68.3%) of
240   respondents reported that Salmonellawassourcedfrom the seminar. In comparison, 66.7%
241   revealed that Salmonellawassourced from the extension agent, and 64.2% of the respondents
242   revealed that Salmonellawassourced from ADP and family/friends. Other identified sources
243   (s) of information about Salmonella by the respondents were newspapers 55.8%, print media
244   53.3%, office calls 50.0%, field demonstrations 48.3%, radio and television 46.7% and the
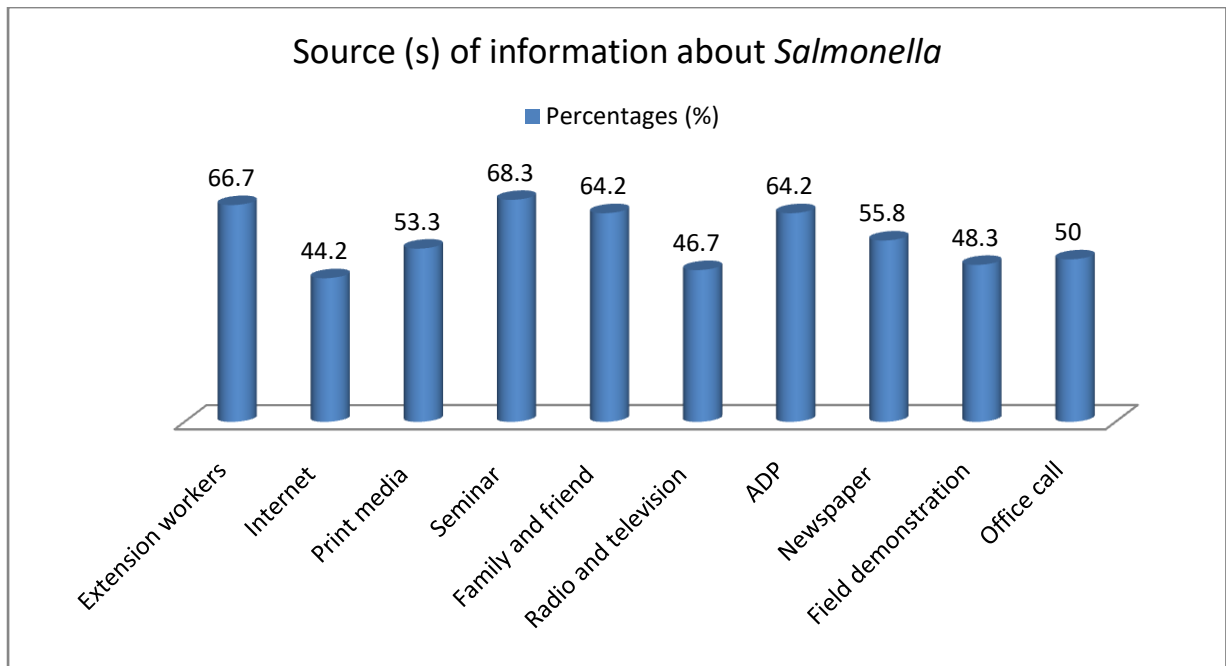245   internet 44.2 %.

246

11

Source (s) of information about *Salmonella*

■ Percentages (%)

Extension workers 66.7 | Internet 44.2 | Print media 53.3 | Seminar 68.3 | Family and friend 64.2 | Radio and television 46.7 | ADP 64.2 | Newspaper 55.8 | Field demonstration 48.3 | Office call 50

247

Figure 2: Source(s) of information about Salmonella in the study area.

Figure 3 reveals the age at which the respondents notice chicks with signs of *Salmonella*. Findings show that 36.7% of the respondents indicate no idea at what age they noticed chicks with Salmonella infection in the study area, as at the time of this study. In comparison, 29.2% of the respondents reveal 6weeks – 8weeks, while 15.8% of them indicate below 6weeks, 12.5% of the respondents reveal 9weeks – 11weeks, and 5.8% of the respondents indicates above 11weeks.
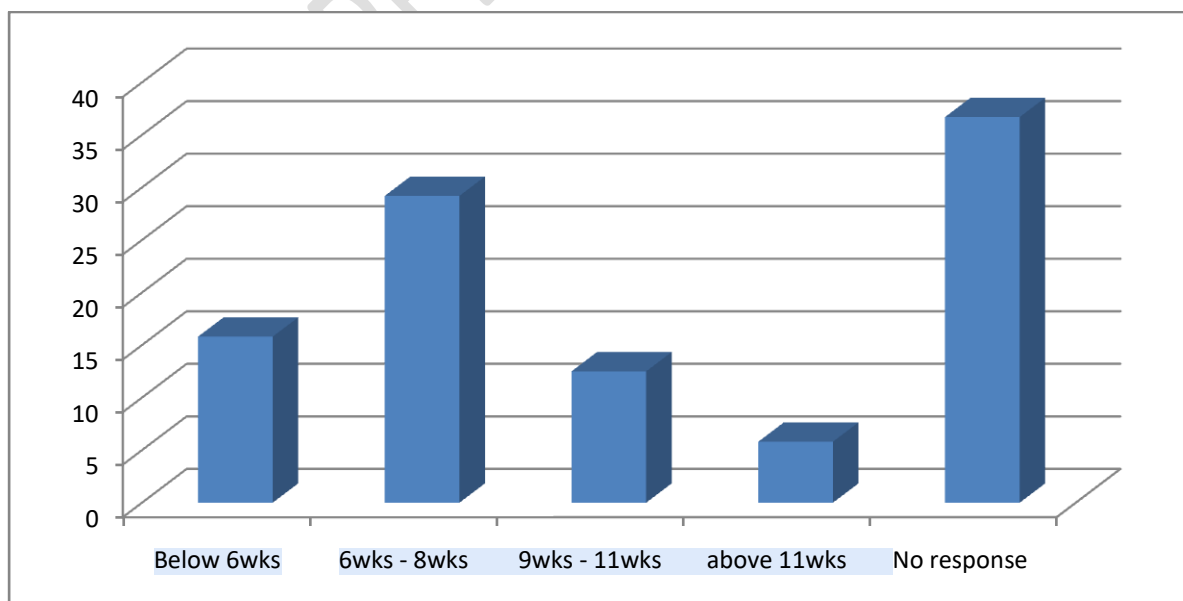
Below 6wks | 6wks - 8wks | 9wks - 11wks | above 11wks | No response

