

**Knowledge, attitudes and practices of the farmers towards antibiotic usage in layer birds in Haryana, India: A cross-sectional survey**

**Abstract**

The antibiotic usage practices of poultry farmers have drastically changed over decades in most of the developing countries like India. The present study carried out in 100 layer farms of state Haryana, India to assess the knowledge, attitudes and practices of farmers towards antibiotic usage in layer birds using structured questionnaire. The findings suggested that 39 (39%) farmers had correct knowledge, 67 (67%) farmers had positive attitudes and 64 (64%) farmers followed good practices towards antibiotic usage in layer farms. The statistical analysis revealed farmers owning small size farms had 0.12 times lower odds ( $p$ -value $<0.01$ , OR=0.12, 95% CI=0.03-0.55) of positive attitudes than farmers owning large size farms. Further, the farmers who used self-made feeds at their farms had 5.08 times lower odds ( $p$ -value $<0.01$ , OR=5.08, 95% CI=1.49-17.25) of positive attitudes towards antibiotic usage as compared to commercial feed users. An interesting finding of the survey was that farmers who had education level up to 12<sup>th</sup> grade showed 5.65 times higher odds ( $p$ -value $<0.01$ , OR=5.65, 95% CI=1.52-20.93) of having better knowledge of antibiotic usage than graduate farmers. A high proportion of farmers even used antibiotics without proper consultation with the veterinarian. The study suggests that there is a significant gap between farmer's knowledge and attitudes. Lack of strict legislation, restrictions on antibiotic use and farmer's self-prescription of antibiotics to the flock are highly accountable for the increasing antibiotic resistance and production of residues contaminated eggs which is a major threat to public health globally.

**Keywords:** Antibiotic resistance, Attitudes, Knowledge, Layer farmers, Practices

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## Introduction:

Antibiotics are significantly employed in poultry flocks for therapeutic purposes, enhancing growth and productivity to meet the increasing demand of meat and eggs. However, their non-prudent use is escalating the problem of antibiotic resistance. India is one of the largest producers of poultry eggs and stands 3<sup>rd</sup> in egg production in the world (FAOSTAT, 2022). Notably, antibiotics are essential for ensuring animal health by lowering the burden of infectious diseases and reducing mortality. Antibiotics such as tetracyclines, fluoroquinolones, sulphonamides, ionophores, macrolides, aminoglycosides, lincosamides, *etc.* are widely used in poultry for improving growth and feed efficiency in addition to treatment and prophylaxis of the diseases (WHO, 2012; Gelband *et al.*, 2015, Manikandan *et al.*, 2020). One of the most important consequences of the non-prudent use of antibiotics in poultry production is the emergence of antibiotic resistant strains of bacteria (Obeng *et al.*, 2012). These antibiotic resistant strains of bacteria subsequently escape and spread in the environment mainly through excreta/ droppings which consequently has major effects on humans and all other living species in the environment (Wang *et al.*, 2021). Additionally, the paucity of data available on antibiotic usage in layer production in India which is the major driver of increasing antibiotic resistance in human and animal populations (Sivagami *et al.*, 2020).

The irrational use of antibiotics, improper hygiene and poor bio-security practices mainly contribute towards the promotion of antibiotic resistant bacteria in the environment (Kraemer *et al.*, 2019). Furthermore, tetracycline group (tetracycline, chlortetracycline, oxytetracycline, and doxycycline) of antibiotics are widely used in the layers as growth promoters or for disease control because of their broad spectrum activity and low cost compared with other antibiotics (Al-Wabel, 2011; Chowdhury *et al.*, 2015; Sreejith *et al.*, 2020). The presence of antibiotic residues in eggs is highly influenced by the knowledge, attitudes and practices (KAP) of farmers towards the antibiotic usage in layer birds (Caudell

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*et al.*, 2020). The non-prudent use of antibiotics such as self-administration of antibiotics, extra-label use, failure to follow label instructions and non-adherence to withdrawal periods prior to egg laying, may leave residues in eggs at levels that are potentially harmful to human health (Kabir *et al.*, 2004; Goetting *et al.*, 2011; Kehinde *et al.*, 2012). Thus, the sound knowledge of farmers towards judicious use of antibiotics in layer birds is fundamental to prevent the occurrence of residues in eggs and further spread of antibiotic resistant bacteria. The findings of the present study will help in recognizing the gaps and identification of the factors associated with antibiotic usage by the farmers in layer birds in Haryana, India. Also, the present study could contribute towards more focused antibiotic resistance control initiatives in India.

