



Assessment of Practices and Awareness of Avian Haemosporidian Infections among Village Poultry Farmers in Gombe State, Nigeria

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Abstract

Haemosporidian infections, caused by blood parasites of the genera *Plasmodium*, *Haemoproteus*, and *Leucocytozoon*, pose significant threats to the health and productivity of poultry populations worldwide. The level of awareness and knowledge among poultry farmers regarding these infections is crucial for effective disease management and prevention. This study aims to assess the awareness and knowledge levels among poultry farmers in Gombe State, shedding light on potential gaps and providing valuable insights for developing effective control strategies. The study employed a cross-sectional design and utilized structured questionnaire to collect data from a sample of poultry farmers in eight Local Government Areas of Gombe State, Nigeria. The findings revealed that majority of poultry farmers were male and are within 30-50 years age group. Most village poultry farmers had a low level of formal education, though some had secondary and tertiary education. The farmers primarily raised village chickens, allowing them to scavenge for food, often in unhygienic areas, and interact with other semi-domestic birds, potentially leading to cross transmission of haemoparasites. The study revealed that many farmers were unaware of avian haemosporidian infections, and a significant number did not provide extra feed supplementation or had never treated their chickens for blood parasites. They relied on fellow farmers and veterinarians for information, with limited access to government agricultural agencies or online sources. The research emphasizes the need for improved knowledge dissemination and extension services. Enhancing disease management practices, biosecurity measures, and vaccination in poultry farming is vital. The study concludes that providing training and support to farmers in disease prevention and control strategies is crucial to improve poultry health outcomes and livelihoods in the study area. Addressing these knowledge gaps can contribute to enhancing poultry production and food security in Gombe State, Nigeria.

Keywords: Awareness; Knowledge; Poultry Farmers; Haemosporidian Infections; Questionnaire Survey; Gombe State

Introduction

In Africa, and most of other developing countries including Nigeria, village poultry includes village chickens (*Gallus gallus domesticus*), guinea fowls (*Numida meleagris galeata pallas*), ducks (*Anas platyrhynchos*), turkeys (*Meleagris gallopavo*) and pigeons (*Columba livia domestica*) [1]. They play a significant economic role by providing high quality protein products, improving house-

hold diets, and generating income [2,3]. In developing countries, a large percentage of sedentary and nomadic individuals in rural societies own small flocks of scavenging poultry known as village poultry. These flocks serve as a means to alleviate poverty by generating cash through the sale of eggs or live birds [4]. Even in the industrialized world there is a niche market for scavenging poultry meat and eggs [5].

Amongst the village poultry species, the village chickens also termed as the “domestic fowl” are the most predominant in the rural poultry sector in Africa, where they are found in almost every rural household [6]. Village chickens are raised extensively in small numbers with minimal investment in their management, often lacking proper attention in terms of feeding, housing, and health-care [7,8]. They scavenge for food and water around households, dumps, or stagnant water, which exposes them to parasitic infections and other diseases [9].

The production system for village chickens is described as low-input and low-output [6], characterized by poor nutrition, predation risks, and low productivity [10]. Disease outbreaks are a major hindrance to village chicken productivity in many African countries [11,12]. The impact of parasitism on these birds can be severe, as blood parasites are known to infect various poultry species [13]. It is estimated that about 68% of all avian species are susceptible to haemosporidian parasites [14].

Haemosporidian infections, including avian malaria caused by blood parasites of the genera *Plasmodium*, *Haemoproteus*, and *Leucocytozoon*, have become a major concern for poultry farming industries globally [15,16]. These blood parasites are known to affect multiple avian species, causing significant economic losses due to weight loss, decreased feed conversion, decreased egg production, increased mortality, compromised flock health, and increased susceptibility to other pathogens [14]. They are primarily transmitted by hematophagous arthropods like mosquitoes, lice, and ticks [17,18]. The awareness and knowledge of village poultry farmers are crucial in preventing infectious diseases, as they play a pivotal role in disease prevention [19]. However, a lack of awareness among farmers may inadvertently contribute to the spread and intensification of haemosporidian infections within their flocks [20].

Nigeria is one of Africa’s largest village poultry producers but faces considerable challenges in maintaining optimal poultry health and productivity [21,22]. Gombe State has a significant village poultry farming industry characterized by a mix of small-scale and large-scale operations [23], but there is limited research on the awareness and knowledge of haemosporidian infections among farmers in Gombe State.

Understanding the awareness and knowledge gaps among village poultry farmers in Gombe State regarding haemosporidian infections is crucial for effective disease management and prevention. Identifying knowledge gaps and misconceptions can help develop strategies to improve disease control practices, minimize economic

losses, and reduce the use of antibiotics [24]. Enhancing awareness and knowledge can promote sustainable farming practices.

While previous studies have explored awareness and knowledge of poultry diseases, limited information is available on haemosporidian infections specifically. Regional variations in awareness and knowledge levels may exist, requiring research focused on specific geographical areas. Studies in South Africa [25], Central Phillipine islands [26] and Ethiopia [27] reported low awareness levels among farmers, while studies in South America [28], Brazil [29], China [30] and Malaysia [31] indicated better awareness and knowledge.

This study aims to assess the awareness and knowledge of haemosporidian infections among village poultry farmers in Gombe State, identify factors influencing awareness, evaluate the association between awareness and disease control practices, and provide recommendations for improvement. This study also aims to provide insights into potential knowledge gaps and factors influencing awareness, leading to improved control measures and better flock health.

The findings will contribute to the existing literature on avian haemosporidian infections in Nigeria’s village poultry farming context. They will inform the design and implementation of effective educational programs to mitigate the impact of haemosporidian infections on village poultry production in Gombe State and guide policymakers, veterinary professionals, and poultry industry stakeholders in implementing targeted interventions.

Materials and Methods

Study area

This study was carried out in Gombe State, Northeastern Nigeria. The state is situated in the North Eastern zone of Nigeria and shares boundaries with Bauchi, Taraba, Adamawa, Yobe and Borno states. Gombe state is located between latitude 9° 30’ and 12° 3’ N and longitude 8° 45’ and 11° 45’ E. The state has a mean annual rainfall of 818.5mm, with a mean maximum temperature of 37°C and a mean minimum temperature of 12°C. The major economic activities of the people of Gombe State include crop and livestock production as well as trading. The total poultry population in Gombe State is approximately 508, 305 comprising 462,000 backyard poultry and 46,305 exotic poultry [32]. Rural and urban areas within Eight (8) out of the Eleven (11) Local Government Areas of the state was visited for data collection *viz*: Gombe, Akko, Funakaye, Kwami, Dukku, Yamaltu-Deba, Kaltungo and Balanga Local Government Areas.