255

Figure 3: Age at which Salmonellawas noticed by the respondents sampled.

Knowledge of respondents about Salmonellainfection

Table 4 reveals that the majority (88.3%) of the respondents were aware that keeping birds in proximity can cause these diseases in their poultry farms. In comparison,the majority (84.2%) of the respondents sampled also knew that regular feed and water should be ensured to prevent the diseases in the poultry farms, 65.0% of the respondents believed and indicated that vaccination of birds can prevent the spread of Salmonellainfection. Furthermore, the majority (63.3%) of the respondents knew that there is a need to wear personal protective equipment during farm operation, also 60.0% of the respondents knew that wild animals, rodents, and birds must not have access to the pen and feed in the farms. Above half (56.7%) of the respondents recognized that regular vehicle wheel washing is necessary to prevent the spread of Salmonella infection in poultry farms, and 55.8% of the respondents also understood that the source of day-old chicks is another means of transmitting Salmonellainfection. Other notable understanding by the respondents wasthat there is a need for declaration from the hen stock supplier that chicks are free of Salmonella (54.2 %), footbaths filled with treated water should be placed at the entrance of each pen (52.5%) and visitors need to be keep away from the pen house to avoid the spread of diseases (50.8%). More so, knowledge about Salmonella disease was recorded as average, and measures to improve it must be implemented by the respondents sampled in Oyo state, as this will safeguard the farm from unnecessary disease that may arise.

Table 4: Knowledge of respondents about Salmonellosis

Knowledge	Yes (%)	No (%)
Keeping birds in proximity can cause these diseases	106(88.3)	14(11.7)
The source of stock is a means of transmitting the disease	59(49.2)	61(50.8)
A source of day-old is another means of transmitting the diseases	67(55.8)	53(44.2)
Visitors need to keep away from the pen house to avoid the spread of diseases.	61(50.8)	59(49.2)
Regular feed and water should be ensured to prevent diseases.	101(84.2)	19(15.8)
Vaccination of birds can prevent the spread of diseases.	78(65.0)	42(35.0)
There is a need for a declaration from the hen stock supplier that chicks are free of the Salmonella organism.	65(54.2)	55(45.8)
Footbaths filled with treated water should be placed at the entrance	63(52.5)	57(47.5)

13

of each pen.		
There should be regular vehicle wheel washing to prevent the spread of disease	68(56.7)	52(43.3)
There is a need to wear personal protective equipment (PPE) during farm operations.	76(63.3)	44(36.7)
Wild animals, rodents and birds must not have access to the pen and feed.	72(60.0)	48(40.0)

277

278 **Management and prevention of Salmonellainfection**

279 Table 5 reveals the management and prevention of Salmonellainfection in the study area.
280 Finding reveals the mean value bio-security practices as indicated by the respondents
281 sampled, poultry farm must not be located within the lake or pond was with the mean value
282 of (= 2.14). At the same time, each material used should be regularly cleaned and disinfected
283 at all times (= 2.13), poultry farms must be a distance from public roads (= 2.12), and poultry
284 farms and pens must be a distance from one another (= 2.02) in the study area. Furthermore,
285 rodent must be control in the farm to minimise level (= 1.99), each pen should have a
286 separated shoe, cap, boot, cloth etc., to wear during operation and activities (= 1.98), also
287 other livestock animal aside poultry must be control to at least 60m to poultry house(= 1.97)
288 and poultry farm surrounding must be weeded and avoid bushy (= 1.95). Biosecurity
289 practices are routine management strategies aimed at preventing disease outbreaks and
290 unforeseen problems on poultry farms. These measures are readily implemented by farmers
291 at a low cost, unlike medication, vaccination, and insurance, which involve higher expenses.
292 The study's findings also highlight key vaccination protocols considered necessary by the
293 respondents for preventing and controlling Salmonella spread. These include vaccinating
294 birds against diseases previously encountered on the farm (= 2.31), administering the Marek
295 vaccine on day one (= 2.24), applying the Immucox vaccine within the first 1–5 days (=
296 2.22), giving the first Gumboro vaccine at 8–10 days followed by a second dose a week later
297 (= 2.19), and ensuring proper vaccination of day-old chicks at the hatchery (= 2.18). Other
298 notable prevention measures were a timely interval of routine de-worming (= 2.16), routine
299 use of NDV Lasota every month, frequency of contact with the veterinary doctor (= 2.15),
300 respectively, a timely interval of routine application of antibiotics (= 2.14), and vaccination
301 against Fowl pox at 8 weeks (= 2.13) as prevention and control against Salmonellosisdisease.
302 This will minimise and prevent the problem of disease occurrences in the farms.