## **Materials and methods**

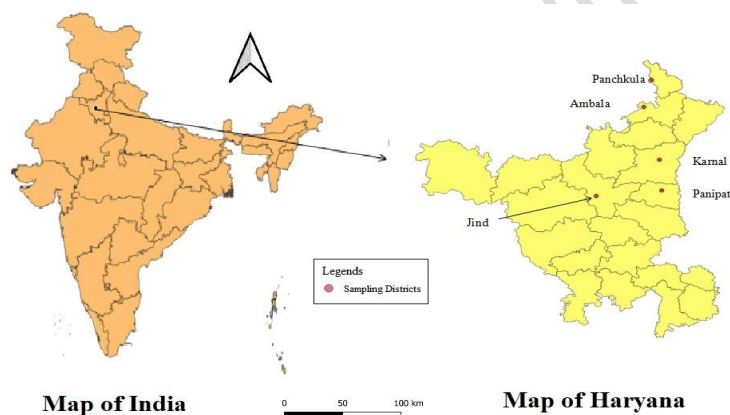
### ***Study area and data collection***

Haryana is a northern Indian state that lies between latitudes 27° 39'N to 30° 35'N and longitudes 74° 28'E to 77° 36'E with an egg production of 66,153 lakhs per annum and stands 6<sup>th</sup> in egg production in the country (BAHS, 2021). A total of 100 layer farms from 05 districts of Haryana *viz.*, Ambala, Panchkula, Panipat, Karnal and Jind were visited in the present study. Twenty (20) layer farms from each of these 05 districts were selected randomly because these districts are among the top contributors to Haryana's total egg production (DAHD, 2020) (Figure 1). The layer farms were visited for the assessment of KAP of farmers towards antibiotic usage in layer birds using a structured questionnaire (Appendix-I). The questionnaire consisted of five sections *viz.*, farm overview, socio-demographic information, knowledge, attitudes and practices towards antibiotic usage. Mostly the valuable information was targeted which could help to identify the gaps. Initially, a pilot study was carried out with five layer farmers to evaluate the viability and suitability of the questionnaire designed for the main study. Following the pilot study, needful revisions and refinements were made to

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the questionnaire for ensuring effective data collection. All the questions pertaining to farmers KAP were close ended which provided holistic approach for better understanding of farmer's perspective towards antibiotic usage. Each respondent was given a unique serial number in order to safeguard their confidentiality. The questionnaire was filled up using information provided by the respondent. Later, the data was entered to a Microsoft Excel spreadsheet (Microsoft Excel 2010, Microsoft Corporation, Redmond, Washington, USA) for further processing and analysis. The data collection process for the survey took place from March 2022 to November 2022, allowing for an extended period of data collection.



**Fig. 1: Geographical area representing the districts of Haryana State from where the responses of layer farmers were recorded**

#### **Statistical analysis**

The collected data was assessed using SPSS statistical software (version 20.0 Armonk, NY: IBM Corp.) for the test of significance. Responses were coded as binary variables in the KAP component of the questionnaire, with 0 denoting "No" and 1 denoting "Yes," making it easy to distinguish between affirmative and negative responses. The socio-demographic data having categorical variables were expressed as frequencies and percentages. Descriptive

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statistics were employed to test the association of socio-demographic factors, including variables such as age, training source, main occupation and level of education. The mean was used as a cut-off point to assess the scores of KAP (Geta and Kibret, 2021). Scores equal to or above the mean were considered indicative of correct knowledge, good practices and positive attitudes towards antibiotic usage, while scores below the mean suggested potential gaps in KAP. The factors associated with the KAP of the farmers towards antibiotic usage were analyzed using the  $\chi^2$  test and logistic regression model. The  $\chi^2$  test examined the relationship between categorical variables therefore enabling the identification of significant associations. On the other hand, the logistic regression model considered multiple factors simultaneously, assessing their effect on the farmer's KAP of antibiotic usage. The Pearson correlation test was used to investigate at the relationship between the farmers' mean KAP scores. A value of  $p < 0.05$  was considered significant. Furthermore, odds ratios (OR) with a 95% confidence interval (CI) were calculated to assess the strength of associations between the factors.