Study design

A cross-sectional study design adopting non-probability sampling techniques was employed using structured questionnaire to collect data and to evaluate poultry farmers’ awareness and knowledge of haemosporidian infections.

Sampling technique

Considering the population of poultry farmers in Gombe State, a representative sample of poultry farmers was selected using a multi-stage sampling technique. In the first stage, eight Local Government Areas (LGAs) were randomly selected out of the eleven LGAs of Gombe State. In the second stage, four districts were randomly selected from each LGA, and in the final stage, five poultry farms were randomly selected from each district.

Data collection and structured questionnaire survey

Data were collected using a structured questionnaire developed specifically for this study. The questionnaire was designed to gather information on the awareness, knowledge, and practices of poultry farmers related to haemosporidian infections. The questionnaire was pre-tested and modified accordingly before being administered to the study participants. Trained research assis-

tants conducted face-to-face interviews with the selected poultry farmers to collect the data. A total of 150 copies of a structured questionnaire were administered to the poultry farmers within the present study area, interpretation of interview to native languages were used where necessary, and the numerical aspects of the information were collected and analyzed.

Data analysis

Descriptive statistics, such as frequencies and percentages, were calculated to summarize the data. Inferential statistical tests, such as chi-square or Fisher’s exact test, were employed to explore associations between variables, such as awareness and knowledge levels with demographic factors and farm characteristics. Statistical significance was set at $p < 0.05$.

Ethical considerations

Informed consent was obtained from all participating poultry farmers before their inclusion in the study. Participants’ confidentiality and anonymity were ensured throughout the study.

Results

The sex, educational status and age of poultry farmers in Gombe State are presented in Table 1. Out of the 150 respondents, 128

Description of Poultry Farmers	Information	Local Government Areas Frequent (N (%))								Total Number of Respondents 150
		Gombe 20	Dukku 18	Akko 20	Funakaye 18	Kwami 18	Balanga 18	Yamaltu Deba 20	Kaltungo 18	
Sex	Male	15 (75.0)	13 (72.2)	15 (75.0)	18 (100.0)	17 (94.4)	16 (88.9)	18 (90.0)	16 (88.9)	128 (85.3)
	Female	5 (25.0)	5 (27.8)	5 (25.0)	0 (0.0)	1 (5.6)	2 (11.1)	2 (10.0)	2 (11.1)	22 (14.7)
Educational Status	Non-formal	8 (40.0)	11 (61.1)	13 (65.0)	10 (55.6)	10 (55.6)	6 (33.3)	8 (40.0)	2 (11.1)	68 (45.3)
	Primary	3 (15.0)	6 (33.3)	4 (20.0)	6 (33.3)	4 (22.2)	2 (11.1)	3 (15.0)	2 (11.1)	30 (20.0)
	Secondary	5 (25.0)	1 (5.6)	3 (15.0)	2 (11.1)	4 (22.2)	7 (38.9)	5 (25.0)	8 (44.4)	35 (23.3)
	Tertiary	4 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (16.7)	4 (20.0)	6 (33.3)	17 (11.3)
Ages	<30	2 (10.0)	1 (5.6)	1 (5.0)	1 (5.6)	2 (11.1)	2 (11.1)	1 (5.0)	1 (5.6)	11 (7.3)
	31-50	17 (85.0)	16 (88.9)	16 (80.0)	15 (83.3)	12 (66.7)	14 (77.8)	18 (90.0)	16 (88.9)	124 (82.7)
	>50	1 (5.0)	1 (5.6)	3 (15.0)	2 (11.1)	4 (22.2)	2 (11.1)	1 (5.0)	1 (5.6)	15 (10.0)

Table 1: Status of Respondents According to Local Government Area Sampled in Gombe State, Nigeria.

(85.3%) were males and 22 (14.7%) were females. Sixty-eight (45.3%) of the respondents have undergone Informal education, while 30 (20.0%) attended primary school, 35 (23.3%) are educated up to secondary school level and 17 (11.3%) are educated up to tertiary education. There was a significant difference ($p < 0.05$) in the educational status of poultry farmers in Gombe State, whereas there was no significant difference ($p > 0.05$) in responses related to their educational status in all the study areas.

One hundred and twenty four (82.7%) of the respondents were within 30-50 years age group, 11 (7.3%) were less than 30 years old while 15 (10.0%) were above 50 years old. There was a significant difference ($p < 0.05$) in ages of poultry farmers in Gombe State.

Table 2 summarizes the results of responses on the breed of chickens reared by poultry farmers in Gombe State. Out of 150 respondents, 66 (44.0%) rear local breed of chickens, 31 (20.7%) rear exotic breeds, and 53 (35.3%) rear both local and exotic breeds. There was a significant difference ($p < 0.05$) recorded based on the breed of chickens reared by the poultry farmers. However, there was no significant difference ($p > 0.05$) recorded in the proportion of response of the farmers based on the breed of chickens reared by poultry farmers in all the study areas. Moreover, 119 (79.3%) of the respondents reported that the predominant breed of chickens in their flock are local breed while 31 (20.7%) of the respondents had exotic breeds as the predominant in their flock. There was no significant difference ($p > 0.05$) in the response to breed of chickens by the poultry farmers in all the study areas.

Variables	Information	Local Government Areas Frequent (N (%))								Total Number of Respondents150
		Gombe 20	Dukku 18	Akko 20	Funakaye 18	Kwami 18	Balanga 18	Yamaltu Deba 20	Kaltungo 18	
Breed of chickens reared	Local only	8 (40.0)	11 (61.1)	8 (40.0)	10 (55.6)	10 (55.6)	8 (44.4)	6 (30.0)	5 (27.8)	66 (44.0)
	Exotic only	4 (20.0)	3 (16.7)	3 (15.0)	1 (5.6)	3 (16.7)	3 (16.7)	6 (30.0)	8 (44.4)	31 (20.7)
	Local + Exotic	8 (40.0)	4 (22.2)	9 (45.0)	7 (38.8)	5 (27.8)	7 (38.8)	8 (40.0)	5 (27.8)	53 (35.3)
Predominant breed reared	Local	16 (80.0)	15 (83.3)	17 (85.0)	17 (94.4)	15 (83.3)	15 (83.3)	14 (70.0)	10 (55.6)	119 (79.3)
	Exotic	4 (20.0)	3 (16.7)	3 (15.0)	1 (5.6)	3 (16.7)	3 (16.7)	6 (30.0)	8 (44.4)	31 (20.7)

Table 2: Breeds of Chickens Reared by Poultry Farmers in Gombe State, Nigeria.