14

303   **Table 5:** Management of Salmonellainfection

Management of Salmonella infection	Always	Occasionally	Never	Mean
Biosecurity practices (Prevention)				
Poultry farm must be a distance from public roads	41(34.2)	52(43.3)	27(22.5)	2.12
Poultry farms and pens must be at least 100 feet apart from one another	38(31.7)	48(40.0)	34(28.3)	2.03
A poultry farm must not be located within the lake or pond	41(34.2)	55(45.8)	24(20.0)	2.14
The poultry pen must have a gate that restricts vehicle access to the farm	25(20.8)	44(36.7)	51(42.5)	1.78
The Poultry farm must be well-fenced	35(29.2)	40(33.3)	45(37.5)	1.92
Rodents must be controlledon the farm to minimisethe level	33(27.5)	53(44.2)	34(28.3)	1.99
The surroundings of the poultry farm must be weeded and avoid bushy areas	28(23.3)	58(48.3)	34(28.3)	1.95
Other livestock must be controlled to at least 60m fromthe poultry house	28(23.3)	60(50.0)	32(26.7)	1.97
Poultry litter should be taken to the poultry house	22(18.3)	53(43.3)	46(38.3)	1.80
Each pen should have a separate shoe, cap, boot, cloth, etc., to wear during operation and activities	25(20.8)	68(56.7)	27(22.5)	1.98
All materials used should be regularly cleaned and disinfected at all times	34(28.3)	68(56.7)	18(15.0)	2.13
The disinfectantatthe entrance of each poultry house must be ensured	22(18.3)	55(45.8)	43(35.8)	1.83
There should be multiple age groups of birds on the farms	27(22.5)	52(43.3)	41(34.2)	1.88
Medication (prevention and control)				
Birds should be vaccinated for agents known to have caused problems on the farm in the past	59(49.2)	39(32.5)	22(18.3)	2.31
Adequate vaccination of day-old birds should be done at the hatchery	45(37.5)	51(42.5)	24(20.0)	2.18
Application of the Immucox vaccine at 1-5 days	47(39.2)	52(43.3)	21(17.5)	2.22

15

Application of the Marek vaccine at 1 day old	54(45.0)	41(34.2)	25(20.8)	2.24
Newcastle disease vaccine at one day old chicks must be given	37(30.8)	45(37.5)	38(31.7)	1.99
Vaccination of 1st Gumboro vaccine at 8 – 10 days and 2nd at 1 week after	41(34.2)	61(50.8)	18(15.0)	2.19
Application of Newcastle disease vaccine Lasota at the 2nd and 5th week	44(36.7)	44(36.7)	32(26.7)	2.10
Vaccination against Fowl pox at 8 weeks	46(38.3)	44(36.7)	30(25.0)	2.13
Application of Newcastle disease vaccine Komorov at 12 weeks	36(30.0)	55(45.8)	29(24.2)	2.06
Routine use of NDV Lasota every month should be done	48(40.0)	42(35.0)	30(25.0)	2.15
Timely interval of routine deworming	46(38.3)	47(39.2)	27(22.5)	2.16
Timely interval of routine application of antibiotics	39(32.5)	59(49.2)	22(18.3)	2.14
Delousing of birds must be done	36(30.0)	52(43.3)	32(26.7)	2.03
Frequency of contact with the veterinary doctor	43(35.8)	52(43.3)	25(20.8)	2.15
Regular examination of sick or dead birds	39(32.5)	54(45.0)	27(22.5)	2.10
Insurance of poultry farm (mitigation)	37(30.8)	56(46.7)	27(22.5)	2.08

304

Categorisation of management of Salmonellainfection

306 The management of poultry diseases, particularly Salmonella widespread, was classified into
307 three categories: (1) Low level (0.00–0.33), (2) Moderate level (0.34–0.66), and (3) High
308 level (0.67–1.00). According to Table 5, the majority of poultry farmers (62.5%) fall within
309 the low-level management category, 25.0% practice moderate-level management, and 12.5%
310 operate at a high level (Table 6).

311 **Table 6:** Distribution of the level of poultry disease management
312 (i.e *Salmonella spp* widespread)

Poultry diseases	Management level	Frequency	Percentages (%)
Low	0.0 – 0.33	75	62.5
Moderate	0.34 – 0.66	30	25.0
High	0.67 – 1.0	15	12.5
Total		**120**	**100.0**

313

16

Strategies implemented for controlling Salmonellainfection widespread in the poultry farm and the environment

It was shown that 80.0 % of the respondents indicated regular hand washing as a good strategy to be implemented in controlling Salmonellosisdisease. In comparison,75.9% of the respondents sampled also suggest that proper preparation of poultry feed is a good strategy to implement in controlling Salmonellosis in poultry farms. 68.3% of the respondents believe and indicate that a good water source can prevent the spread of Salmonellainfectionif implemented. Furthermore, 65.0 % of the respondents indicate that regular vaccination of birds and the environment is a good strategy to be implemented in controlling Salmonellosis disease, 64.2% of them indicate that general cleaning of the farm environment, and 63.3% of them also indicate that personal (body) hygiene is a good strategy to be implemented in controlling Salmonellosis. Others were proper disposal of waste, regular screening of people visiting farms, reporting to the veterinary clinic when birds are sick, and appropriate monitoring and evaluation of poultry farms (Table 7).

Table 7: Strategies implemented in controlling Salmonellaspp in the poultry farm and environment.

