ISSN (Online): 2091-2609
DOI Prefix: 10.3126/ijasbt

International Journal of Applied Sciences and Biotechnology (IJASBT)

Research Article

Assessment of Farmer's Knowledge of Antimicrobial Resistance, Their Practice of Antimicrobial Usage and Biosecurity Status of Poultry Farms in Kathmandu Valley and Chitwan District, Nepal

Sushan Dhakal[1*], Tulsi Ram Gompo[2]

[1]Agriculture and Forestry University, Rampur, Nepal
Email: sushand18@gmail.com

[2]Central Veterinary Laboratory, Tripureshwor, Kathmandu, Nepal
Email: tulsi.gompo@colostate.edu

Article Information

Received: 25 December 2021
Revised version received: 11 March 2022
Accepted: 15 March 2022
Published: 29 March 2022

Cite this article as:
S. Dhakal and T.R. Gompo (2022) Int. J. Appl. Sci. Biotechnol. Vol 10(1): 50-59.
DOI: 10.3126/ijasbt.v10i1.41675

***Corresponding author**
Sushan Dhakal,
Agriculture and Forestry University, Rampur, Nepal.
Email: sushand18@gmail.com

Abstract

The poultry industry has transformed into one of the vibrant economic activities in Nepal, contributing to almost 4% of the national GDP. We conducted a cross-sectional survey among the poultry farmers of Kathmandu valley and Chitwan district to assess their knowledge of antimicrobial resistance (AMR); their practice of antimicrobial usage and the biosecurity status of their poultry farms. The survey was done to understand the level of knowledge gap among the farmers regarding successful poultry farming with strict biosecurity protocol and minimal use of antibiotics. A semi-structured questionnaire was prepared to interview a total of 112 farmers, with 56 respondents from each study sites. Only nineteen percent (11/56) of the farmers from the Kathmandu valley and 16% (9/56) of that of Chitwan district knew about the antimicrobial resistance (AMR). Doxycycline (25.9%, 29/112) was the most used antibiotic followed by Tylosin (21.5%, 24/112), Colistin (18.75%, 21/112), Ciprofloxacin (13.4%, 15/112) and Neomycin (12.5%, 14/112) in both districts.

Majority of the surveyed respondents lacked the proper awareness regarding the importance of considerate use of antimicrobial drugs, effectiveness of implementing proper biosecurity protocols in the farms, and the increasing challenge of AMR in the present world scenario. The findings and results of this survey identify the critical gaps in the knowledge of the farmers concerning the day-to-day operations in their poultry business. Immediate strategic actions and road-maps are required to solve the burgeoning problem of AMR considering the imprudent use of antibiotics in the poultry sector.

Keywords: Antibiotics; Anti-microbial Resistance; Biosecurity; Poultry farming; Nepal

Introduction

The poultry sector of Nepal has undergone a massive transformation in terms of investment scale, operations costs, marketing strategies, employment opportunities, and revenue generation in the past four decades, mainly due to the boom in intensive poultry production (Sharma, 2010). The poultry industry of Nepal is an indispensable economic activity and contributes to about 4% of the country's total GDP (as of 2017) (MOALD, 2020)). This rapid evolution in the poultry industry is due to various factors such as the inclination of consumers towards the readily available and cheaper source of protein, i.e. chicken egg and meat. It is a potential source of livelihood for small and medium- scale farmers due to its short cycle of meat production, relatively easier rearing, and the massive use of its by-products in other animal feeds such as feather meal, bone meal, etc. Currently the poultry population of the country stands at 82.59 million with the highest proportion in Bagmati province. (MOALD, 2020)The poultry industry in Nepal, however, faces many challenges due to multiple factors such as substandard farm biosecurity, overuse and under-use of antimicrobials, and low disease reporting (Gompo *et al*., 2020; Karki, 2017; Sharma, 2010). Besides, the knowledge of farmers on antimicrobial resistance is very insufficient which has led to the imprudent use of antibiotics in poultry farming to achieve faster growth with minimal loss of flock units (Acharya *et al*., 2019; Gompo *et al*., 2020; Karki, 2017; Sharma, 2010). These factors remain to be an unsolved problem in the poultry sector, depriving the farmers of optimum profit and contributing to the growth of AMR.

In poultry farming, antibiotics have long been used for therapeutics and promotion of growth rate in the birds (Adekanye *et al*., 2020; Diarra *et al*., 2007; Mehdi *et al*., 2018). However, the unregulated and haphazard use of antibiotics has led to the development of anti-microbial resistance (AMR) in various strains of bacteria against multiple chemotherapeutic agents. (Chantziaras *et al*., 2014; English & Gaur, 2010; Shrestha *et al*., 2017; Spoor *et al*., 2013; Yewale, 2014). According to a survey conducted in 2012 in Nepal, the sales volume of veterinary antibiotics rose over 50% between 2008 and 2012. Out of that, majority (70% of the total sold antibiotics) were obtained without a prescription (Basnyat *et al*., 2015). This unregulated consumption of antimicrobials is highly expected to increase in the following years. Studies conducted previously in the poultry meat shops of Chitwan have demonstrated the presence of multiple drug-resistant (MDR) and extended-spectrum beta-lactamase (ESBL) producing strains of gram-negative bacteria in the poultry meat (Subedi *et al*., 2018). A similar study in Kathmandu observed the co-existence of *mcr-1* (colistin-resistant gene) along with other antibiotic-resistant genes (Bista *et al*., 2020; Joshi *et al*., 2019). The dissemination of these resistant genes via the interaction between poultry, humans, and the environment makes AMR a huge threat and an important One Health challenge on a global scale (Acharya *et al*., 2019; Adekanye *et al*., 2020; Manzetti & Ghisi, 2014).