The result of poultry farmers’ responses on the practice of feed supplementation in village chickens production in Gombe State is shown in Table 3. Out of 150 respondents, 50 (33.3%) of the village chickens farmers provide feed supplements for their village chickens while 100 (66.7%) do not provide feed supplementation. There was a significant difference ($p < 0.05$) between poultry farmers that provide feed supplements in addition to scavenging of their village chickens in Gombe State and those that do not.

Also, 119 (79.3%) village chicken farmers revealed that the village chickens usually scavenge for feeds on refuse dumps, near stagnant pools of water and other unhygienic places while 31 (20.7%) revealed that their village chickens are usually restricted from scavenging. There was a significant difference ($p < 0.05$) between poultry farmers whose village chickens scavenge on refuse dumps and near stagnant pools of water and those that do not.

Table 4 show the response of farmers on rearing village chickens with other domestic birds. Out of 150 respondents, 119 (79.3%) respondents revealed that they rear village chickens with other domestic birds such as ducks, turkeys, guinea fowls and pigeons, while 31 (20.7%) respondents revealed that they do not rear their village chickens with other domestic birds. There was a significant difference ($p < 0.05$) between proportion of respondents that rear village chickens with other domestic birds and those that do not. Also, 16 (10.7%) poultry farmers revealed that the village chickens usually mingled with wild birds which were ornamental such as the peacock, geese and water fowls while 134 (89.3%) revealed that their village chickens do not mingle with wild birds. There was a significant difference ($p < 0.05$) between proportion of respondents whose village chickens mingled during scavenging with wild birds and those whose chickens do not mingle with wild birds.

Variables	Response	Local Government Areas Frequent (N (%))								Total Number of Respondents 150
		Gombe 20	Dukku 18	Akko 20	Funakaye 18	Kwami 18	Balanga 18	Yamaltu Deba 20	Kaltungo 18	
Village chickens with other poultry species	Yes	16 (80.0)	15 (83.3)	17 (85.0)	17 (94.4)	15 (83.3)	15 (83.3)	14 (70.0)	10 (55.6)	119 (79.3)
	No	4 (20.0)	3 (16.7)	3 (15.0)	1 (5.6)	3 (16.7)	3 (16.7)	6 (30.0)	8 (44.4)	31 (20.7)
Village chickens mingle with wild birds	Yes	5 (25.0)	1 (5.6)	3 (15.0)	0 (0.0)	1 (5.6)	0 (0.0)	2 (10.0)	4 (22.2)	16 (10.7)
	No	15 (75.0)	17 (94.4)	17 (85.0)	18 (100.0)	17 (94.4)	18 (100.0)	18 (90.0)	14 (77.8)	134 (89.3)

Table 4: Interactions of Village Chickens with other Avian Species in Gombe State, Nigeria.

Variables	Response	Local Government Areas Frequent (N (%))								Total Number of Respondents 150
		Gombe 20	Dukku 18	Akko 20	Funakaye 18	Kwami 18	Balanga 18	Yamaltu Deba 20	Kaltungo 18	
Awareness of blood parasites by poultry farmers	Aware	2 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (15.0)	1 (5.6)	6 (4.0)
	Unaware	18 (90.0)	18 (100.0)	20 (100.0)	18 (100.0)	18 (100.0)	18 (100.0)	17 (85.0)	17 (94.4)	144 (96.0)
Treat chickens for blood parasites	Yes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	No	20 (100.0)	18 (100.0)	20 (100.0)	18 (100.0)	18 (100.0)	18 (100.0)	20 (100.0)	18 (100.0)	150 (100.0)
Other type of Parasites treated	Ectoparasites	3 (15.0)	1 (5.6)	1 (5.0)	2 (11.1)	1 (5.6)	3 (16.7)	3 (15.0)	3 (16.7)	17 (11.3)
	Gastrointestinal	17 (85.0)	17 (94.4)	19 (95.0)	16 (88.9)	17 (94.4)	15 (83.3)	17 (85.0)	15 (83.3)	133 (88.7)

Table 5: Level of Avian Haemoparasites Awareness and Treatments amongst Poultry Farmers in Gombe State, Nigeria.

The results on the responses of poultry farmers on awareness of the occurrence of haemoparasites in village chickens in Gombe State are shown in Table 5. Out of 150 respondents, 6 (4.0%) reported that they are aware of the occurrence of haemoparasites in village chickens while 144 (96.0%) reported that they were not aware. There was a significant difference ($p < 0.05$) between proportion of poultry farmers that revealed that they were aware of the occurrence of haemoparasites in village chickens and those that were unaware.

Also, all the 150 (100%) respondents interviewed reported that they have never engaged in the treatment of their village chicken flocks against any type of blood parasites. However, 17 (11.3%) of these poultry farmers reported that they usually treat their chickens against ectoparasites such as lice, flea and mites, while 133 (88.7%) reported that they engaged in the treatment of their flocks

against gastrointestinal parasites using several kinds of medications. There was no significant difference ($p > 0.05$) in the response of these poultry farmers in all the entire study area.

Table 6 presents the findings concerning the sources of information on poultry health and diseases in Gombe State, Nigeria, as reported by poultry farmers. Out of 150 respondents, 87 (58.0%) reported that they obtained information from fellow poultry farmers, 48 (32.0%) from Veterinary professionals, 9 (6.0%) from government agricultural agencies, and 6 (4.0%) from online sources such as websites and social media.

The results of the poultry farmers' satisfaction levels with the information received from these sources revealed that, 105 (70.0%) of the village chicken farmers expressed dissatisfaction with the information they received, while 45 (30.0%) reported

Source of Information regarding:	Response	Local Government Areas Frequent (N (%))								Total Number of Respondents N = 150
		Gombe 20	Dukku 18	Akko 20	Funakaye 18	Kwami 18	Balanga 18	Yamaltu Deba 20	Kaltungo 18	
Poultry health and diseases	Veterinary professionals	5 (25.0)	6 (33.3)	9 (45.0)	3 (16.7)	1 (5.6)	5 (27.8)	9 (45.0)	10 (55.6)	48 (32.0)
	Government agricultural agencies	3 (15.0)	4 (22.2)	1 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (5.6)	9 (6.0)
	Fellow poultry farmers	9 (45.0)	8 (44.4)	9 (45.0)	15 (83.3)	17 (94.4)	13 (72.2)	11 (55.0)	5 (27.8)	87 (58.0)
	Online sources (websites, social media)	3 (15.0)	0 (0.0)	1 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (11.1)	6 (4.0)
Satisfaction with the information receive from these sources	Not satisfied	16 (80.0)	15 (83.3)	17 (85.0)	17 (94.4)	15 (83.3)	15 (83.3)	14 (70.0)	10 (55.6)	105 (70.0)
	Satisfied	4 (20.0)	3 (16.7)	3 (15.0)	1 (5.6)	3 (16.7)	3 (16.7)	6 (30.0)	8 (44.4)	45 (30.0)

Table 6: Source of Information regarding poultry health and diseases by poultry farmers in Gombe State, Nigeria.

being satisfied with the information provided by their sources on poultry health and diseases.