Preventive and control measures of Salmonellainfection by the respondents	Yes(%)	No (%)
Regular hand washing	96(80.0)	24(20.0)
Personal (body) hygiene	76(63.3)	44(36.7)
Reporting to the veterinary clinic when birds are sick	69(57.5)	51(42.5)
Good water source	82(68.3)	38(31.7)
Proper preparation of poultry feed	91(75.8)	29(24.2)
Regular screening of people visiting the farm	71(59.2)	49(40.8)
General cleaning of the farm environment	77(64.2)	43(35.8)
Regular vaccination of birds and the environment	78(65.0)	42(35.0)
Proper monitoring and evaluation of farms	60(50.0)	60(50.0)
Proper disposal of waste	72(60.0)	48(40.0)

Factors influence the level of poultry disease management

The overall adequacy of the model was confirmed using the Chi-square test, which was statistically significant at the 1 % level (χ^2 = 102.45, p = 0.0001), indicating a strong fit for

17

333   the data. The marginal effects analysis revealed several key factors influencing poultry
334   disease management levels among farmers. The sex of the respondent had a notable impact;
335   female poultry farmers were 21 % less likely to achieve a moderate level of disease
336   management compared to their male counterparts. This suggests that female farmers are less
337   likely to implement moderate disease control practices. Education showed a positive
338   relationship with disease management. For each additional year of formal education, the
339   probability of attaining a moderate level of disease control increased by 1 % compared to a
340   low level. This implies that higher educational attainment enhances the likelihood of adopting
341   effective and modern disease management practices. More so, the household size also played
342   a significant role, where an increase in household members was associated with a 13 % rise
343   in the probability of achieving moderate disease management. Similarly, each additional year
344   of poultry farming experience increased the likelihood of moderate disease control by 2%.
345   These findings are consistent with the study by Ezeh *et al*. (2012), which suggested that more
346   farming experience enhances a farmer's ability to manage disease outbreaks effectively.

347   Furthermore, marital status was found to raise the likelihood of achieving moderate disease
348   management by 11 %. Also, the farmer's nationality and ethnic background (tribe) increased
349   the chances of reaching a moderate level of disease control by 23 % and 25 %, respectively.
350   Farmers who are Yoruba-speaking natives of the study area were more likely to possess
351   better knowledge and practices for disease prevention compared to non-natives. Farm
352   capacity was also a significant predictor, larger-scale operations had a 21 % higher likelihood
353   of achieving moderate disease management compared to smaller farms. In terms of achieving
354   a high level of disease management, being female slightly reduced the probability by 2 %,
355   while a larger household size increased it by 6 %. An additional year of farming experience
356   marginally raised the likelihood of high-level disease control by 0.3%. Moreover, both
357   nationality and farm capacity contributed to a 10 % increase in the likelihood of reaching a
358   high level of disease management compared to a low level.

359

360

361

362

18

363 **Table 8:** Results of the multinomial logit model of determinants of the level of poultry
364 disease management

Explanatory variables	Marginal effect	Std. error	t-value	Marginal effect	Std. error	t-value
Age	-0.3421	0.2151	-0.453	-0.1261	0.3971	-1.602
Sex	-0.2159**	2.1412	-2.326	-0.0264**	0.1127	-0.167
Educational level	0.0148**	0.3823	1.324	0.0072	0.0013	0.079
Household size	0.1356**	0.2814	0.874	0.0643*	0.0112	1.178
Hired labour	-0.0003	0.0453	-0.321	0.0732	0.0033	2.187
Poultry farm experience	0.0244*	0.1417	0.645	0.0033**	0.0132	0.433
Marital status	0.1102**	0.3216	2.254	0.1224	0.0094	1.704
Nationality	0.2373*	0.5365	1.382	-0.1017*	0.1014	-1.346
Tribe	-0.2564**	0.1563	0.237	0.0429	0.1142	0.355
Poultry system	0.2026	0.4212	0.443	- 0.1627	0.0624	-1.052
Farm capacity	0.2138**	0.1021	-0.253	0.1008*	0.3121	0.353
Age of birds	0.0023	0.0641	0.243	0.0023	0.0124	0.178
Mortality rate (%)	0.2543	0.1034	1.462	0.0033	0.0157	0.135

365 *Significant at 10%, **Significant at 5%, ***Significant at 1%, No. of obs = 120 LR χ^2 =
366 102.45 Prob>χ^2 = 0.0001, Log likelihood = -112.2302 Pseudo R^2 = 0.1014.

Discussion

368 Most of the poultry farmers surveyed were within their economically active age group. They
369 were relatively young, making them more likely to adopt innovations that could enhance
370 poultry production in Oyo State, Nigeria.The outcome suggested that contemporary poultry
371 farming remains a male profession rather than a female occupation, still likely due to the
372 nature of the risk that is involved, labor-intensive, as well as the other activities that are
373 involved in farm husbandry are not favourable to most women. This finding aligns with
374 earlier studies by Lawal *et al*. (2009), Adisa and Akinwumi(2012),and Uzokwe and Bakare
375 (2013). Nevertheless, 35.8 % of the participants were still unmarried, with 85 % having a
376 formal education. In terms of worshipped religions, Islam and Christianity are the main
377 dominantreligions, as 77.5% of the sampled respondentsareNigerians. Most of the poultry