In addition to AMR, the misuse of antibiotics results in the presence of drug residues in animal products (Gompo *et al*., 2020; Kabir *et al*., 2004; Lee *et al*., 2001; Mund *et al*., 2017). Currently, approximately 80% of all food-producing animals receive medication for part or most of their lives (Gonzalez Ronquillo & Angeles Hernandez, 2017). The consumption of these residues leads to allergic reactions in the human body, chelation of teeth, etc. (Dewdney *et al*., 1991; Wallman & Hilton, 1962). There are published studies that have shown the presence of multiple antibiotic residues in poultry meats of Kathmandu valley, Kaski, and Chitwan district of Nepal (Gompo *et al*., 2020; Prajapati *et al*., 2018). Gentamicin, fluoroquinolones, sulphonamides, and tetracycline groups of drugs had the highest amount of residue compared to other antibiotics indicating their overuse in specified places (Gompo *et al*., 2020; Prajapati *et al*., 2018). The global consumption of antibiotics within human treatment and animal production is estimated between 1×10^5 and 2×10^5 tons (Manzetti & Ghisi, 2014). The annual consumption of antibiotics in Nepal in 2019 was estimated to be 48 tons (VSDRL Technical Bulletin, 2020). This leads to the release of enormous quantities of antibiotics into the environment, making confined aquatic ecosystems such as ponds, lakes, and soils close to urban sites more vulnerable (Manzetti & Ghisi, 2014) and eventually predisposing the environment to further degradation.

Biosecurity is defined as the exclusion, eradication, and effective management of risks posed by pests and diseases to the economy, environment, and human health (Ministry of Agriculture and Forestry (MAF) Biosecurity New Zealand, 2009). Nevertheless, in the context of Nepal, the level of biosecurity maintained by most of the small and medium-scale farmers is sub-standard (Basnyat *et al*., 2015; Gompo *et al*., 2020; Sharma, 2010) which predisposes the farms to outbreaks of several infectious diseases, quite often. It results in substantial economic losses, reduced profitability, loss of enthusiasm in poultry farming, and sometimes poses a zoonotic threat to the workers on the farm (Alexander, 2007; Gompo *et al*., 2020).

Through this survey-based research, we aimed to assess the knowledge of farmers about AMR and their practice of poultry farming. We prepared a semi-structured questionnaire which included questions on sociodemographic, farm structures, biosecurity protocols, usage of antimicrobials, awareness on AMR, one-health, and the impact of avian influenza (high and low pathogenic) in the poultry sector of Nepal. The survey was conducted among 112 respondents (poultry farmers) with 56 each from Kathmandu valley and Chitwan, since they are considered as the major poultry hubs in Nepal.

Materials and Methods

Study Site

The study was conducted at Central Veterinary Laboratory (CVL), Kathmandu, and National Avian Disease Investigation Laboratory (NADIL), Bharatpur where the poultry farmers visited for the diagnostic services and therapeutic recommendation from the poultry specialist veterinarians. (Fig. 1).

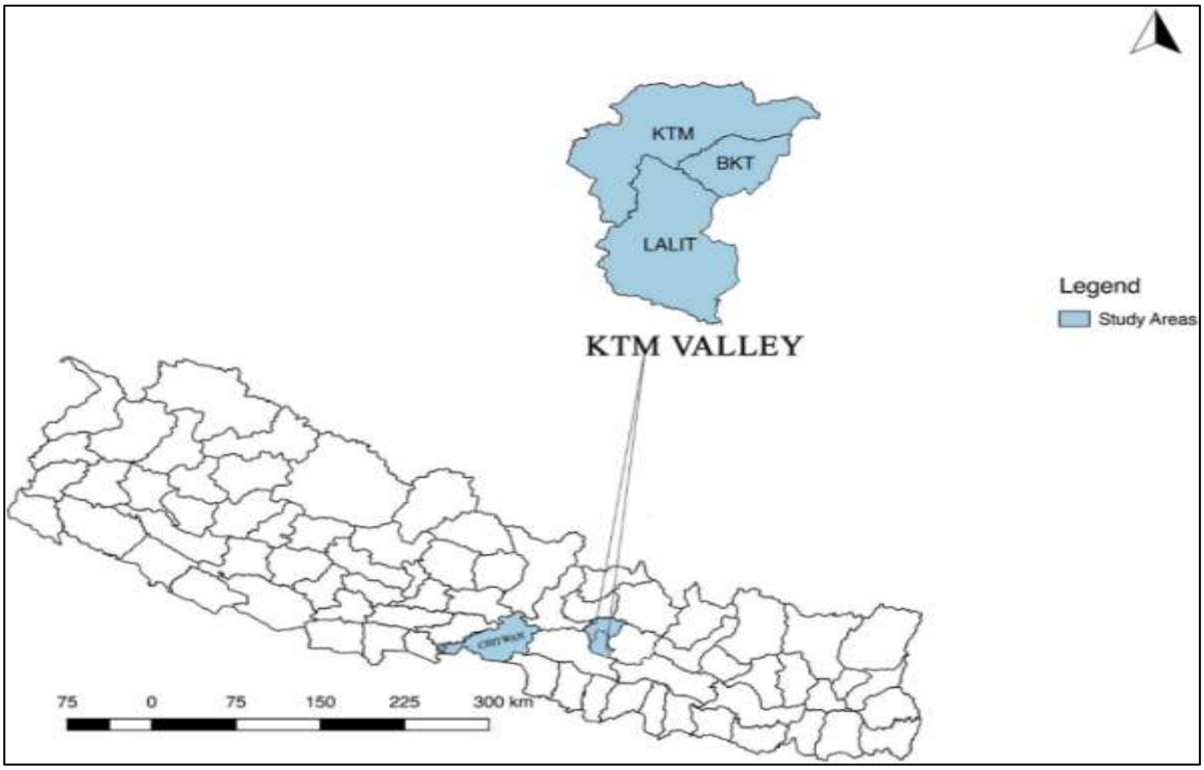

Fig. 1: A map of Nepal with the study districts highlighted in blue

Study Design

It is a cross-sectional survey conducted from December 2019 to August 2020. A paper-based questionnaire was used to collect each farmer's sociodemographic status, the condition of biosecurity in their respective farms, their knowledge of antimicrobials, AMR, and one- health ideology. A total of 112 farmers were interviewed with equal distribution among the two sites i.e., fifty-six from both Kathmandu valley and Chitwan district.