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## Results

### *Respondent's socio-demographic characteristics*

In the present study, personal interview of 100 layer farmers was conducted and response rate was 100%. Majority of the participants had layer birds, while only few had both layers and breeders on their farms. All the respondents were male and most of them had poultry farming as their main occupation. Out of total, 28% of farmers had experience of more than 50 years in layer farming, all held ancestral training. In terms of education, only 21% of the participants had education level upto 12 th grade. The detailed socio-demographic characteristics of the farmers are given in Table 1.

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**Table 1. Socio-demographic characteristics of the respondents:**

Variables	N (%)
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<b>Type of birds at the farm</b>	<b>Layers</b>	90 (90%)
	<b>Layers + Breeders</b>	10 (10%)
<b>Farm size</b>	<b>Small (<math>\leq 25000</math>)</b>	25 (25%)
	<b>Medium(25000-50000)</b>	40 (40%)
	<b>Large(<math>\geq 50000</math>)</b>	35 (35%)
<b>Type of feed used at the farm</b>	<b>Self-made</b>	36 (36%)
	<b>Commercial</b>	64 (64%)
<b>Feeding schedule</b>	<b>Twice</b>	86 (86%)
	<b>Thrice</b>	14 (14%)
<b>Age of the farmer</b>	$\leq 40$	31 (31%)
	<b>40-50</b>	41 (41%)
	$\geq 50$	28 (28%)
<b>Training of poultry farming</b>	<b>Ancestrol</b>	35 (35%)
	<b>Friends</b>	41 (41%)
	<b>Professional institution trained</b>	17 (17%)
	<b>Others</b>	7 (7%)
<b>Experience in poultry farming</b>	$\leq 10$ years	25 (25%)
	<b>10-20 years</b>	46 (46%)
	$\geq 20$ years	29 (29%)
<b>Main Occupation</b>	<b>Poultry farming</b>	95 (95%)
	<b>Others</b>	5 (5%)
<b>Level of Education</b>	<b>12<sup>th</sup> grade</b>	21 (21%)
	<b>Graduate</b>	79 (79%)

### ***Respondent's knowledge, attitudes and practices***

The results revealed a limited level of knowledge among the participants. Only 39 (39%) farmers responded correctly towards the knowledge-based questions (Table 2). All the farmers knew about the antibiotics (100%). Results showed that the majority of the farmers (88%) did not know about the antibiotic residues and most of the farmers (98%) did not know the withdrawal period of antibiotics. When asked about the reduction in the efficacy of the same antibiotic when used over a period of time only 21% of the farmers had correct knowledge. Nevertheless, 35% of farmers knew that antibiotics are used in the feed of poultry for the prevention of diseases. It was interesting to note that 53% of farmers knew that adoption of biosecurity measures and improved hygiene can reduce the use of antibiotics.

**Table 2: Knowledge of farmers towards antibiotic usage in layer birds**

<b>KNOWLEDGE</b>			
<b>Questions (Correct answer)</b>		<b>Correct response</b>	<b>Incorrect response</b>
1	Do you know about antibiotics? (Yes)	100	0
2	Do you know about antibiotic residues? (Yes)	12	88
3	Do you know about antibiotic resistance? (Yes)	56	44
4	Do you know antibiotics pass in the eggs of treated birds? (Yes)	10	90
5	Do you know about withdrawal period of antibiotics? (Yes)	10	90
6	Do you know frequent use of same antibiotics will decrease their efficacy? (Yes)	21	79