19

378 farmers (83.4 %) were experienced in poultry farming,with a maturity of 1-17 years.This is
379 anticipated to contribute to improved disease management, as greater years of experience in
380 poultry farming generally equip farmers with better exposure and skills, making them more
381 effective in preventing and managing poultry diseases.The present study findingsshow that
382 insecure practices of disease prevention had a high relative contribution to disease
383 management as compared to medications and insurance. However, this is because bio-
384 security practices are normal business practices that the poultry farmers are performing
385 easily, which does not incur high cost as compared to medication and insurance. This
386 observation is in contradiction to the results that were obtained by Obi *et al*. (2008), who
387 found that poultry production in Nigeria is largely backyard poultry production with
388 insignificant or no bio-security, as opposed to minimal or moderate bio-security of peri-urban
389 and urban commercial poultry production.The respondents' knowledge of salmonellosis was
390 evaluated through their awareness of its prevention and control measures in poultry farms,
391 along with their ability to recognize the disease's symptoms.In the majority of cases, it
392 became evident that the diseases of salmonellosis are unfamiliar to most farm handlers. This
393 could be attributed to their low level of education and exposure to related issues, which
394 indicates a lack of awareness of the disease (Agada *et al*., 2014). This, nevertheless, could
395 have been due to the high rate of prevalence that some poultry farms had been reported to
396 have. In addition, the lack of knowledge has also increased the risk of exposure and
397 transmission of Salmonella spp.from farm handlers to flocks, as reported by several studies
398 (Charles and Takayuki, 2010; Mai et al., 2013), especially with the recent surge in poultry
399 farming business in Jos.Salmonellosis is considered one of the most significant bacterial
400 disease challenges facing the global poultry industry.Salmonellaspecies are responsible for a
401 variety of acute and chronic diseases in both poultry and humans (Majowicz*et al*., 2010;
402 Okwori*et al*., 2013). Infected poultry products are among the most significant sources
403 offoodborne outbreaks in humans. Our study revealed that the hygienic practices of poultry
404 farmers did not meet the hygiene standards for handling meat products as recommended by
405 the World Health Organisation and the Food and Agriculture Organisation Joint Committee
406 (Codex Alimentarius Commission, 2005).

407 Poultry feed accounts for the most significant proportion of production costs in both Oyo
408 State and Nigeria as a whole.The feed is commonly mixed with animal constituents like egg
409 shells, blood meal, fish meal, and bone meal. Soybean cake and groundnut cake, which are
410 plant-based sources of protein and calcium, are commonly used in animal feed. However,

improper preservation, storage, and packaging of these ingredients often lead to contamination risks in poultry feed.As noted by Jones and Richardson (2004), the climatic weather in Nigeria consists of warm and humid conditions, and Salmonella organisms can, under these circumstances, multiply in the feed, especially during farm storage and administration. Importantly, contamination can also occur during the processing, transportation, and distribution of poultry feed. In an effort to reduce costs, many farmers either prepare feed themselves on the same premises where birds are kept or source it from local feed mills with poor hygiene standards. Thesepracticesheighten the risk of disease outbreaks.This high variety of ingredients used to produce poultry feed, as well as the high level of diversification among the farms in the feed production and processing and the general low level of hygienic practices can explain the high prevalence of Salmonella in feed samples and the heterogeneity of serovars isolated from this source (Fagbamila*et al*., 2017).

The outcome of this research has shown that the importance of bio-security practice (disease prevention) by poultry farmers in disease management is ranked very close to medication and insurance within the study region. This actually shows that bio-security measures are a normal managerial practice that is practised readily by the poultry farmers with minimum cost incurred as compared to medication and insurance, which requiresa high cost. The application of standard biosecurity measures is vital in protecting poultry birds from any disease, as demonstrated by Dorea *et al*. (2010). However, biosecurity has focused on maintaining or improving the health status of animals and preventing the introduction of new disease pathogens by assessing all possible risks to animal health (Fraser *et al*., 2010; Julien and Thomson, 2011). Augustine *et al*. (2010) reported that the implementation of sound bio-security measures will go a long way in minimising the problems of disease outbreak and spread in the Nigerian poultry industry, and also maintain consumers' confidence in Nigerian poultry products. Nevertheless, evidence gathered showed that there is a diverse urgency to sensitise the poultry farmers on the need to adopt good hygienic practices and sanitary measures in an effort to contain the spread of Salmonella. Aside from resource constraints, several measures are suggested to limit vertical and horizontal transmissions of *Salmonella* on farms and make the birds less vulnerable to Salmonella, as noted by some scholars (Humphrey, 2006; Wales *et al*., 2007; Ishihara *et al*., 2009).Specifically, to ensure feed and water remain free from *Salmonella* contamination, farms must implement effective cleaning and disinfection practices, establish strong protective measures against both inanimate and

21

443   animate vectors, and enhance the overall hygiene and sanitary conditions of the poultry
444   environment.

Conclusion

446   The outcome of this research indicates that the poultry farming industry is predominantly
447   male, and the farmers were active, agile and within productive age ranges; they were well-
448   educated with significant formal education and possessed considerable poultry farming
449   experience. Moreover, the study populations demonstrated a high awareness
450   ofSalmonellosisdisease, including its signs, symptoms, past occurrences, and preventive
451   measures. In addition, key information sources for Salmonellosis disease were identified as
452   seminars, extension workers, family/friends, and the Agricultural Development Programme
453   (ADP), with most study participants being well-informed about disease prevention. However,
454   the findingssuggested that biosecurity practices significantly influence poultry disease
455   management in Oyo State, Nigeria. Nevertheless, most farmers practiced low levels of
456   disease management, with only a minority achieving moderate or high levels. Positive factors
457   associated with moderate disease management, compared to low levels, included years of
458   formal education, household size, and poultry farming experience, whereas the farmer's sex
459   had a notable negative effect. In addition, marital status, nationality, tribe, and farm capacity
460   were important determinants of disease management levels.