Statistical Analysis

The data collected was recorded in MS Excel 2016. Firstly, a descriptive analysis was performed using a pivot table in MS Excel to generate two by two table between two categorical variables. Next, a chi-square test was used to test independence between the categorical variables, and their corresponding p-values were calculated to detect the significant associations between the two categorical variables. All the statistical tests were performed by the application of online statistical software Open Epi version 3.01. A two-tailed p-value ≤ of 0.05 was considered statistically significant.

Results and Discussion

Demographic Information

The descriptive analysis showed that male farmers were much higher than female farmers in both districts. The percentages of males and females were 91.1% (51/56) and 8.9% (5/56) respectively in Chitwan while in Kathmandu valley 85.7% (48/56) were male and 14.3% (8/56) were female with no significant difference between gender-based poultry farming in both districts (Table 1). 59.8% (67/112) of the farmers had pursued higher education than Secondary Education Examination (SEE) (Table 1) Only an average of 15.2% (17/112) generated income above fifty-thousand through a single lot/batch of poultry units (Table 1). Poultry farming contributed to more than or equal to fifty percent of the total annual income to 51.8% (29/56) and 46.4% (26/56) of the farmers, respectively, in Chitwan and Kathmandu valley (Table 1). 53.6% (30/56) and 50% (28/56) of the farmers, respectively, from Chitwan and Kathmandu, had an experience of at least five years in poultry farming (Table 1). About 55.4% (31/56) respondents from Chitwan and 64.3% (33/56) respondents from Kathmandu valley were involved in poultry farming without prior training (Table 1) Most of the farmers were middle-aged (25-40 years), with 50% (28/56) and 46.4% (26/56), respectively, from Chitwan and Kathmandu valley (Table 1).

Khas Arya was the dominant ethnic group in the poultry production business, with 25 and 23 farmers out of 56 respectively, in Chitwan and Kathmandu valley, followed by Janajati, Dalit, Madhesi, and other ethnic groups (Fig. 2). In terms of religion, Hindus were the largest in the poultry farming business with 41 and 37 farmers out of 56 respectively, in Chitwan and Kathmandu valley, followed by Buddhist and others (Fig. 3)

Table-1 Demographic information of the farmers

Variables	Category	Chitwan		Ktm valley		p value
		n=56	n%	n=56	n%	
Gender	Male	51	91.1	48	85.7	0.39
	Female	5	8.9	8	14.3	
Education	Illiterate	3	5.4%	6	10.7%	NA
	Below SEE	6	10.7%	7	12.5%	
	SEE/SLC	12	21.4%	11	19.6%	
	Above SEE	35	62.5%	32	57.1%	
Income	Below 50k	47	83.9%	48	85.7%	NA
	Above 50k	9	16.1%	8	14.3%	
Contribution to gross annual income	<50%	27	48.2%	30	53.6%	0.58
	>=50%	29	51.8%	26	46.4%	
Experience	<5 years	26	46.4%	28	50.0%	0.71
	>= 5 years	30	53.6%	28	50.0%	
Prior training	Yes	25	44.6%	20	35.7%	0.34
	No	31	55.4%	36	64.3%	
Age of farmers	<25	13	23.2%	16	28.6%	NA
	25-40	28	50.0%	26	46.4%	
	>40	15	26.8%	14	25.0%	

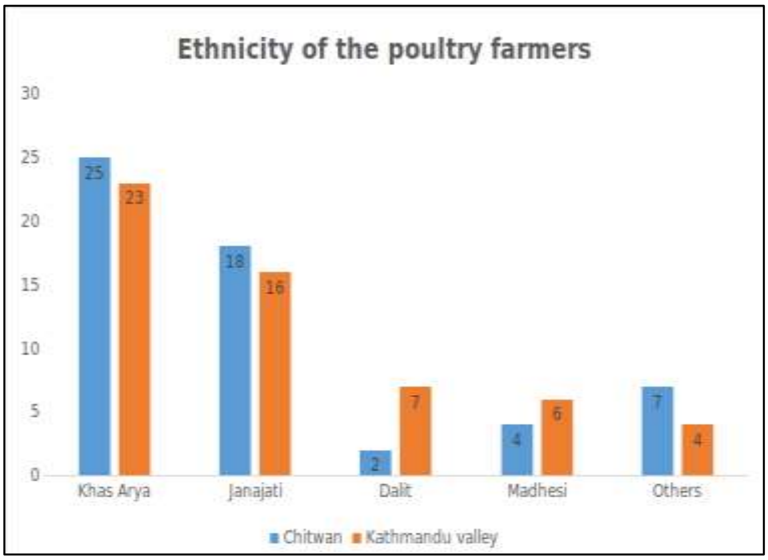

Fig. 2: Ethnicity of the poultry farmers

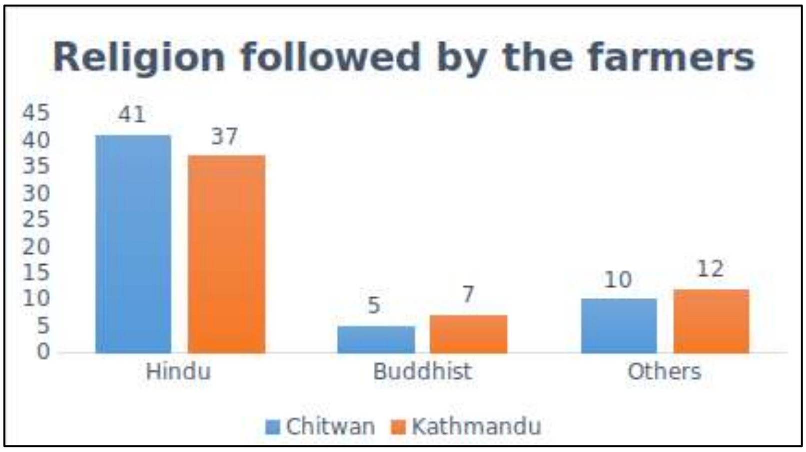

Fig. 3: Religion followed by the farmersFarm characteristics, antibiotics usage, and knowledge of AMR.