7	Do you know specific antibiotics acts against specific disease? (Yes)	5	95
8	Do you know consumption of antibiotic residue containing eggs causes some side effects in humans? (Yes)	8	92
9	Do you know treatment is needed for whole flock when only some birds are diseased? (No)	11	89
10	Do you know antibiotics are used in feed of poultry for prevention of disease? (No)	35	65
11	Do you know biosecurity and improved hygiene can reduce the use of antibiotics? (Yes)	53	47
12	Do you have any idea that antibiotics are used to cure infections caused by viruses? (No)	0	100
<b>Overall level of knowledge</b>		<b>Frequency (%)</b>	
Correct		39 (39%)	
Incorrect		61 (61%)	

More than half of the farmers (67%) had positive attitudes towards antibiotic usage (Table 3). Results showed that 100% of farmers agreed to reduce the usage of antibiotics if they knew the antibiotics are harmful in some sense. About 81% of farmers admitted that only veterinarians are eligible to prescribe antibiotics for poultry whilst 71% of farmers had opinion that the regular vaccination can reduce the use of antibiotics and adoption of good hygiene practices and vaccination can prevent the occurrence of diseases. The fact that

inappropriate use or half course of antibiotics leads to antibiotic resistance was accepted by only 21% of farmers and only 10% of farmers thought that the withdrawal period should be followed before selling the eggs of treated birds.

**Table 3: Attitudes of farmers towards antibiotic usage in layer birds**

<b>ATTITUDES</b>			
<b>Questions (Correct answer)</b>		<b>Correct response</b>	<b>Incorrect response</b>
1	Do you think antibiotics should be used as growth promoter any time in the feed /water for a prevention of disease? (No)	100	0
2	Do you think poultry deaths can be reduced through antibiotics usage? (Yes)	31	69
3	Do you think it is possible to reduce antibiotic use and yet achieve maximum production? (Yes)	50	50
4	Do you think any herbal drugs could be alternative to antibiotics? (Yes)	18	82
5	Do you think seasons and diseases have relation? (Yes)	43	57
6	Would you reduce usage of antibiotics if you knew they are harmful in some sense? (Yes)	100	0
7	In your opinion, only veterinarians are eligible to prescribe antibiotics for poultry? (Yes)	81	19
8	Do you think regular vaccination can reduce the use of	70	30

	antibiotics? (Yes)		
9	Do you think inappropriate use or half course of antibiotics leads to antibiotic resistance? (Yes)	21	79
10	Do you think withdrawal period should be followed before selling eggs of treated birds? (Yes)	10	90
11	Do you think good hygiene practices and vaccination can prevent occurrence of diseases? (Yes)	70	30
<b>Overall level of attitude</b>		<b>Frequency (%)</b>	

The mean score of good practices was observed in 64 (64%) farmers on antibiotic usage in layer farms (Table 4). Results reported that about 81% of farmers checked the expiry date of drugs and followed the complete course of antibiotics. About 19% of the farmers had good practices of not disposing off the farm waste near a water body. Moreover, 89% of farmers had attended training to improve their knowledge of antibiotic usage and 100% of the farmers agreed that they follow proper biosecurity measures. Surprisingly, it was observed that 65% of the farmers increase the dose of antibiotics by themselves if the birds don't recover and nearly half of the respondents (49%) used antibiotics in all sheds if some birds in the flock get the infection.

**Table 4: Practices of farmers towards antibiotic usage in layer birds**

<b>PRACTICES</b>			
<b>Questions (Correct answer)</b>		<b>Correct response</b>	<b>Incorrect response</b>
1	Do you use antibiotic by yourself or with veterinarian	19	81

	consultancy? (No)		
2	Do you check expiry date of drugs? (Yes)	81	19
3	Do you use antibiotics as additives for growth promoter in feed? (No)	34	66
4	Do you follow antibiotic withdrawal period? (Yes)	10	90
5	Do you increase dose of antibiotic by yourself if the birds don't recover? (No)	65	35
6	Do you complete course of antibiotics? (Yes)	81	19
7	Do you dispose farm waste near water sources? (No)	81	19
8	Do you sell the eggs of antibiotic treated birds? (No)	5	95
9	Do you use combination of antibiotics? (Yes)	65	35
10	Do you follow vaccination schedules for your flock regularly? (Yes)	17	83
11	Have you ever attended any training to improve the knowledge on antibiotic usage? (Yes)	89	11
12	If flock / some birds get infection, do you use antibiotic in all sheds? (No)	49	51
13	Do you follow proper bio-security measures? (Yes)	100	0
14	Do you maintain records of antibiotics given to flocks in each shed? (Yes)	19	81
<b>Overall level of practices</b>		<b>Frequency (%)</b>	
Good		64(64%)	
Bad		36(36%)	