There was statistically significant difference ($p < 0.05$) between the satisfaction levels of poultry farmers who were content with the information and those who were not satisfied. However, there was no significant difference ($p > 0.05$) observed in the responses of the poultry farmers across all the study areas.

The outcomes of the questionnaire survey on disease management practices among poultry farmers in Gombe State, Nigeria, have been presented in Table 7. Out of 150 respondents, the results indicate that 85 (56.7%) respondents use various medications for managing diseases, while 4 (2.7%) respondents rely on vaccination. Additionally, 13 (8.7%) respondents implement biosecurity measures as part of their disease management practices, and 48 (32.0%) respondents seek professional veterinary assistance for disease management strategies on their poultry farms. There was a significant difference ($p < 0.05$) between poultry farmers' responses on the difference disease management practices. However, in terms of the overall responses from poultry farmers across all study areas, there were no significant differences ($p > 0.05$) found.

The outcome of the questionnaire survey conducted in Gombe State, Nigeria, presented in Table 8 focused on poultry farmers' experiences with training or support in poultry disease management

over the past year. Out of 150 respondents, 16 (10.7%) reported having received training or support for poultry disease management, while the majority, 134 farmers (89.3%), stated that they did not receive any such training or support during the past year. Statistical analysis revealed a significant difference ($p < 0.05$) between poultry farmers who received training or support and those who did not. However, there was no significant difference ($p > 0.05$) observed in the responses of poultry farmers across all the study areas.

Table 8 also presents the outcomes of a questionnaire survey, focusing on poultry farmers' responses regarding preventive measures to reduce the risk of Haemosporidian infections in their flocks in Gombe State, Nigeria. Surprisingly, 100% of the village chicken farmers (150 out of 150 respondents) reported that they had not implemented any strategies to minimize the risk of Haemosporidian infections in their village chicken flocks. On the contrary, none of the respondents (0 out of 150) admitted to having any preventive strategies for their chicken flocks. Statistical analysis revealed a significant difference ($p < 0.05$) between poultry farmers who implemented strategies to reduce the risk of Haemosporidian infections in their village chicken flocks and those who did not. However, the study did not find any significant difference ($p > 0.05$) in the responses of poultry farmers across all the study areas.

Management Practices	Response	Local Government Areas Frequent (N (%))								Total Number of Respondents N = 150
		Gombe 20	Dukku 18	Akko 20	Funakaye 18	Kwami 18	Balanga 18	Yamaltu Deba 20	Kaltungo 18	
Disease Management Practices on poultry farm	Medication	11 (55.0)	12 (16.7)	11 (55.0)	13 (72.2)	17 (94.4)	10 (55.6)	7 (35.0)	4 (22.2)	85 (56.7)
	Vaccination	1 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (5.6)	1 (5.0)	1 (5.6)	4 (2.7)
	Biosecurity measures	3 (15.0)	0 (0.0)	0 (0.0)	2 (11.1)	0 (0.0)	2 (11.1)	3 (15.0)	3 (16.7)	13 (8.7)
	Seek veterinary assistance	5 (25.0)	6 (33.3)	9 (45.0)	3 (16.7)	1 (5.6)	5 (27.7)	9 (45.0)	10 (55.6)	48 (32.0)

Table 7: Disease Management Practices on poultry farms by poultry farmers in Gombe State, Nigeria.

Training or support of Poultry farmers	Response	Local Government Areas Frequent (N (%))								Total Number of Respondents N = 150
		Gombe 20	Dukku 18	Akko 20	Funakaye 18	Kwami 18	Balanga 18	Yamaltu Deba 20	Kaltungo 18	
Experiences with Training or support regarding poultry disease management in the past year	Yes	5 (25.0)	2 (11.1)	0 (0.0)	0 (0.0)	0 (0.0)	1 (5.6)	3 (15.0)	5 (27.8)	16 (10.7)
	No	15 (75.0)	16 (88.9)	20 (100.0)	18 (100.0)	18 (100.0)	17 (94.4)	17 (85.0)	13 (72.2)	134 (89.3)
Preventive measures in place to minimize the risk of Haemosporidian infections	Yes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	No	20 (100.0)	18 (100.0)	20 (100.0)	18 (100.0)	18 (100.0)	18 (100.0)	20 (100.0)	18 (100.0)	150 (100.0)

Table 8: Training/support and Preventive measures regarding poultry disease management by poultry farmers in Gombe State, Nigeria.

Discussion

The questionnaire survey on awareness and knowledge of haemosporidian infections among village poultry farmers in this study revealed that the majority of village chicken farmers are male, indicating that men are more involved in the village chicken production systems than females. This finding is consistent with previous studies in different regions of Nigeria [33] and some parts of Africa [34], where men were reported to be the major owners and participants in poultry farming. This could be due to the high level of risk and other husbandry processes which are not attractive to most women.

However, there are some variations in the ownership and involvement of women in village poultry farming across different communities in Nigeria [35]. In some areas, women are more involved in indigenous poultry production and may be more knowledgeable about the business than men [36]. The variation in the ownership of chicken between men and women may be associated to the socio-cultural norms existing between the different com-

munities in Nigeria. Women and their children often assist men in various tasks related to poultry farming, such as feeding, watering, and cleaning the poultry houses, as they are major beneficiaries of village chicken production systems in households [37].

Despite playing significant roles in the development of village poultry production systems, particularly in extension work and vaccination programs as reported by Sonaiya and Swan [38], men are usually dominant as decision makers of the household to purchase replacement stock, shelter constructions and buy drugs to treat sick birds as reported by Yakubu [39].

It was reported by Okitoi *et al.* [40] that the ownership of the village poultry business is shared among family members, reflecting a collective effort in managing and benefiting from the poultry farming enterprise.

This study also revealed low level of literacy among poultry farmers and designates that village chicken farmers educational

background are within the non-western education (*karatun tsan-gaya or karatun allo*), and first leaving school certificate, but, some poultry farmers have secondary school and tertiary education. These findings consistent with that of Lawal, *et al.* [41] and Dunya, *et al.* [42] who reported low level of literacy among village chicken farmers in Bauchi and Borno States respectively, other investigators reported that majority of village chicken farmers in Plateau and Oyo States of Nigeria are formally educated [33]. However, Samkange, *et al.* [43] in Namibia reported that low western education level among village chickens farmers could be one of the major constraints that can hinder specialized production at a significant commercial level. Also, Conroy, *et al.* [44] have reported illiteracy or lack of adequate education and civilization among small holder poultry farmers in developing countries among the constraints towards successful poultry production, while Adisa, *et al.* [45] reported that education is a continuous issue and there is a positive correlation between education and farm efficiency.