Most of the farmers preferred broiler rearing over layers and other breeds. The farming method was exclusively intensive with a deep litter farming system. All the farmers (100%, 56/56) claimed to have used antibiotics for therapeutic purposes only and ended the use of antibiotics only after completing the course of time prescribed by the vets or para-vets. About 41.1% (23/56) of the farmers in Chitwan and 33.9% (19/56) of Kathmandu, could tell the names and composition of antibiotics they used in their farms (Table 2). Only a minority of farmers knew about AMR in Chitwan (16.1%, 9/56) and Kathmandu valley (19.6%, 11/56) as well (Table 2). About 62.5% (35/56) of the farmers, each from Chitwan and Kathmandu valley, understood the importance of completing the withdrawal period after the use of antibiotics before selling their poultry products in the market (Table 2). However, fewer percentage (avg. 57.15%, 33/112) of them actually followed the withdrawal period (Table 2). The percentage of farmers who were aware about the harmful side effects of drug residues present in poultry products upon consumer health was 44.6% (25/56) from Chitwan and 37.5% (21/56) from Kathmandu valley (Table 2). An average of 26.7% (31/112) of farmers claimed that the efficacy of the antibiotics had gradually diminished over the past years. Doxycycline (25.9%, 29/112) was the most prescribed/ bought antibiotic followed by Tylosin (21.5%, 24/112), Colistin (18.75%, 21/112), Ciprofloxacin (13.4%, 15/112) and Neomycin (12.5%, 14/112), according to the farmers (Fig. 4).

Table 2: Farm characteristics, antibiotics usage, and knowledge of AMR.

Variables	Category	Chitwan (n=56); n (%)[#]	Kathmandu (n=56); n (%)	p-value
Bird type	Broilers	44 (78.6)	44 (78.6)	>0.99
	Others	12 (8.9)	12 (12.5)	
Rearing system	Intensive	56 (100)	56 (100)	NA
	Extensive	0 (0)	0 (0)	
Closed system type	Deep litter	56 (100)	56 (100)	NA
	Cage	0 (0)	0 (0)	
Purpose of antibiotics	Therapeutic	56 (100)	56 (100)	NA
	Preventive and Supplement	0 (0)	0 (0)	
Antimicrobial use	Until recommended course of time	56 (100)	56 (100)	NA
	Discontinue when clinical signs disappear	0 (0)	0 (0)	
Know the names and composition of the antibiotics	Yes	23 (41.1)	19 (33.9)	0.44
	No	33 (58.9)	37 (66.1)	
Keep the record of antibiotics	Yes	25 (44.6)	19 (33.9)	0.25
	No	31 (55.4)	37 (66.1)	
Antibiotics prescribed by	Veterinarians	48 (85.7)	50 (89.3)	NA
	Para-vets	8 (14.3)	5 (8.9)	
	Pharmacies	0 (0)	1 (1.8)	
Efficacy of current antibiotics compared to past years	Effective previously	15 (26.8)	16 (28.6)	NA
	Same as before	17 (30.4)	18 (32.1)	
	Don't know	29 (51.8)	22 (39.3)	
Heard about the withdrawal period	Yes	35 (62.5)	35 (62.5)	>0.99
	No	21 (37.5)	21 (37.5)	
Follow the withdrawal period	Yes	34 (60.7)	30 (53.6)	0.45
	No	22 (39.3)	26 (46.4)	
Knowledge of harmful effects of Drug residues	Yes	25 (44.6)	21 (37.5)	0.45
	No	31 (55.4)	35 (62.5)	
Heard about AMR	Yes	9 (16.1)	11 (19.6)	0.63
	No	47 (83.9)	45 (80.4)	
Heard about AMR in humans	Yes	12 (21.5)	18 (32.1)	0.21
	No	44 (78.6)	38 (67.9)	