### Data analysis

Data analysis revealed that odds of using antibiotics at farm increased with the increase in farm size. For example, farmers owning small sized layer farms had 0.12 times lower odds ( $p$ -value<0.01, OR=0.12, 95% CI=0.03-0.55) of positive attitudes than farmers owning large size farms. Further, the farmers who used self-made feeds at their farms had 5.08 times lower odds ( $p$ -value<0.01, OR=5.08, 95% CI=1.49-17.25) of positive attitudes towards antibiotic usage as compared to commercial feed users. An interesting finding of the survey was that farmers who had education levels up to 12<sup>th</sup> grade showed 5.65 times higher odds ( $p$ -value<0.01, OR=5.65, 95% CI=1.52-20.93) of having better knowledge of antibiotic usage than graduate farmers. Other variables, including district, feeding schedule, farmer's age, poultry farming training and experience did not significantly affect the outcomes of interest and are summarized in Table 5 and 6.

In the present study, knowledge and attitudes showed a correlation coefficient of -0.049, which indicated a very weak negative correlation. However, this correlation was not statistically significant ( $p$ -value=0.626). The correlation coefficient of -0.041 was observed between farmer's knowledge and practices. Similar to the former association, knowledge and practices also did not show any significant linear relationship ( $p$ -value=0.685). A very weak positive correlation of 0.05 was found between attitudes and practices but it was not statistically significant ( $p$ -value=0.624). Overall, Pearson's correlation test revealed no significant correlation between farmer's KAP towards antibiotic use (Table 7).

### Discussion

The present survey aimed to assess the KAP of farmers towards antibiotic usage was the first survey to be done among layer farmers in Haryana. The 100% response rate indicates a high level of participation and engagement from the farmers. It is noteworthy that all of the respondents were male, which could be attributed to the cultural and societal norms prevalent in the study area where poultry farming is mostly viewed as a male occupation (Babyusha *et al.*, 2020). The mean scores suggested that 39% of farmers had correct knowledge, 67% of

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**Table 5: Test of statistical significance of variation in the knowledge, attitudes and practices of the farmers towards antibiotic usage**

Variables		Knowledge			Attitudes			Practices		
		Correct n(%)	Incorrect n(%)	<i>p</i> - value	Positive n(%)	Negative n(%)	<i>p</i> - value	Good n(%)	Bad n(%)	<i>p</i> - value
<b>District</b>	<b>Ambala</b>	6 (30)	14 (70)	0.61	13 (65)	7 (35)	0.42	16 (80)	4 (20)	0.34
	<b>Panchkula</b>	6 (30)	14 (70)		15 (75)	5 (25)		10 (50)	10 (50)	
	<b>Panipat</b>	10 (50)	10 (50)		10 (50)	10 (50)		12 (60)	8 (40)	
	<b>Karnal</b>	9 (45)	11 (55)		15 (75)	5 (25)		14 (70)	6 (30)	
	<b>Jind</b>	8 (40)	12 (60)		14 (70)	6 (30)		12 (60)	8 (40)	
<b>Farm size</b>	<b>Small (<math>\leq 25000</math>)</b>	10 (40)	15 (60)	0.77	11 (44)	14 (56)	<b>0.01</b>	19 (76)	6 (24)	0.22
	<b>Medium (25000-50000)</b>	14 (35)	26 (65)		28 (70)	12 (30)		26 (65)	14 (35)	
	<b>Large (<math>\geq 50000</math>)</b>	15(42.8)	20(57.14)		28 (80)	7 (20)		19(54.28)	16(45.71)	
<b>Type of feed used at farm</b>	<b>Self-made</b>	17 (47.2)	19 (52.7)	0.20	26 (72.2)	10 (27.7)	0.40	24 (66.6)	12 (33.3)	0.67