Most poultry farmers in the study fell within the age range of 30 to 50 years, which is considered the most productive age group. This finding aligns with previous reports from Ezra, *et al.* [34], Issa, *et al.* [36] and Ndahi, *et al.* [33] who also observed that chicken farmers are primarily within this age group and are eager to enhance their income through productive ventures to improve their livelihood and the national economy.

The study revealed that in Gombe State, many poultry farmers only keep village chickens, while some solely keep exotic chickens, and others have mixed flocks of both village and exotic chickens. The farmers practice both extensive and intensive management systems for their poultry. These findings are consistent with a study by Adedeji, *et al.* [46] which identified chickens, ducks, guinea fowls, turkeys, and pigeons as the most commonly reared species in Nigeria.

Furthermore, the study's results agree with Lawal, *et al.* [41] who conducted a similar survey in Bauchi State, reporting that most farmers kept village chickens (62.2%) compared to exotic chickens (37.8%). The popularity of village chickens is attributed to their ease of keeping and the lack of a need for sophisticated production systems to manage them effectively.

The research revealed that poultry farmers in Gombe State predominantly raise village chickens, which corroborates earlier findings indicating that these chickens are the most commonly kept breed in developing nations, including Nigeria, especially in rural and suburban regions [47]. Village chickens have extensive distri-

bution and hold significant importance in the agricultural practices of rural communities across various developing countries, including Nigeria [48].

In Gombe State, a significant number of poultry farmers raise village chickens alongside other domestic birds like ducks, turkeys, guinea fowls, and pigeons. This practice of keeping different poultry species together is common in rural Nigeria, as reported by Mohammed and Sunday [49]. The birds share the same feeding and roosting areas, increasing the risk of infections spreading among them. However, this cohabitation can lead to potential problems. Previous reports by Mohammed [50] have highlighted the possibility of maintaining cycles of infections, particularly parasitic diseases. Additionally, rearing different species of birds together might facilitate the occurrence of accidental infectious parasitic diseases in birds that are not the definitive hosts of those diseases.

Most respondents do not provide extra feed supplementation to their village chickens, opting to let them solely scavenge for food. This aligns with a similar practice reported in Borno State by Dunya, *et al.* [42]. However, this approach may lead to nutritional deficiencies in the chickens, which could reduce their immunity to infections. Abanigbe, *et al.* [51] highlighted that inadequate nutrients can cause weight loss, lower market values, and increase susceptibility to infectious diseases in chickens. On the other hand, Rajiur [52] argued that supplementation can improve the quantity and quality of the chickens' daily ration. The availability of scavenged feed resources is affected by seasonal fluctuations, and in many developing countries, the village chicken production system heavily relies on the quality and quantity of available scavenging resources, as mentioned by Hayat, *et al.* [53].

This study found that village chickens in the Gombe State scavenge for food in unhygienic places like refuse dumps and stagnant pools of water. This behavior was found to be positively correlated with the presence of haemoparasites in these chickens [54]. The unhygienic sites, such as refuse dumps and stagnant water, serve as breeding grounds for arthropods that can transmit parasites to the chickens. Consequently, the chickens may get infected with haemoparasites through bites from these infected vectors while scavenging for food.

The study found that village chickens interact with semi-domestic birds like peacocks and waterfowls such as geese in the study area. While these interactions may not be prolonged, they occur during the free scavenging period, potentially leading to cross transmission of haemoparasites. This transmission is facilitated by the presence of an active arthropod vector.

Previous studies by Valkiūnas, *et al.* (2014) and [9] (2015) support the idea that cross transmission of haemoparasites is possible when birds mingle, especially when competing for grains and insects in the field and in the presence of an active vector.

This study found that a significant number of respondents were unaware of avian haemoparasites in village chickens. This lack of awareness contributes to the ignorance surrounding the need for preventive measures against haemoparasitic diseases in poultry. Similar findings have been reported in previous studies in Nigeria, where low awareness and inadequate extension services hinder the successful production of village chickens in rural areas Adisa, *et al.* [45]. Extension services are essential for technology adoption in chicken management and disease prevention.

This study further revealed that village chicken farmers in the study areas have never treated their chickens for blood parasites, which may explain the presence of avian haemoparasites in Gombe State as reported by Lawal, *et al.* [54]. Consequently, without treatment or preventive measures, these parasites can continue to circulate within infected flocks.

The findings of the present study revealed that majority of poultry farmers (58.0%) primarily depend on fellow poultry farmers for information on poultry health and diseases, 32.0% of respondents got their knowledge from veterinarians, 6.0% from government agricultural agencies, and 4.0% from online sources. This might be connected with the fact that village chicken farmers prefer getting information from fellow farmers due to the close-knit nature of rural communities and the traditional practice of sharing knowledge and experiences among local farmers. Farmers frequently exchange knowledge and practical experiences, especially in areas where formal sources of information are limited [55]. The significant reliance on fellow poultry farmers for information highlights the role of informal knowledge networks. While this can be beneficial for practical insights, it may not always provide accurate and up-to-date information on avian haemosporidian infections [56]. Some village poultry farmers, however, turn to veterinarians for advice which indicates recognition of their expertise and experience in identifying and treating poultry diseases and, their credibility and expertise make them a reliable source of information on poultry health and diseases [34]. Limited access to professional expertise, relying heavily on fellow farmers and having only 32.0% of respondents consulting veterinary professionals might lead to inadequate knowledge about avian haemosporidian infections and other infectious poultry disease. This could result in misdiagnosis, improper treatment, and the spread of the infection within poultry

flocks. However, some poultry farmers get their information from governmental agricultural organizations. These organizations may offer instructional resources or run campaigns to raise awareness of the health and diseases that affect poultry [55]. The low percentage of farmers rely on government agencies, however, suggests insufficient outreach or communication with village chicken farmers compared to other sources in the study area. Such programs are essential for disseminating crucial information about avian haemosporidian infections and other poultry-related diseases [57]. However, few of the village chicken farmers indicated they obtained their knowledge online. The comparatively low percentage could be attributed to limited access to the internet and digital resources by village chicken farmers in the study area, especially in rural areas. Online sources may not be as reliable compared to established ones like veterinarians or fellow farmers [58]. With only 4.0% of respondents obtaining information from online sources, there is an opportunity to enhance digital literacy among poultry farmers in the study area. Utilizing online platforms can help disseminate valuable information about poultry health and diseases more widely [58].

