RESEARCH ARTICLE

FARMER'S KNOWLEDGE ON ANTI-MICROBIAL RESISTANCE, THEIR PRACTISE OF ANTIMICROBIALS USAGE AND BIOSECURITY STATUS OF POULTRY FARMS IN KATHMANDU VALLEY AND CHITWAN DISTRICT, NEPAL

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ABSTRACT

The poultry industry has transformed into one of the vibrant economic activities in Nepal, contributing to almost 4% of the national GDP. A cross-sectional survey was conducted among the poultry farmers of Kathmandu valley and Chitwan district to assess the knowledge of antimicrobial resistance (AMR) among the farmers; their practice of antimicrobial use in poultry productions and the biosecurity status of their poultry farms. A semi-structured questionnaire was used to interview a total of 112 respondents, 56 each from the study sites. 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). About 53.6% (30/56) of farmers from Kathmandu valley and 60.7% (34/56) from Chitwan district followed the drug's withdrawal period. About 33.9% (19/56) of the farmers of Kathmandu valley and 41.1% (23/56) of Chitwan could tell the names of antibiotics they used in their farms. 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. On average of 41.05% (46/112) farmers knew about the harmful effects of drug residues present in the poultry products. 69.6% (39/56) of poultry farms in Kathmandu valley 53.6% (30/56) of Chitwan district had fences. All the farmers of both districts had separate boots for their farms (100%). 8.9% (5/56) of farms in Chitwan district and 16.1% (9/56) of farms in Kathmandu valley disinfected vehicles entering the farms. Nearly 53.6% (30/56) of the farms in Kathmandu valley and 46.4% (26/56) in Chitwan were in close contact with wild birds. Identifying the critical gaps in knowledge and practice of antimicrobials and improving the farms' biosecurity status could address the issues of AMR in poultry. We suggest a reduction of antimicrobials in the poultry production by adopting alternative measures.

KEYWORDS

Antibiotics, Anti-microbial Resistance, Biosecurity, Poultry farming, Nepal

1. 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) (Agritech, 2017). 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-scale farmers due to its short cycle of meat production, relatively more comfortable rearing, and the use of its by-products in other animal feeds such as feather meal, bone meal, etc. According to the report of the Food and Agriculture Organization (FAO), Nepal (2007 to 2017), the production of poultry increased by approximately two hundred and eighty-nine per cent, i.e. 19.4 million chicken heads in 2007 to 75.4 million in 2017.

The poultry industry in Nepal, however, faces many challenges due to factors such as substandard farm biosecurity, overuse of antimicrobials,

and low disease reporting (Gompo, Shah, et al., 2020; Karki, 2017; Sharma, 2010). Besides, the knowledge of farmers on antimicrobial resistance is insufficient which led to the imprudent use of antibiotics in poultry productions (Acharya et al., 2019; Gompo, Shah, et al., 2020; Karki, 2017; Sharma, 2010). These factors remain to be a burden in the poultry sector, depriving the farmers of optimum profit and contributing to the growth of AMR.

Another major problem rising concurrently with the growing poultry sector is the imprudent use of antimicrobial drugs/ antibiotics. In poultry farming, antibiotics have been used for theurapatics and promotion of growth purpose (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 mechanisms leading to antimicrobial Resistance (AMR) against different strains of bacteria (Chantziaras et al., 2014; English & Gaur, 2010; Shrestha et al., 2017; Spoor et al., 2013; WHO, 2014). According to a survey conducted in 2012 in Nepal, the sales volumes of veterinary antibiotics rose over 50% between 2008 and 2012. Out of that, majority (70%) were obtained without a prescription (Basnyat et al., 2015). This unregulated consumption of antimicrobials is highly expected to increase in the upcoming years. Studies conducted previously in the

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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 gene (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, Sapkota, 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, Sapkota, 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 denoting its overuse in these places (Gompo, Sapkota, et al., 2020; Prajapati et al., 2018). The global consumption of antibiotics in human 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 results in the release of enormous quantities of antibiotics into the environment particularly, making confined aquatic ecosystems such as ponds, lakes, and soils close to urban sites more vulnerable (Manzetti & Ghisi, 2014) 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, Shah, et al., 2020; Sharma, 2010) which predisposes the farms to outbreaks of several infectious diseases. 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, Shah, et al., 2020).