Recommendations

462   In light of the study's findings, the following recommendations are suggested:

463   1. The point of policy focus must be directed towards the enlightenment programmes on
464   the importance of bio-security as a very important aspect of managing poultry disease
465   within the study region, or indeed to the whole country.
466   2. It should be required that the extension agency spread better bio-security measures
467   and better medication methods to all poultry farmers,which will enhance the current
468   level of poultry disease control in the study area.
469   3. Furthermore, it is stipulated that the government ought to educate poultry farmers
470   regularly with reference to biosecurity, disease reactions, and integration of current
471   husbandry-grazingpractices, which will protect our livestock sector.
472   4. Poultry farmers in the southwest of Nigeria have a very low mitigation option
473   utilisinga livestock insurance policy. Consequently, the government should implement

22

474   a policy that increases subsidies on livestock insurance to make it more affordable for
475   poultry farmers.

5. Lastly, educating poultry farmers and raising awareness about the advantages of
476   livestock insurance through extension agents is vital to boost their engagement in
477   using insurance as a tool to manage the risks associated with disease outbreaks in
478   poultry farming.
479

480

481

482

483

484

485

486

487

488

489

490

491

492

493

494

495

496

23

References

498 Abiodun, A., Lloyd, W., Lisa, M., Bowen, L., George, J., Alva, S.J. et al., (2014). 'Resistance
499 to antimicrobial agents among *Salmonella* isolates recovered from layer farms and
500 eggs in the Caribbean region', *Journal of Food Protection* 77(12), 2153–2160.

501 Adene D F and Oguntade A. (2008). Poultry sector review: Nigeria. FOOD Agric Organ
502 UNITED NATIONS.;1–95.

503 Adepoju, A.A. (2008). Technical efficiency of egg production in Osun State. Int. J. Agric.
504 Econ. Rural Dev., 1: 7-14.

505 Adesiyun, A., Offiah, N., Seepersadsingh, N., Rodrigo, S., Lashley, V., Musai, L. et al.
506 (2005). 'Microbial health risk posed by table eggs in Trinidad', *Epidemiology and*
507 *Infection* 133, 1049–1056.

508 Adisa, B.O. and Akinkunmi, J.A. (2012). Assessing participation of women in poultry
509 production as a sustainable livelihood Choice in Oyo State, Nigeria. *Int. J. Plant*
510 *Anim. Environ. Sci.,* 2: 73-82.

511 Agada,A.O.G., Abdullahi,O.I., Aminu, M, Odugbo, M, Chollom,C.S., and Okeke, A.L.
512 (2014). Prevalence and risk factors associated with Salmonella species contamination
513 of commercial poultry farms in Jos, Plateau State, Nigeria. *World Journal of*
514 *Biological Science* 2:49-61.

515 Ahmed, O.A., Mamman, P.H., Raji, M.A., Kwanashie, C.N., Raufu, I.A. and Aremu, A.,
516 (2017). 'Distribution of virulence genes in Salmonella Serovars isolated from poultry
517 farms in Kwara State, Nigeria', *Ceylon Journal of Science* 46(4), 69–76.

518 Akintunde, O.K and Adeoti, A.I. (2014). Assessment of Factors Affecting the Level of
519 Poultry Disease Management in Southwest, Nigeria. *Trends in Agricultural*
520 *Economics, 7: 41-56.*

521 Akter, M.R., Choudhury, K.A., Rahman, M.M. and Islam, M.S., (2007). 'Seroprevalence of
522 salmonellosis in layer chickens with isolation, identification and antibiogram study of
523 their causal agents', *Bangladesh Journal of Veterinary Medicine* 5, 32–42.

524 Appiah-Kubi, K., Amanning-Ampomah, E. and Ahortor, C. (2007). Multi-dimensional
525 analysis of poverty in Ghana using fuzzy sets theory. PMMA Working Paper 2007-
526 21, July 2007, pp: 1-37. http://portal.pep-net.org/documents/download/id/13551.

24

527   Augustine, C., Mojaba D. I. and Igwebuike, J.U. (2010). An assessment of bio-security status
528   of poultry farms in Mubi Zone of Adamawa State, Nigeria. *J. Agric. Vet. Sci.,* 2: 65-
529   67.

530   Babcock, B.A., N.M. Chaherli and P.G. Lakshminarayan, (1995). Program participation and
531   farm-level adoption of conservation Tillage: Estimates from a multinomial logit
532   model. Working Paper No. 95-WP 136, Centre for Agricultural and Rural
533   Development, Iowa State University, Ames, Iowa, May 1995, pp: 1-23.

534   Bettridge, J. M., Lunch, S. E, Brena, M. C., Melese, K., Dessie, T., Terfa, Z. G., et al.
535   (2014).Infection-interactions in Ethiopian village chickens. Prev Vet Med; 117, 358–
536   366. PMCID:PMC4235779 pmid:25085600.

537   Bhunia, A. K. (2008). Food borne Microbial Pathogens: Mechanisms and Pathogenesis.
538   Springer Science and Business Media, LLC, United States of America.