The study reveals that a significant number of poultry farmers (70.0%) are dissatisfied with the information they receive, while only 30.0% reported being satisfied. Statistical analysis shows a significant difference in satisfaction levels between these two groups. High levels of dissatisfaction suggest a lack of awareness and knowledge among poultry farmers about avian haemosporidian infections. This may lead to insufficient preventive measures and treatment, increasing the risk of disease outbreaks and economic losses. Also, farmer dissatisfaction might lead to inadequate implementation of disease management practices, negatively affecting poultry health, productivity, and overall production in the study area. Heavy reliance on fellow farmers might limit the adoption of modern, evidence-based disease management practices. Access to updated information from veterinary professionals and government agencies is crucial for improving poultry health outcomes [59]. The present study emphasizes the importance of improving the dissemination of accurate and relevant information to poultry farmers. Strengthening extension services, organizing workshops, and enhancing access to online resources can bridge the information gap and enhance poultry health awareness in the study area. Addressing the information needs of poultry farmers and providing them with accurate and up-to-date information on avian haemosporidian infections and other poultry health issues is essential for improving poultry production outcomes in Gombe State, Nigeria.

The present study showed that many respondents were not familiar with avian haemosporidian infections, indicating a lack of awareness about this type of disease among poultry farmers in the study area. This revealed significant gaps in knowledge of avian haemosporidian infections and disease management practices. Insufficient knowledge and awareness of avian haemosporidian infections might result in delayed or incorrect diagnosis and treatment, leading to higher mortality rates, reduced flock productivity, and economic losses for the poultry farmers. A large majority of poultry farmers relied on medications for disease management, while only a small percentage used vaccination. This suggests that many farmers might not be aware of the benefits of vaccination in preventing infectious avian diseases. The reliance on medications alone may not effectively control avian haemosporidian infections. Lack of other reliable preventive measures could lead to higher disease prevalence and economic losses for the farmers [34]. Only a small proportion of respondents reported implementing biosecurity measures, indicating a lack of awareness about its importance in preventing and controlling the spread of infectious diseases, including avian haemosporidian infections. The limited implementation of biosecurity measures could result in the easy spread of avian haemosporidian infections between poultry farms, leading to disease outbreaks and difficulties in disease control [60]. A significant number of farmers sought professional veterinary assistance for disease management strategies, but a considerable proportion attempted to manage diseases without professional guidance.

The finding of the present study have revealed that only a small proportion (10.7%) of poultry farmers received training or support for poultry disease management in the past year, while the majority of farmers (89.3%) did not receive any training or support. Statistical analysis showed a significant difference between farmers who received training/support and those who did not ($p < 0.05$). The low percentage of farmers receiving training suggests limited awareness or knowledge about the importance of disease management in poultry production, leading to poor disease prevention and control practices. The high percentage of farmers without training or support may indicate a lack of access to resources like training programs or veterinary assistance, hindering effective disease management [34,36]. Inadequate training and support could lead to disease outbreaks among poultry flocks, resulting in economic losses for farmers and impacting overall poultry production in the study area. Lack of proper knowledge and support might negatively impact the productivity and profitability of poultry farming in Gombe State. Poultry farming is vital for livelihoods and food security, therefore, the lack of disease management training and support could affect farmers' livelihoods and their contribution to the local food supply [34].

The present study has also revealed that all village poultry farmers surveyed did not implement any measures to minimize the risk of Haemosporidian infections in their flocks. This highlights a significant gap in understanding the importance of preventive measures for poultry health. None of the respondents reported having any preventive strategies, indicating a lack of awareness and knowledge about avian haemosporidian infections and their potential impact on poultry health and production. Without preventive measures, poultry flocks are at a higher risk of haemosporidian infections and other infectious diseases, leading to disease outbreaks, increased mortality rates, and reduced productivity [61,62]. Disease outbreaks can cause economic losses for poultry farmers, as sick or dead chickens result in reduced revenue, affecting their livelihoods and overall economic stability.

Conclusions

In conclusion, the study highlights that men are predominantly involved in village chicken production systems, and are within 30-50 years age group in Gombe State. The study identifies a low level of literacy among village poultry farmers, with many having only non-western or basic education. Although some farmers have secondary or tertiary education, the majority lack formal education. The study shows that village chickens are the most commonly reared breed of chickens in Gombe State, followed by exotic chickens. Village chickens are allowed to scavenge in unhygienic places and interacting with semi-domestic and waterfowl species pose a risk of infectious disease transmission. These practices may lead to accidental infectious parasitic diseases, emphasizing the need for improved management practices. A significant number of poultry farmers are unaware of avian haemoparasites, highlighting a knowledge gap in disease prevention and management. This lack of awareness may lead to improper diagnosis and treatment, increasing the risk of disease outbreaks and economic losses.

Recommendations

From this study it is recommended that:

- **Improve extension services and veterinary support:** Strengthening extension services and enhancing access to veterinary professionals can bridge the information gap and provide poultry farmers in Gombe State with accurate and up-to-date information on avian haemosporidian infections and other poultry health issues. Workshops and training programs can be organized to disseminate crucial information effectively.

- **Promote biosecurity measures:** Increase awareness about the importance of biosecurity measures among poultry farmers in Gombe State to prevent and control the spread of infectious diseases. Implementing biosecurity practices can reduce disease prevalence and improve overall poultry health.
- **Encourage vaccination:** Promote the benefits of vaccination in preventing infectious avian diseases, including haemoparasitic infections. Educate farmers in Gombe State on the importance of incorporating vaccination as a preventive measure in their poultry management practices.
- **Enhance digital literacy and online resources:** Improve access to online platforms and resources to disseminate valuable information about poultry health and diseases. Increasing digital literacy among poultry farmers in Gombe State can help them access reliable information and adopt modern disease management practices.
- **Provide training and support for disease management:** Develop and implement training programs and support systems for poultry farmers in Gombe State in disease management strategies. This will empower farmers with the knowledge and skills needed to prevent and control avian haemoparasitic infections effectively.
- **Promote cooperative efforts and knowledge-sharing:** Encourage collaboration and knowledge-sharing among poultry farmers in Gombe State to leverage informal knowledge networks. This will facilitate the dissemination of practical insights while complementing information from formal sources.
- **Monitoring and Surveillance:** Establish a system for monitoring and surveillance of avian haemosporidian infections in poultry farms in Gombe State. Regularly collect data on disease incidence, prevalence, and treatment outcomes to assess the effectiveness of control measures and identify emerging challenges.
- **Foster research on haemoparasitic infections:** Support further research on avian haemoparasitic infections in Gombe State to better understand their prevalence, transmission patterns, and effective management strategies. Research findings can guide targeted interventions to control and prevent these infections.