[#]Values in the parentheses indicate percentage,

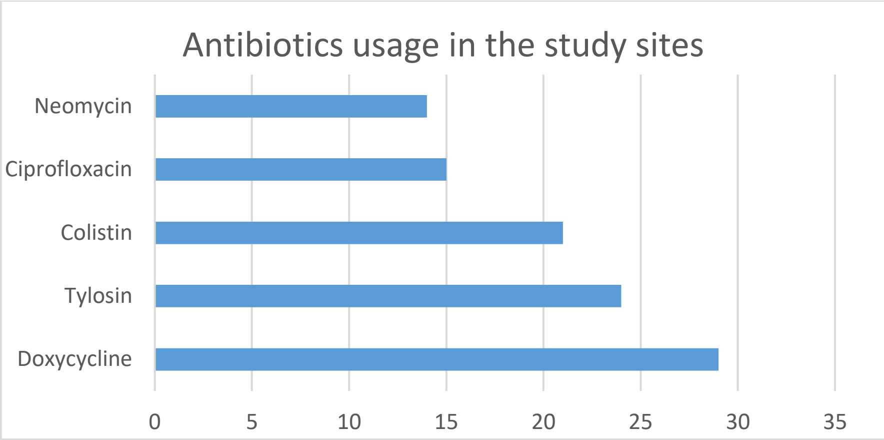

Fig. 4: Usage of antibiotics in both sites

**only includes the responses of the farmers who knew the names of the antibiotics they used*

Biosecurity Status

The Table 3 shows the number of farms with compound fence was higher in Kathmandu valley (69.6%, 39/56) than Chitwan (53.6%, 30/56). More farmers of the Kathmandu valley (78.6%, 44/56) had adopted the habit of disinfecting their foot covers before entering the farms than Chitwan (62.5%, 35/56) (Table 3). A significant difference ($p=0.04$) was observed between the farms of Chitwan (3.6%, 2/56) and Kathmandu valley (21.5%, 12/56) in keeping the logbooks of delivery vehicles (Table 3). Farms from Chitwan had a significantly lower entry of transport vehicles into the farm (32.1%, 18/56) than Kathmandu valley (51.8, 29/56) ($p=0.038$) (Table 3) However, before entry into the farm, the disinfection rate of delivery vehicles was low in both Chitwan (8.9%, 5/56) and Kathmandu valley (16.1%, 9/56), with no significant difference (Table 3). A separate room made to quarantine sick birds within the farm was higher in Chitwan's farms (87.5%, 49/56) than in Kathmandu valley (73.2%, 41/56) (Table 3). An average of 97.3% (109/112) farmers and 82.1% (92/112) farmers had adopted the habit of daily water and utensils cleaning, respectively, before feeding to the birds (Table 3). The number of farms that had contact with wild birds was high in both Chitwan (46.4%, 26/56) and Kathmandu valley (53.6%, 30/56), while only an average of 24.2% (27/112) farms had contact with wild animals in their proximity (Table 3). A significant difference ($p=0.03$) was observed in the practice of rearing different aged birds in the same flock between the farmers of Chitwan (3.6%, 2/56) and Kathmandu (16.1%, 9/56) (Table 3). The periphery of poultry farms in Chitwan (50%, 28/56) had frequent water-logging problems than that of Kathmandu (14.3%, 8/56) with $p<0.0001$ (Table 3). Approx. 57.1% (32/56) of farmers each, from both sites, disposed of the used poultry litter far from the shed. About 17.9% (10/56) farmers in Kathmandu valley disinfected the poultry litter before disposal, while the number was as low as 1.8% (1/56) in Chitwan with $p=0.01$ (Table 3). Significantly higher ($p<0.0009$) number of farmers from Kathmandu valley (17.9%, 10/56) sold their dead birds to pig farms instead of pit burial compared to Chitwan (100%, 56/56) (Table 3). An average of 91.1% (102/112) of all farmers preferred the all-in-all-out program, especially in the case of broiler farming (Table 3). None of the farmers in Chitwan recalled visiting a nearby farm with a recent disease outbreak, while 8.9% (5/56) of the farmers in the Kathmandu valley recalled to have visited such farms in their proximity, just out of curiosity (Table 3).

The current study assessed the farmers' knowledge of AMR, their practice of antibiotics usage in their farms, and the level of biosecurity status in their farms, within the major poultry hubs of the country, i.e., Kathmandu valley and Chitwan district. On an average, 48.2% (54/112) of the farmers were in between the age group 25-40 from both districts, indicating the involvement of the youths in poultry sector (Table 1) The majority of the poultry farmers was males (88.4%, 99/112) and 40.15%, (45/112) mentioned that they started their poultry enterprise without any prior workshop or training (Table 1). This may lead to a huge information gap in the farmers regarding the adoption of proper and effective poultry farming model. Without prior training and workshops, most of the farmers will lack the information about the methods of maintenance of strict biosecurity measures in the farm for sustainable profitability and income generation. They will also be less aware about the importance of prudent and considerate use of antimicrobials in the farm. This will not only hamper their farm production and business in the long run, but also aggravate the growing concern of anti-microbial resistance. On an average, nearly half (51.8%, 58/112) of the farmers were involved in poultry farming for more than five years (Table 1). Farmers from different ethnic background and religions farmers were involved in the poultry business indicating its popularity among diverse communities.

Table 3: Biosecurity status in the poultry farms of Kathmandu and Chitwan

Variables	Response	Chitwan (n=56); n (%) #	Kathmandu (n=56); n (%)	p-value
Farm compounded	Yes	30 (53.6)	39 (69.6)	0.08
	No	26 (46.4)	17 (30.4)	
Disinfection at gate	Yes	35 (62.5)	44 (78.6)	0.06
	No	21 (37.5)	12 (21.5)	
Separate boot	Yes	56 (100)	56 (100)	NA
	No	0 (0)	0 (0)	
Visitor logbook	Yes	15 (26.8)	12 (21.5)	0.52
	No	41 (73.2)	44 (78.6)	
Vehicle disinfection	Yes	5 (8.9)	9 (16.1)	0.27
	No	51 (91.1)	47 (83.9)	
Separate room for sick birds	Yes	49 (87.5)	41 (73.2)	0.06
	No	7 (12.5)	15 (26.8)	
Fumigation before new stocking	Yes	56 (100)	56 (100)	NA
	No	0 (0)	0 (0)	
Mice control management	Yes	30 (53.6)	33 (58.9)	0.574
	No	26 (46.4)	23 (41.1)	
Contact with wild birds	Yes	26 (46.4)	30 (53.6)	0.457
	No	30 (53.6)	26 (46.4)	
All-in all-out program	Yes	51 (91.1)	51 (91.1)	>0.99
	No	5 (8.9)	5 (8.9)	
Rearing of different aged birds	Yes	2 (3.6)	9 (16.1)	0.03*
	No	54 (96.4)	47 (83.9)	
Farm floor	Earthen	40 (71.4)	43 (76.8)	0.527
	Cemented	16 (28.6)	13 (23.2)	
Feed storage	Floor	0 (0)	7 (12.5)	0.006*
	Raised	56 (100)	49 (87.5)	
Litter disposal	Far from shed	32 (57.1)	32 (57.1)	>0.99
	Near to shed	24 (42.9)	24 (42.9)	
Disposal of dead birds	Pit burial	56 (100)	46 (82.1)	0.001*
	Dispatch to pig farms	0 (0)	10 (17.9)	

#Values in the parentheses indicate percentage, * Indicates p<0.05 and significant