	<b>Commercial</b>	22 (34.3)	42 (65.6)		41 (64.06)	23 (35.9)		40 (62.5)	24 (37.5)	
<b>Feeding schedule</b>	<b>Twice</b>	33 (38.3)	53 (61.6)	0.75	57 (66.2)	29 (33.7)	0.70	53 (77.9)	33 (38.3)	0.22
	<b>Thrice</b>	6 (42.8)	8 (57.1)		10 (71.4)	4 (28.5)		11 (78.5)	3 (21.4)	
<b>Age of farmer</b>	<b>≤40</b>	13 (41.9)	18 (58.06)	0.88	20 (65.51)	11 (35.48)	0.93	19 (61.29)	12 (38.7)	0.35
	<b>40-50</b>	16 (30.02)	25 (60.98)		28 (68.28)	13 (31.7)		24 (58.53)	17 (41.46)	
	<b>≥50</b>	10 (35.71)	18 (64.29)		19 (67.85)	9 (32.14)		21 (75)	7 (25)	
<b>Training of poultry farming</b>	<b>Ancestral</b>	16 (45.71)	19 (54.29)	0.31	25 (71.43)	10 (28.57)	0.30	24 (68.57)	11 (31.43)	0.77
	<b>Friends</b>	12	29		29	12		25	16	

		(29.27)	(70.73)		(70.13)	(29.27)		(60.98)	(39.02)	
	<b>Professional institution trained and Others</b>	11 (45.83)	13 (54.17)		13 (54.17)	11 (45.83)		15 (2.50)	9 (37.9)	
<b>Experience in poultry farming</b>	<b>≤10 years</b>	7 (28)	18 (72)	0.31	17 (68)	8 (32)	0.93	18(72)	7 (28)	0.17
	<b>10-20 years</b>	18 (39.13)	28 (60.87)		30 (65.22)	16 (34.78)		25 (54.35)	21 (45.65)	
	<b>≥20 years</b>	14 (48.28)	15 (51.72)		20 (68.97)	9 (31.09)		21 (72.41)	8 (27.59)	
<b>Level of Education</b>	<b>12<sup>th</sup> grade</b>	13 (61.9)	8 (38.10)	<b>0.01</b>	14 (66.67)	7 (33.33)	0.97	11 (52.38)	10 (47.62)	0.21
	<b>Graduate</b>	26 (32.91)	53 (67.09)		53 (67.09)	26 (32.91)		53 (67.09)	26 (32.91)	

$p < 0.05$ - The mean difference was significant at 5% level

**Table 6: Logistic regression analysis of the factors associated with farmer's knowledge, attitudes and practices towards antibiotic usage**

Variables		Knowledge	Attitudes	Practices
		OR, 95% CI, <i>p</i> -value	OR, 95% CI, <i>p</i> -value	OR, 95% CI, <i>p</i> -value
District	Ambala	0.64,0.11-3.81,0.62	0.88,0.17-4.74,0.89	2.43,0.45-13.24,0.31
	Panchkula	0.51,0.09-2.84,0.44	0.71,0.12-4.10,0.70	0.66,0.14-3.18,0.61
	Panipat	5.39,0.91-31.86,0.06	0.59,0.11-3.21,0.54	1.27,0.25-6.43,0.77
	Karnal	3.24,0.65-16.11,0.15	1.17,0.22-6.28,0.85	1.39,0.29-6.78,0.68
	Jind	*	*	*
Farm size	Small ( $\leq 25000$ )	1.04,0.23-4.70,0.96	0.12,0.03-0.55, <b>0.01</b>	1.81,0.43-7.67,0.42
	Medium (25000-50000)	0.92,0.25-3.39,0.90	0.53,0.13-2.16,0.38	1.36,0.40-4.63,0.63
	Large ( $\geq 50000$ )	*	*	*
Type of feed used at farm	Self-made	5.08,1.49-17.25, <b>0.01</b>	1.19,0.39-3.57,0.76	1.49,0.51-4.34,0.47
	Commercial	*	*	*
Feeding schedule	Twice	0.53,0.13-2.25,0.39	0.70,0.16-3.07,0.64	0.42,0.09-2.00,0.28
	Thrice	*	*	*
Age of farmer	$\leq 40$	1.32,0.39-4.51,0.65	0.83,0.24-2.90,0.77	0.44,0.13-1.51,0.19