By implementing these recommendations, policymakers, agricultural agencies, and stakeholders can work together to enhance poultry health awareness, reduce disease burden, and improve the livelihoods of village poultry farmers in Gombe State, Nigeria.

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Conflict of Interest

The authors declare no conflicts of interest regarding the publication of this manuscript.

Bibliography

1. Opara MN., *et al.* "Blood and Gastrointestinal Parasites of Chickens and Turkeys Reared in the Tropical Rainforest Zone of Southeastern Nigeria". *Open Journal of Veterinary Medicine* 4 (2014): 308-313.
2. Salami SA., *et al.* "Farmer's Perception on the Benefits of Poultry Production in Abuja Municipal Area Council, Federal Capital Territory, Nigeria". *Nigerian Agricultural Journal* 52.1 (2021): 96-101.
3. Attia YA., *et al.* "Poultry Production and Sustainability in Developing Countries under the COVID-19 Crisis: Lessons Learned". *Animals* 12 (2022): 644.
4. Chepkemoi M., *et al.* "Physical Characteristics and Nutritional Composition of Meat and Eggs of five Poultry species in Kenya". *Livestock Research for Rural Development* 29 (2017): 153.
5. Gemechu T and Amene T. "Review on Production, Husbandry and Sustainability of Free-Ranging Poultry Production Systems in Ethiopia". *International Journal of Sciences* 4.04 (2015): 28-34.
6. Blackie S. "Village Chicken Production System in the Greater Accra Region, Ghana". *Journal of Biology, Agriculture and Healthcare* 4.9 (2014): 89-94.
7. Alders RG and Pym RAE. "Village poultry: still important to millions eight thousand years after domestication". *World's Poultry Science Journal* 65.2 (2009): 181-190.
8. Nnadi PS and George SO. "A Cross-sectional survey on Parasites of Chickens in selected Villages in the sub humid zones of South-eastern Nigeria". *Journal of Parasitology Research, Article* ID141824 (2010): 1-19.

9. Sehgal RNM. "Manifold Habitat effects on the Prevalence and diversity of Avian Blood Parasites". *International Journal for Parasitology, Parasites and Wildlife* 4 (2015): 421-430.
10. Malatji DP, et al. "A Description of Village Chicken Production Systems and Prevalence of Gastrointestinal Parasites: Case studies in Limpopo and KwaZulu-Natal Provinces of South Africa". *Onderstepoort Journal of Veterinary Research* 83.1 (2016): 968.
11. Weyuma H., et al. "Studies on Management Practices and Constraints of Back Yard Chicken Production in Selected Rural Areas of Bishoftu". *Journal of Veterinary Science and Technology* S12 (2015): 3.
12. Hafez HM and Attia YA. "Challenges to the Poultry Industry: Current Perspectives and Strategic Future after the COVID-19 Outbreak". *Frontiers in Veterinary Science* 7 (2020): 516.
13. Tostes R., et al. "*Plasmodium* spp. and *Haemoproteus* spp. infection in Birds of the Brazilian Atlantic Forest Detected by Microscopy and Polymerase Chain Reaction". *Pesquisa Veterinária Brasileira* 35.1 (2015): 67-74.
14. Valkiūnas G. "Avian Malaria Parasites and Other Haemosporidia". CRC; Boca Raton, FL, USA (2005): 1-932.
15. Valkiūnas G., et al. "Increase of avian *Plasmodium circumflexum* prevalence, but not of other malaria parasites and related haemosporidians in northern Europe during the past 40 years". *Malarial Journal* 21.1 (2022): 105.
16. Valkiūnas G and Iezhova TA. "Insights into the Biology of *Leucocytozoon* Species (Haemosporida, Leucocytozoidae): Why Is There Slow Research Progress on Agents of Leucocytozoonosis?" *Microorganisms* 11.5 (2023): 1251.
17. Mirzaei F., et al. "Blood Parasites in Domestic Birds in Central Iran". *Veterinary Science* 7 (2020): 126.
18. Žiegytė R and Bernotienė R. "Contribution to the knowledge on black flies (Diptera: Simuliidae) as vectors of Leucocytozoon (Haemosporida) parasites in Lithuania". *Parasitology International* 87 (2022): 102515.
19. Serbessa TA., et al. "Review on diseases and health management of poultry and swine". *International Journal of Avian and Wildlife Biology* 7.1 (2023): 27-38.
20. Adam VY., et al. "Assessment of the Knowledge of Poultry Farmers and Live Poultry Sellers to Preventive and Control Measures on Bird Flu, Benin City, Nigeria". *Epidemiology Research International* 6 (2014).
21. Anosike FU., et al. "Challenges of poultry production in Nigeria: A review". *Nigerian Journal of Animal Production* 45.1 (2020): 252-258.
22. Food and Agriculture Organisation (FAO). "The State of Food Security and Nutrition in the World".
23. Panwal EF, et al. "Economic Analysis of Broiler Production in Akko Local Government Area of Gombe State, Nigeria. Akwa Ibom State University". *Journal of Agricultural Economics, Extension and Rural Development* 3.1 (2020): 50-56.
24. Stig W. "Prevention of antibiotic resistance an epidemiological scoping review to identify research categories and knowledge gaps". *Global Health Action* 12 (2019): 1756191.
25. Okanga S., et al. "Host specificity and co-speciation in avian haemosporidia in the Western Cape, South Africa". *PLoS One* (2014): 9.
26. Silva-Iturriza A., et al. "Prevalence of Avian Haemosporidian Parasites and their Host Fidelity in the Central Philippine Islands". *Parasitology International* 61.4 (2012): 650-657.
27. Etisa E., et al. "Prevalence of Haemoparasites Infections in Scavenging Indigenous Chickens in and Around Bishoftu. Middle-East". *Journal of Scientific Research* 25.1 (2017): 157-162.
28. Smith MM and Ramey AM. "Prevalence and Genetic Diversity of Haematozoa in South American Waterfowl and evidence for intercontinental redistribution of Parasites by migratory Birds". *International Journal for Parasitology: Parasites and Wildlife* 4 (2015): 22-28.
29. Khan AU. "Diversity of Avian Haemosporidian Parasites in Brazil from Large to Small Scale. PhD Dissertation presented to the Graduate Program in Parasitology of the Department of Parasitology of the Institute of Biological Sciences of the Universidade Federal de Minas Gerais". Area of concentration: *Immunoparasitology* (2019): 1-87.
30. Li Z., et al. "First report of haemosporidia and associated risk factors in red junglefowl (*Gallus gallus*) in China". *Parasites Vectors* 15 (2022): 275.
31. Gimba FI., et al. "Haemoparasites of Domestic Poultry and Wild Birds in Selangor, Malaysia". *Malaysian Journal of Veterinary Research* 5.1 (2014): 43-51.
32. Adene DF and Oguntade AE. "The Structure and Importance of the Commercial and Village based Poultry Industry in Nigeria Poultry Production Systems". *Journal of Poultry Science* 7.12 (2006): 1216-1218.