We aimed to assess the knowledge of farmers on anti-microbial resistance, and anti-microbial uses (AMU) on the farm and explore the biosecurity status of poultry farms of Kathmandu and Chitwan, the two leading poultry pockets in the nation.

2. MATERIALS AND METHOD

2.1 Study Site

The study was conducted at Central Veterinary Laboratory (CVL), Kathmandu, and National Avian Disease Investigation Laboratory (NADIL), Bharatpur where the poultry farmers of Kathmandu valley and Chitwan district respectively visited for the diagnostic services and therapeutic recommendation of their sick/dead birds (Fig1).

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

2.2 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, their knowledge and use of antimicrobials, and the condition of farm biosecurity. An equal number of farmers, i.e., fifty-six from both Kathmandu valley and Chitwan district, were included in the study.

2.4 Statistical Analysis

The data collected was recorded in MS Excel 2016. Firstly, a descriptive analysis was performed using a pivot table in 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 ≤ 0.05 was considered statistically significant.

3. RESULTS

3.1 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 respectively with no significant difference between gender-based poultry farming between the districts. 59.8% (67/112) of the farmers had a higher education than SEE. Only an average of 15.8% (17/112) generated income above fifty-thousand through a single lot/batch of poultry farming. Poultry farming contributed to more than fifty percent of the total revenue 51.8% (29/56) and 46.4% (26/56) of the farmers, respectively, in Chitwan and Kathmandu valley. 53.6% (30/56) and 50% (28/56) of the farmers, respectively, from Chitwan and Kathmandu, had experience of at least five years in poultry farming. 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. 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.

Figure 2: Ethnicity of the poultry farmers

Figure 3: Religion followed by the farmers

3.2 Farm characteristics, antibiotics usage, and knowledge of AMR

Most of the farmers preferred broiler rearing to layers and other breeds. For instance, the majority from both districts were involved in broiler rearing. The farming method was exclusively intensive with a deep litter farming system. All of the farmers (100%, 56/56) claimed to have used antibiotics for therapeutic purposes only and ended the use of antibiotics only after completing the recommended course from vets or para-vets. About 41.1% (23/56) of the farmers in Chitwan and 33.9% (19/56) of Kathmandu, respectively, could tell the names of antibiotics they used in their farms. Only a minority of farmers knew about AMR in Chitwan (16.1%, 9/56) and Kathmandu valley (19.6%, 11/56). About 62.5%

(35/56) of farmers from Chitwan and Kathmandu valley had known about the withdrawal period of antibiotics. 87.5% (98/112) of the farmers in aggregate asked to write the prescriptions from certified veterinarians. The percentage of farmers who knew the harmful 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. An average of 26.7% (31/112) of farmers thought that the antibiotics' efficacy 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).

Table 1: 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	56	100	56	100	NA
	Leave when birds stops signs	0	0	0		
Know the names of antibiotics	Yes	23	41.1	19	33.9	0.44
	No	33	58.9	37	66.1	
Keep antibiotics record	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	1.8		
Efficacy of current antibiotics compared to past	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 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

Figure 4: Most frequently used antibiotics in poultry

3.3 Biosecurity status

The number of farms with the 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). A significant difference ($p=0.04$) was observed between the farms of Chitwan (3.6%, 2/56) and Kathmandu valley (21.5%, 12/56) of keeping the logbooks of delivery vehicles. 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) ($p=0.038$). However, before entry into the farm, the disinfection rate of delivery vehicles was meager in both Chitwan (8.9%, 5/56) and Kathmandu valley (16.1%, 9/56), with no significant difference. 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). 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. 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. A significant difference ($p=0.03$) was observed in the rearing of different aged birds in the same flock between the farmers of Chitwan (3.6%, 2/56) and Kathmandu (16.1%, 9/56). The poultry farms of Chitwan (50%, 28/56) had greater eating water-logging problems than the farms of Kathmandu (14.3%, 8/56) with $p<0.0001$. 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 $p=0.01$. Significantly ($p<0.0009$), higher numbers 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). An average of 91.1% (102/112) of all farmers preferred the all-in-all-out program, especially in the case of broiler farming. None of the farmers in Chitwan suggested visiting a nearby farm with a recent disease outbreak of disease while 8.9% (5/56) of farmers in Kathmandu show eagerness to visit the nearby farms.