Broiler rearing was the most popular option among the farmers (avg. 78.6%, 88/112) in both Kathmandu and Chitwan district (Table 2). Most of the poultry farms in both sites had the capacity of 500-1500 birds. All the farmers were involved in intensive poultry production with a deep litter rearing system (100%, 112/112 (Table 2)). All the farmers (100%, 112/112) from both sites, agreed to have used antibiotics in the farm for therapeutic purposes only (Table 2), but the reports of Basnyat *et al*., (2015); Joshi *et al*., (2019); and Shrestha *et al*., (2017), on growing nature of AMR in Nepal showed different reports The respondents also claimed to have discontinued the use of antibiotics only after the completion of the recommended course prescribed by the concerning veterinarian (Table 2). Certain antibiotics were used most frequently, without drug rotation, such as doxycycline, tylosin, colistin, neomycin, and ciprofloxacin (Figure 4). This has increased the vulnerability of these antibiotics to losing their efficacy against specific bacterial strains due to the development of AMR. Colistin had to be banned in the poultry farms of certain countries, after many bacterial strains developed resistance to it, as a result of overuse in livestock farming (McDougal, 2019; Walsh & Wu, 2016). The majority of the farmers took antibiotics prescription from the concerned veterinarian (avg. 87.5%, 98/112) while a minority took the same prescription from para-vets (avg. 11.6%, 13/112) (Table 2) Most of the farmers knew about the withdrawal period (avg. 62.5%, 70/112) while only a lesser fraction of farmers followed the withdrawal period (avg. 57.15%, 33/112) before selling their products in the market (Table 2) This indicates the negligence of farmers and the concerned authorities in the proper supervision and inspection of the poultry products in the market. Less than half of the farmers interviewed (41.1%, 46/112) knew about the negative effects of drug residues in poultry products upon consumer health (Lee *et al*., 2001) (Table 2). This information gap has led the poultry farmers to supply their products into the market without consideration for the withdrawal period and the impact of drug residues upon public health.

Only an average of 17.85% (20/112) of the farmers knew about the concept of AMR (Table 2). The rest had no information about it, nor were they ever made aware of it. Nearly 26.8% (30/112) of the farmers knew about AMR in humans (Table 2).. They claimed to have heard about antibiotics that were previously useful in human beings but were no longer working in the current scenario. Similarly, about 27.7% (31/112) of the farmers from both sites considered the efficacy of antibiotics to have gradually decreased over the past years (Table 2).. The rest of the farmers either couldn't differentiate the efficacy or thought the efficacy was the same as that of the past years. An alarming, but not surprising, finding was that many of the farmers could easily buy the antibiotics in the pharmacies without any proper disease diagnosis and certified vet prescription (Table 2).. This is the predicament of the current drug regulatory policies in Nepal which have not yet provided a strict guideline regarding the purchase and sales of antibiotics (Basnyat *et al*., 2015). Many of the farmers agreed upon the fact that they were recommended antibiotics without Antibiotic Sensitivity Test (AST) by their local para vets and/or veterinary pharmacies The reason they chose to come a long way to visit CVL and NADIL, distant from their farms, was for proper diagnosis, AST, and therapeutic recommendation from the certified veterinarians.

The biosecurity status maintained in most of the farms seemed sub-standard. It might either be due to the lack of farmer's awareness about its importance or due to additional cost of production in the starting phase (Ministry of Agriculture and Forestry (MAF) Biosecurity New Zealand, 2009; Sharma, 2010). Only 53.6% (30/56) of the farms in Chitwan and 69.6% (39/56) of the farms in Kathmandu valley had a compound fence around their farms (Table 3). Thus, the chances of a predatory attack from wild animals or theft from humans were minimal in these farms. The habit of disinfecting the boots/foot cover before entering through the farm gate was low in Chitwan (62.5%, 35/56) compared to Kathmandu valley (78.6%, 44/56), indicating a higher possibility of disease introduction in the farms of Chitwan (Table 3). Only an average of 24.1% (27/112) of the farmers maintained the logbook of visitors visiting the farm (Table 3). This increases the probability of the introduction of virulent micro-organisms into the farm through unwanted visitors without any evidence of contact tracing. Similarly, the number of farms that allowed the entry of vehicles without prior disinfection was high (91.1%, 51/56 from Chitwan and 83.9 %, 47/56 from Kathmandu) (Table 3). This predisposes the farms to the outbreak of foreign infections carried into the farm by the delivery vehicles from other potential sources (Sims, 2007). The habit of cleaning utensils and drinking water daily before bird-feeding was very high with an avg. of 82.1% (92/112) and 97.2% (109/112) respectively in both sites (Table 3). It reduces the chances of ingestion of potential pathogenic microbes through contaminated sources. 46.4% (26/56) of the farms in Chitwan and 53.6% (30/56) of the farms in Kathmandu valley were in close contact with the migratory routes of wild birds (reservoirs of avian influenza) (Table 3). This may lead to the outbreak of highly- pathogenic avian influenza (HPAI) in the farm, consequently leading to health and financial crisis (Gompo, Shah, *et al*., 2020; Karki, 2017). Chitwan had a greater percentage (87.5%, 49/56) of farms with the facility of quarantine for sick birds than Kathmandu (73.2%, 41/56) (Table 3). The majority of the farmers (57.1%, 64/112) disposed of the used litter far away from the farm, however, without prior disinfection (Table 3). This can result in the survival of infectious microbes such as coccidia, salmonella, etc. (Davies & Wray, 1996; Reyna *et al*., 1983) which can re-emerge within the farm again through various vectors. The farming of different aged birds within a single flock was low (avg. 9.5%, 11/112) (Table 3), and the majority of the farmers adopted the all-in all-out program (avg. 91.1%, 102/112). This reduces the probability of disease sharing among different age groups in the same farm (due to different health and immunological status) (Alexander, 2007; Sims, 2007). The dispatch of dead birds to pig farms, as a source of secondary revenue, was mostly seen in Kathmandu Valley (17.9%, 10/56) compared to Chitwan (*nil)* (Table 3). It shows that there is a higher possibility of dissemination of the infectious agents in the Kathmandu valley while en route to the pig farms.