539   Centre for Disease Control and prevention (CDC). (2009). Multistate outbreak of Salmonella
540   infections associated with peanut butter and peanut butter containing products. USA
541   2009. Mmw F. Morbidity and Mortality 47th edition. McGraw Hill Co. 1250-1252.

542   Cerioli, A. and Zani, S. (1990). A Fuzzy Approach to the Measurement of Poverty. In:
543   Income and Wealth Distribution, Inequality and Poverty,

544   Charles, O.A.O., and Takayuki, K. (2010). Salmonella enterica serovar Enteritidis: a mini-
545   review of contamination routes and limitations to effective control. JARQ 44 (1), 7 -
546   16
547   http://www.jircas.affrc.go.jp. .

548   Costa, M., (2002). A multidimensional approach to the measurement of poverty. IRISS
549   Working   Paper   Series   No.   2002-05,   Luxembourg,   pp: 1-
550   17.http://iriss.ceps.lu/documents/irisswp28.pdf.

551   Dagum, C. and Costa, M. (2004) .Analysis and Measurement of Poverty. Univariate and
552   Multivariate Approaches and their Policy Implications. A Case Study: Italy. In:
553   Household Behaviour, Equivalence Scales, Welfare and Poverty, Dagum, C. and G.
554   Ferrari (Eds.). Physica-Verlag, Berlin, Germany, ISBN-13: 9783790826814, pp: 221-
555   271.

556   Dawoud, T.M., Hererra, P., Hanning, I., Kwon, Y.M. and Ricke, S.C., (2011). '*In vitro*
557   invasion of laying hen ovarian follicles by *Salmonella* Enteritidis strains', *Poultry*
558   *Science* 90, 1134–1137.

559 Dorea, F.C., Berghaus, R. Hofacre, C. and Cole, D.J.(2010). Survey of biosecurity protocols
560   and practices adopted by growers on commercial poultry farms in Georgia, U.S.A.
561   Avian Dis., 54: 1007-1015.

562 Ezeh, C.I., Anyiro, C.O. and Chukwu, J.A. (2012). Technical efficiency in poultry broiler
563   production in Umuahia capital territory of Abia state, Nigeria. *Greener J. Agric. Sci.,*
564   2: 1-7.

565 Fagbamila, I. O., Barco, L., Mancin, M., Kwaga J, Ngulukun SS, Zavagnin P. et al., (2017).
566   Salmonella serovars and their distribution in Nigerian commercial chicken layer
567   farms. PLoS One; 12 (3): 1-15.

568 Food and Agriculture Organization. (2018). Livestock and livelihoods spotlight NIGERIA:
569   Cattle   and   Poultry   Sectors.   2018;   Available   from:
570   http://www.fao.org/3/CA2149EN/ca2149en.pdf.

571 Fraser, R.W., William, N.T. Powell L.F and Cook, A.J.C. (2010). Reducing *Campylobacter*
572   and *Salmonella* infection: Two studies of the economic cost and attitude to adoption
573   of on-farm biosecurity measures. Zoonoses Public Health, 57: e109-e115.

574 Gast, R. K. (2003). Paratyphoid infections. In Diseases of Poultry, 11th ed., Eds., Y.M. Saif,
575   H.J. Barnes, A.M. Fadly, J.R. Glisson, L.R. McDougald and D.E. Swayne. IowaState
576   University Press, Ames, IA, pp: 583-613.

577 Hannah, J.F., Wilson, J.L., Cox, N.A., Richardson, L.J., Cason, J.A., Bourassa, D.V. et al.,
578   (2011). 'Horizontal transmission of *Salmonella* and *Campylobacter* among caged and
579   cage-free laying hens', *Avian Diseases* 55, 580–587.

580 Humphrey T. (2006). Are happy chickens safer chickens? Poultry welfare and disease
581   susceptibility. Br Poult Sci; 47, 379–391. pmid:16905463.

582 Hussein, M., Hala, K. and Khalil, A., (2009). 'Characterization of
583   *Salmonella*Lipopolysaccharide isolated from poultry farms in Jordan', *Dirasat Pure*
584   *Sciences* 36 (1), 30–37.

585 Ishihara K, Takahashi T, Morioka A, Kojima A, Kijima A, Asai T et al. (2009). National
586   surveillance of *Salmonella enterica* in food-producing animals in Japan. Acta Vet
587   Scand; 51: 35. PMCID:PMC2743694 pmid:19703311.

588 Isiorhovoja, R.A., (2013). Socioeconomic factors as predictors of entrepreneurial behaviour
589   in poultry farm. *Mediterr. J. Social Sci.,* 4: 511-517.

590 Jones F.T, and Richardson K.E. (2004). *Salmonella* in commercially manufactured feeds.
591   Poultry Science; 83, 384–391. pmid:15049490.

592   Julien, D. and Thomson, S. (2011). Interactive methods to educate and engage poultry
593   producers on the importance of practicing on-farm bio-security. *J. Agric. Ext. Rural*
594   *Dev.,* 3: 137-140.

595   Kwon, Y.K., Kim, A., Kang, M.S., Her, M., Jung, B.Y., Lee, K.M. et al., (2010). 'Prevalence
596   and characterization of *Salmonella*Gallinarum in the chicken in Korea during 2000 to
597   2008', *Poultry Science* 89, 236–242.

598   Lawal, B.O., Torimiro, D.O. and Makanjuola, B.A. (2009). Impact of agricultural extension
599   practices on the Nigerian poultry farmers' standard of living: A perceptional analysis.
600   Trop. Subtrop. Agroecosyst., 10: 465-473.