4. DISCUSSION

The current study assessed the knowledge AMR, and antibiotics usage habit of poultry farmers and measure the of biosecurity status of their farms in Kathmandu valley and Chitwan district. On average, 48.2% (54/112) of farmer's between the age group 25-40 from both districts were involve in the poultry farming, indicating youth's involvement in poultry sector. The majority of the poultry farmers were males (88.4%, 99/112) and 40.15%, (45/112) mentioned they started their poultry enterprise without training. This may create be the gaps among the farmers regarding the awariness of antimicrobials use and proper biosecurity to be applied on the farms for profitable and hygienic poultry production. On average, nearly half (51.8%, 58/112) of the farmers were involved in poultry farming for more than five years. Multi-ethnic and multi-religion farmers were involved in the poultry business indicating its popularity and role in revenue generation among diverse communities. Broiler rearing was the most popular option among the farmers (avg. 78.6%, 88/112) in both Kathmandu and Chitwan district. Most of the poultry farms in both sites could hold 500-1500 birds. All of the farmers were involved in intensive poultry production with a deep litter rearing system (100%, 112/112). All of the farmers (100%, 112/112) from both

sites, agreed to have used antibiotics in the farm for therapeutic purposes only, but the reports of the growing nature of AMR in Nepal says otherwise (Basnyat et al., 2015; Joshi et al., 2019; Shrestha et al., 2017). They also claimed to have stopped using antibiotics only after the completion of the recommended course prescribed by the concerning veterinarian. Certain antibiotics were used most frequently, with or without drug rotation, such as doxycycline, tylosin, colistin, neomycin, and ciprofloxacin. 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). 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. This indicates the negligence of farmers and 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). This information gap has led the poultry workers 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. The rest had no information about it nor they were ever made aware of it. Nearly 26.8% (30/112) of the farmers knew about AMR in humans. 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. 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, observation was that many of the farmers answered how easily they could obtain antibiotics in pharmacies without any vet prescription once they had an idea about the disease. This is the predicament of the current 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 community para vets or vet clinics. The reason they chose 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 due to farmer's awariness 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 compound at their farms. Thus, the chances of a predatory attack from wild animals or even humans were minimal in these farms. The habit of disinfecting the boots/foot cover before at 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. Only an average of 24.1% (27/112) of the farmers maintained the logbook of visitors visiting the farm. This increases the probability of the introduction of virulent micro-

organisms into the farm through unwanted visitors without any evidence of 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). This predisposes the farms to the outbreak of foreign infections carried into the farm by the delivery vehicles from other sources (Sims, 2007). The habit of cleaning utensils and water daily before feeding was very high with an avg. of 82.1% (92/112) and 97.2% (109/112) respectively in both sites. It reduces the chances of ingestion of 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 wild birds (reservoirs of avian influenza). This may cause a highly- pathogenic avian influenza (HPAI) outbreak 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 than Kathmandu (73.2%, 41/56) that had an isolation pen

for sick birds to be quarantined. The majority of the farmers (57.1%, 64/112) disposed of the used-up litter far away from the farm, however, without prior disinfection. 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. The farming of different aged birds was low (avg. 9.5%, 11/112), and the majority of the farmers adopted the all-in all-out program (avg. 91.1%, 102/112) which lowers the chances of spread of diseases between different age group in the same farm (due to different health and immunological status) and introduction of infection from newer flocks as well (Alexander, 2007; Sims, 2007). The dispatch of dead birds to pig farms, as a source of secondary revenue, was mostly seen in Kathmandu valley Valley (17.9%, 10/56) compared to Chitwan (*nil*). It indicates a higher probability of dissemination of the infectious agents while en route to the pig farms in the valley.

Table 2: 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	

* Indicates p<0.05 and significant

5. 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 of the farmers during the survey was low, and as such, the study's findings may not be generalizable to the whole of the country. Some farmers were reluctant to answer about the real use of antibiotics on the farm which may affect the validity of the responses.

6. CONCLUSION

Based on this survey, the knowledge and practice of poultry farmers in Chitwan and Kathmandu valley regarding knowledge of AMR, antibiotic usage and biosecurity measures of the farms were evaluated. The majority of the farmers started their poultry enterprise without prior training. This creates an information gap among the farmers and they fail to achieve optimum profitability from the farm.

Regarding the use of antibiotics on the farm, it is crucial to teach the farmers about the prudent use of antibiotics only after a prescription from a certified veterinarian. All of the farmers in the survey claimed to use antibiotics for therapeutic purposes only, but the scenario may not be the same in the whole country. 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 formed and the investors should be provided with comprehensive information for successful poultry farming.

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