Limitations

This survey was limited to the poultry farmers who had visited CVL of Kathmandu, and NADIL of Chitwan for the health inspection of their sick/dead birds. Many poultry farms are distantly located and do not have easy access to these laboratories. So, they could not be included in this survey. The response rate of some farmers during the survey was low, and as such, the study's findings may not be applicable to the whole country. Some farmers were reluctant to answer about the real use of antibiotics on the farm which may affect the validity of the responses.

Conclusion

Based on this survey, the assessment of farmer's knowledge on the importance of biosecurity measures in the farm, anti-microbial resistance, and prudent antimicrobial usage in the farm was made. The majority of the farmers started their poultry enterprise without prior training. This may lead to a huge information gap in the farmers regarding the adoption of proper and successful poultry farming model. Without prior training and workshops, most of the farmers will lack the information about the methods of maintenance of strict biosecurity measures in the farm for sustainable profitability and income generation.

Regarding the use of antibiotics in the farm, it is crucial to teach and train the farmers about the importance of adopting the habit of prudent use of antibiotics only after the recommendation from a certified veterinarian. All the farmers in the survey claimed to use antibiotics for therapeutic purposes only, but the reports of the growing nature of AMR in Nepal say otherwise. There is an urgent need for dissemination of information about the withdrawal period and harmful effects of drug residues found in poultry products upon consumer health. Farmers and para-vets should be made aware of the consequences of the misuse of antibiotics and how the AMR impacts the health of humans, animals, and the environment as a whole. Additionally, strategies are to be formed to increase the availability of and accessibility to veterinary laboratory services across the country with the provision of the antibiotic sensitivity test (AST) at affordable costs to the farmers.

There is a need to create awareness among the farmers about the role of proper biosecurity measures such as disinfecting foot covers before entry into the farm, maintaining an isolation pen for sick birds, disinfection of litter before disposal, traffic control, sanitary measures, and regular surveillance. Training workshops must be conducted in various poultry farming pocket areas and the amateur poultry farm investors should be provided with comprehensive information and roadmap for a successful poultry farming.

Author's Contribution

Both authors contributed equally at all stages of research, data analysis, preparation of manuscript and finalization of manuscript

Conflict of Interest

The authors declare that there is no conflict of interest with present publication.

Acknowledgment

Both of authors would like to acknowledge all the farmers who agreed to participate on the survey. They would also like to express their gratitude to all the staff of CVL and NADIL who helped directly or indirectly during this research.

References

Acharya KP, Karki S, Shrestha K & Kaphle K (2019) One health approach in Nepal: Scope, opportunities and challenges. *One Health* **8**: 100101. DOI: 10.1016/j.onehlt.2019.100101

Adekanye UO, Ekiri AB, Galipó E, Muhammad AB, Mateus A, La Ragione RM, Wakawa A, Armson B, Mijten E, Alafiatayo R, Varga G & Cook AJC (2020) Knowledge, attitudes and practices of veterinarians towards antimicrobial resistance and stewardship in Nigeria. *Antibiotics* **9**(8): 453. DOI: 10.3390/antibiotics9080453

Alexander DJ (2007) An overview of the epidemiology of avian influenza. *Vaccine* **25**(30): 5637-5644. DOI: 10.1016/j.vaccine.2006.10.051

Basnyat B, Pokharel P, Dixit S & Giri S (2015) Antibiotic Use, Its Resistance in Nepal and Recommendations for Action: A Situation Analysis. *Journal of Nepal Health Research Council* **13**(30): 102-111. http://www.jnhrc.com.np/index.php/jnhrc/article/view/632

Bista S, Shrestha UT, Dhungel B, Koirala P, Gompo TR, Shrestha N, Adhikari N, Joshi DR, Banjara MR, Adhikari B, Rijal K R & Ghimire P (2020) Detection of plasmid-mediated colistin resistant mcr-1 gene in *Escherichia coli* isolated from infected chicken livers in Nepal. *Animals* **10**(11): 2060.

Chantziaras I, Boyen F, Callens B & Dewulf J (2014) Correlation between veterinary antimicrobial use and antimicrobial resistance in food-producing animals: A report on seven countries. *Journal of Antimicrobial Chemotherapy*. **69**(3): 827-834. DOI: 10.1093/jac/dkt443

Davies RH & Wray C (1996) Persistence of Salmonella enteritidis in poultry units and poultry food. *British Poultry Science*. **37**(3): 589-596. DOI: 10.1080/00071669608417889

Dewdney JM, Maes L, Raynaud JP, Blanc F, Scheid JP, Jackson T, Lens S & Verschueren C (1991) Risk assessment of antibiotic residues of β-lactams and macrolides in food products with regard to their immuno-allergic potential In *Food and Chemical Toxicology* **29**(7): 477-483. DOI: 101016/0278-6915(91)90095-O

Diarra MS, Silversides FG, Diarrassouba F, Pritchard J, Masson L, Brousseau R, Bonnet C, Delaquis P, Bach S, Skura BJ & Topp E (2007) Impact of feed supplementation with antimicrobial agents on growth performance of broiler chickens, Clostridium perfringens and Enterococcus counts, and antibiotic resistance phenotypes and distribution of antimicrobial resistance determinants in Escheric. *Applied and Environmental Microbiology* **73**(20): 6566-6576. DOI: 10.1128/AEM.01086-07

English BK & Gaur AH (2010) The use and abuse of antibiotics and the development of antibiotic resistance. *Advances in Experimental Medicine and Biology* **6**: 73-82. DOI: 10.1007/978-1-4419-0981-7_6

Gompo TR, Sapkota R, Subedi M, Koirala P, Koirala P & Bhatta DD (2020) Monitoring of Antibiotic Residues in Chicken Meat, Cow and Buffalo Milk Samples in Nepal. *International Journal of Applied Sciences and Biotechnology*. **8**(3): 355-362. DOI: 10.3126/ijasbt.v8i3.31314