33. Ndahi MD., *et al.* "Determination of antimicrobial use in commercial poultry farms in Plateau and Oyo States, Nigeria". *Antimicrobial Resistance and Infection Control* 12 (2023): 30.
34. Ezra OA., *et al.* "Poultry Farming and Disease Management Practices in Small- Scale Farmers in Kisii County". *Kenya Global Journal of Science Frontier Research: D Agriculture and Veterinary* 20.8:1 (2020): 1-8.
35. Akinleye AJ., *et al.* "Indigenous Poultry Production in Ogun State, Nigeria: A Case of Yewa North Local Government Area". *Journal of Agricultural Science and Environment* 11.2 (2011): 52-64.
36. Issa FO., *et al.* "Assessment of training needs of poultry farmers in Zaria local government area of Kaduna State, Nigeria". *Association of Deans of Agriculture in Nigeria Journal of Agriculture* 2.1 (2021): 1-12.
37. Ankrah DA., *et al.* "Gendered access to productive resources-evidence from smallholder farmers in Awutu Senya West District of Ghana". *Scientific African* 10 (2020): e00604.
38. Sonaiya FB and Swan SEJ. "Small-scale Poultry Production: Technical guide". FAO Animal Production and Health Manual 1: FAO of United Nations, Rome, Italy 1 (2004): 1-60.
39. Yakubu A. "Indigenous Chicken Flocks of Nassarawa State, Nigeria: Their Characteristics, Husbandry and Productivity". *Tropical and Subtropical Agroecosystems* 12.1 (2010): 69-76.
40. Okitoi LO., *et al.* "Gender issues in Poultry Production in Rural Households of Eastern Kenya". *Livestock Research for Rural Development* 19.2 (2007): 17.
41. Lawal JR., *et al.* "Causes of Village Chicken (*Gallus gallus domesticus*) Losses and Level of Awareness of Newcastle Disease Consequence among Village Chicken Farmers in Bauchi State, North Eastern Nigeria". *International Journal of Life Sciences Research* 3.1 (2015): 251-260.
42. Dunya AM., *et al.* "Local Chicken Management in Rural Borno State, Nigeria". *Journal of Biology, Agriculture and Healthcare* 5.4 (2015): 113-120.
43. Samkange A., *et al.* "Characterization of poultry production and management systems in communal areas of Namibia". *African Journal of Poultry Farming* 6.3 (2015): 266-276.
44. Conroy C., *et al.* "The Significance of Predation as a Constraint in Scavenging Poultry Systems: Some findings from India". *Livestock Research for Rural Development* 17 (2005).
45. Adisa RS., *et al.* "Farmer's Perception on Organic Poultry Production in Kwara State, Nigeria". *Nigerian Journal of Agriculture, Food and Environment* 13.4 (2017): 40-44.
46. Adedeji OS., *et al.* "Assessment of Poultry production system in Ilesha West Local Government Area of Osun State, Nigeria". *Scholars Journal of Agriculture and Veterinary Sciences* 1.1 (2014): 20-27.
47. Belay F and Oljira A. "Socioeconomic importance and production characteristics of village poultry production in Ethiopia: A review". *Nigerian Journal of Animal Science* 21.2 (2019): 112-122.
48. Akintunde OK., *et al.* "Effect of Disease Management on Profitability of Chicken Egg Production in Southwest Nigeria". *Asian Journal of Poultry Science* 9.1 (2015): 1-18.
49. Mohammed BR and Sunday OS. "An Overview of the Prevalence of Avian Coccidiosis in Poultry Production and Its Economic Importance in Nigeria". *Veterinary Research International* 3.3 (2015): 35-45.
50. Mohammed A. "Major Constraints and Health Management of Village Poultry Production in Ethiopia: Review School of Veterinary Medicine, Jimma University, Jimma, Ethiopia". *International Journal of Research Studies in Microbiology and Biotechnology* 4.1 (2018): 1-10.
51. Abanigbe SA., *et al.* "Characteristics of Free-Range Chicken Production in Ogun State, Nigeria". *Journal of Agricultural Extension* 22.1 (2018): 79-90.
52. Rajiur SM. "Documentation of Good Practices (GP) for Family Poultry Development in Swaziland". *International Network for Family Poultry Development* (2012).
53. Hayat N., *et al.* "Chemical Composition of Scavenging Feed Resource of Indigenous Chickens". *Asian Journal of Animal Sciences* 10 (2016): 182-188.
54. Lawal JR., *et al.* "Molecular Detection of Avian Haemosporidian Parasites in Village Chickens (*Gallus gallus domesticus*) in Gombe State, Nigeria". *Journal of Veterinary Medicine and Animal Science* 5.1 (2022): 1095.
55. Adi K., *et al.* "Access and use of agricultural information in Africa: Conceptual review". *Information and Knowledge Management* 10.7 (2020): 1-5.

56. Rahman T, *et al.* "Agro-information service and information-seeking behaviour of small-scale farmers in rural Bangladesh". *Asia-Pacific Journal of Rural Development* 30.1-2 (2020): 175-194.
57. Antwi-Agyei P and Stringer LC. "Improving the effectiveness of agricultural extension services in supporting farmers to adapt to climate change: Insights from northeastern Ghana. *Climate Risk Management* 32 (2021): 100304.
58. Obazi SA, *et al.* "Access and Usefulness of Agricultural Information among Poultry Farmers". *International Journal of Agricultural Sciences, Research and Technology in Extension and Education Systems* 12.2 (2022): 65-74.
59. Yaseen M, *et al.* "Farmers' Access to Agricultural Information Sources: Evidences from Rural Pakistan". *Journal of Agricultural Chemistry and Environment* 5 (2016): 12-19.
60. Tasié CM, *et al.* "Adoption of biosecurity for disease prevention and control by poultry farmers in Imo state, Nigeria". *Journal of Agriculture and Food Sciences* 18.2 (2020): 84-87.
61. Mutinda WU, *et al.* "Pathogenicity of Kenyan Infectious Bursal Disease Virus Isolates in Indigenous Chickens". *International Journal of Poultry Science* 18 (2019): 523-529.
62. Silva D, *et al.* "Are medicinal plants an alternative to the use of synthetic pharmaceuticals in animal healthcare in the Brazilian semi-arid?" *Ethnobotany Research and Applications* 19.2 (2020): 1-20.