601   Maddala, G.S., (1983). Limited-Dependent and Qualitative Variables in Econometrics.
602   Cambridge University Press, Cambridge, UK., ISBN-13: 9780521338257, Pages:
603   401.

604   Mai, H. M, Zahraddeen, D, Qadeers, M.A, Bawa, I.A, and Echeonwu, I.E. (2013).
605   Investigation of some species of Salmonella in table eggs sold at different markets in
606   Jos South, Plateau State, Nigeria. *Global Advanced Research. Journal of*
607   *Microbiology* 2(11):234-238.

608   Majowicz, S.E, Musto, J, Scallan, E, Angulo, F.J, Kirk, M, O'Brien, S. J, et al. (2010). The
609   global burden of non-typhoidal Salmonella gastroenteritis. Clin Infect Dis.50:882–
610   889.

611   Mamman, P. H, Kazeem, H.M., Raji, M.A., Nok, A.J., and Kwaga J.K.P. (2014). Isolation
612   and characterization of *Salmonella*Gallinarum from outbreaks of fowl typhoid in
613   Kaduna State, Nigeria. *Int J Public Health Epidemiol*.; 3, 082–088.

614   Mughini-Gras, L., Enserink, R., Friesema, I., Heck, M., Van Duynhoven, Y. and Van Pelt,
615   W., (2014). 'Risk factors for human salmonellosis originating from pigs, cattle,
616   broiler chickens and egg laying hens: A combined case-control and source attribution
617   analysis', *PLoS One* 9, e87933.

618   Namata, H., Meroc, E., Aerts, M., Faes, C., Abrahantes, J.C., Imberechts, H., Mintiens, K.
619   (2008). *Salmonella* in Belgianlaying hens: an identification of risk factors. *Preventive*
620   *Veterinary Medicine* 83**,** 323-336.

621   NPC., (2006). Analysis of Nigerian 2006 census results. National Population Commission
622   (NPC), Abuja, Nigeria.

623   Obi, T.U., O.A. Olubukola and G.A. Maina, (2008). Pro-Poor HPAI risk reduction strategies
624   in Nigeria: Background paper. DFID Pro-poor HPAI Risk Reduction Strategies
625   Project, Africa/Indonesia Region Report No. 5, South Africa.

27

626   Ojo, S.O., (2003). Productivity and technical efficiency of poultry egg production in Nigeria.
627   Int. J. Poult. Sci., 2: 459-464.

628   Okwori, A.E.J., Ogbe, R.J., Chollom, S.C., Agada, G.O.A., Ujah, A., Okwori, E., Adeyanju,
629   O.N., and Echeonwu, G.O.N. (2013). Isolation of Salmonella Gallinarum from
630   poultry droppings in Jos metropolis, Plateau State, Nigeria. *IOSR Journal of*
631   *Agriculture and Veterinary Science* (IOSR-JAVS) e-ISSN: 2319-2380, p-ISSN: 2319-
632   2372 Volume 5,Issue 2, pp. 41-44. http://: www.iosrjournals.org.

633   Oladeebo, J.O. and Ambe-Lamidi, A. I. (2007). Profitability, input elasticities and economic
634   efficiency of poultry production among youth farmers in Osun state, Nigeria. Int. J.
635   Poult. Sci., 6: 994-998.

636   Olagunju, F.I. and Babatunde, R.O. (2011). Impact of credit on poultry productivity in South-
637   Western Nigeria. ARPN J. Agric. Biol. Sci., 6: 58-64.

638   Poppe, C., (2000). '*Salmonella* infections in the domestic fowl', in C. Wray and A. Wray
639   (eds.), *Salmonella* in domestic animals, CAB International, New York, p. 2000.

640   Raufu, I, Bortolaia, V, Svendsen, C.A, Ameh, J.A, Ambali, A.G, Aarestrup, F.M. et al.
641   (2013). The first attempt of an active integrated laboratory-based *Salmonella*
642   surveillance programme in the north-eastern region of Nigeria. *J App Microbiol*. 115,
643   1059–1067.

644   Raufu, I.A, Fashae, K, Ameh, J.A, Ambali, A, Ogunsola, F.T, Coker, A.O, and Hendriksen,
645   R.S. (2014) Persistence of fluoroquinolone-resistant Salmonella enterica serovar
646   Kentucky from poultry and poultry sources in Nigeria. *J Infect Dev Ctries* 8:384-388.
647   doi: 10.3855/jidc.3495.

648   Ritz, C.W., (2011). Poultry disease prevention checklist. Eggs Program Online, Issue No.
649   10/August 2011.

650   Solari, C.A, Mandarino, J.R, Panizzutti, M.H.M, and Farias, R.H.G. (2003). A new serovar
651   and a new serological variant belonging to Salmonella enteric sub species.
652   Diarizonae. Memórias do Instituto Oswaldo Cruz 98(4):501-502.

653   Uzokwe, U.N. and Bakare, E.A (2013). The effects of climate variability on poultry
654   production in Ose Local government area of Ondo State, Nigeria: Socio-economic
655   characteristics and perceptions of farmers. *Int. J. Agric.*Biosci., 2: 39-44.

656   Wales, A.; Breslin, M.; Carter, B.; Sayers, R. and Davies, R. (2007). A longitudinal study of
657   environmental Salmonella contamination in caged and free-range layer flocks. Avian
658   Pathol, 36, 187–197.

659   Zadeh, L.A., (1965). Fuzzy sets. Inform. Control, 8: 338-353.

28

660