Gompo TR, Shah BR, Karki S, Koirala P, Maharjan M & Bhatt DD (2020) Risk factors associated with Avian Influenza subtype H9 outbreaks in poultry farms in Kathmandu valley, Nepal. *PLoS ONE* **15**(4): e0223550. DOI: 10.1371/journal.pone.0223550

Gonzalez Ronquillo, M, & Angeles Hernandez, J C (2017) Antibiotic and synthetic growth promoters in animal diets: Review of impact and analytical methods. *Food Control* **72**: 255-267. DOI: 10.1016/j.foodcont.2016.03.001

Joshi PR, Thummeepak R, Paudel S, Acharya M, Pradhan S, Banjara MR, Leungtongkam U & Sitthisak S (2019) Molecular Characterization of Colistin-Resistant Escherichia coli Isolated from Chickens: First Report from Nepal. *Microbial Drug Resistance* **25**(6): 846-854. DOI: 10.1089/mdr.2018.0326

Kabir J, Umoh VJ, Audu-okoh E, Umoh JU & Kwaga JKP (2004) Veterinary drug use in poultry farms and determination of antimicrobial drug residues in commercial eggs and slaughtered chicken in Kaduna State, Nigeria. *Food Control* **15**(2): 99-105. DOI: 10.1016/S0956-7135(03)00020-3

Karki S (2017) Effects of Highly Pathogenic Avian Influenza H5N1 Outbreak in Nepal from Financial and Social Perspectives: A Case Study. *Nepalese Veterinary Journal* **34**: 26-35. DOI: 10.3126/nvj.v34i0.22861

Lee MH, Lee HJ & Ryu PD (2001) Public Health Risks: Chemical and Antibiotic Residues. In *Asian-Australasian Journal of Animal Sciences* **14**(3): 402-413. DOI: 10.5713/ajas.2001.402

Manzetti S & Ghisi R (2014) The environmental release and fate of antibiotics. *Marine Pollution Bulletin* **79**(1-2): 7-15. DOI: 10.1016/j.marpolbul.2014.01.005

McDougal T (2019) Indian government bans Colistin. *Poultry World*. https://www.poultryworld.net/Health/Articles/2019/8/Indian-government-bans-Colistin-457309E/

Mehdi Y, Létourneau-Montminy MP, Gaucher M, and et al. (2018) Use of antibiotics in broiler production: Global impacts and alternatives. *Animal Nutrition* **4**(2): 170-178. DOI: 10.1016/j.aninu.2018.03.002

Ministry of Agriculture and Forestry (MAF) Biosecurity New Zealand. (2009). Biosecurity surveillance strategy 2020. *C.* https://www.mpi.govt.nz/dmsdocument/7152/direct

MOALD. (2020). Statistical Information in Nepalese Agriculture. *Ministry of Agriculture and Livestock*, 290. Retrieved from: https://nepalindata.com/resource/statistical-information-nepalese-agriculture-207374-201617/

Mund MD, Khan UH, Tahir U, Mustafa BE & Fayyaz A (2017) Antimicrobial drug residues in poultry products and implications on public health: A review. In *International Journal of Food Properties* **20**(7): 1433-1446. DOI: 10.1080/10942912.2016.1212874

Prajapati M, Ranjit E, Shrestha R, Shrestha SP, Adhikari SK & Khanal DR (2018) Status of Antibiotic Residues in Poultry Meat of Nepal. *Nepalese Veterinary Journal* **35**: 55-62. DOI: 10.3126/nvj.v35i0.25240

Reyna PS, McDougald LR & Mathis GF (1983) Survival of coccidia in poultry litter and reservoirs of infection. *Avian Diseases*. **1**: 464-473. DOI: 10.2307/1590172

Sharma B (2010) Poultry Production, Management and Bio-Security Measures. *Journal of Agriculture and Environment*. **11**: 120-125. DOI: 10.3126/aej.v11i0.3659

Shrestha A, Bajracharya AM, Subedi H, Turha RS, Kafle S, Sharma S, Neupane S & Chaudhary DK (2017) Multi-drug resistance and extended spectrum beta lactamase producing Gram negative bacteria from chicken meat in Bharatpur Metropolitan, Nepal. *BMC Research Notes*. **10**(1): 1-5. DOI: 10.1186/s13104-017-2917-x

Sims LD (2007) Lessons learned from Asian H5N1 outbreak control. *Avian Diseases* **51**(s1): 174-181. DOI: 10.1637/7637-042806r.1

Spoor LE, McAdam PR, Weinert LA, Rambaut A, Hasman H, Aarestrup FM, Kearns AM, Larsen AR, Skov RL & Ross Fitzgerald J (2013) Livestock origin for a human pandemic clone of community-associated methicillin-resistant Staphylococcus aureus. *MBio* **4**(4): e00356-13. DOI: 10.1128/mBio.00356-13

Subedi M, Luitel H, Devkota B, Bhattarai RK, Phuyal S, Panthi P, Shrestha A & Chaudhary DK (2018) Antibiotic resistance pattern and virulence genes content in avian pathogenic Escherichia coli (APEC) from broiler chickens in Chitwan, Nepal. *BMC Veterinary Research* **14**(1): 1-6. DOI: 10.1186/s12917-018-1442-z

Wallman IS & Hilton HB (1962) TEETH PIGMENTED BY TETRACYCLINE. *The Lancet* **279**(7234): 827-829. DOI: 10.1016/S0140-6736(62)91840-8

Walsh TR & Wu Y (2016) China bans colistin as a feed additive for animals. *The Lancet Infectious Diseases*. **16**(10): 1102. DOI: 10.1016/S1473-3099(16)30329-2

Yewale VN (2014) Antimicrobial resistance — A ticking bomb! *Indian Pediatr* 51: 171–172. DOI: 10.1007/s13312-014-0374-3