	<b>40-50</b>	1.15,0.35-3.76,0.82	0.98,0.16-3.07,0.64	0.36,0.11-1.19,0.09
	<b>≥50</b>	*	*	*
<b>Training of poultry farming</b>	<b>Ancestrol</b>	0.63,0.14-2.84,0.55	4.44,0.87-22.72,0.07	1.09,0.24-4.95,0.92
	<b>Friends</b>	0.54,0.13-2.25,0.40	1.82,0.44-7.57,0.41	0.93,0.22-3.82,0.91
	<b>Professional institution trained and Others</b>	*	*	*
<b>Experience in poultry farming</b>	<b>≤10 years</b>	0.27,0.05-1.47,0.13	3.27,0.54-19.83,0.20	0.72,0.13-4.08,0.71
	<b>10-20 years</b>	0.50,0.13-1.89,0.31	1.54,0.39-6.06,0.54	0.37,0.09-1.52,0.17
	<b>≥20 years</b>	*	*	*
<b>Level of Education</b>	<b>12<sup>th</sup> grade</b>	5.65,1.52-20.93, <b>0.01</b>	0.60,0.16-2.27,0.46	0.54,0.16-1.79,0.31
	<b>Graduate</b>	*	*	*

\*- Reference value

$p < 0.05$ - The mean difference was significant at 5% level

**Table 7: Correlations between knowledge, attitudes and practices**

		<b>Knowledge</b>	<b>Attitudes</b>	<b>Practices</b>
<b>Knowledge</b>	<b>Correlation Coefficient</b>	1	-0.049	-0.041
	<b>Sig. (2-tailed)</b>	-	0.626	0.685
<b>Attitudes</b>	<b>Correlation Coefficient</b>	-0.049	1	0.05
	<b>Sig. (2-tailed)</b>	0.626	-	0.624
<b>Practices</b>	<b>Correlation Coefficient</b>	-0.041	0.05	1
	<b>Sig. (2-tailed)</b>	0.685	0.624	-

farmers had positive attitudes and 64% of farmers followed good practices towards antibiotic usage in layer birds. All the selected socio-demographic characteristics of the respondents provided insightful information for the targeted sample population of layer farmers. The extensive time period also ensured a thorough and accurate survey of layer farmers and their practices towards antibiotic usage along with any seasonal variations or patterns that might affect the use of antibiotics by farmers.

The descriptive statistics suggested that farmers had limited knowledge about the term antibiotic resistance (56%). These observations are similar to the findings of previous studies

in other countries where nearly half of the participants were not aware of antibiotic resistance (Moffo *et al.*, 2020; Hassan *et al.* 2021; Islam *et al.*, 2022; Mudenda *et al.*, 2022). Also, antibiotic resistance has become a global issue in the last two decades, posing a serious threat to the health of humans and animals (Moffo *et al.*, 2020). A high proportion of farmers even used antibiotics without consulting veterinarian. The lack of control over these practices is may be due to the lack of strict laws or restrictions on antibiotic usage in the animal husbandry sector. The practices such as self-administration of antibiotics, their dose, frequency and duration are possible risk factors for the emergence of antibiotic resistance bacterial strains (Prestinaci *et al.* 2015).

Most of the layer farmers were unaware about the term withdrawal period (90%) which consequently affects their attitude towards non-adherence to withdrawal periods during antibiotic treatment of birds. Along with triggering antibiotic resistance problems it also results in occurrence of residues contaminated eggs, which is a serious food safety concern (Owusu-Doubreh *et al.*, 2022). Although majority of farmers (67%) had positive attitudes but only few (18%) agreed to use herbal drugs as alternatives for antibiotics and majority of them (70%) acknowledged the importance of vaccination of birds to reduce the usage of antibiotics in birds. According to the survey, the practices of selling eggs of antibiotic treated birds was prominent among farmers (95%) and instead of being aware of importance of vaccination only limited number of farmers (17%) followed proper schedule. Half of the farmers practiced antibiotic usage in all sheds if few birds were diagnosed with disease which results in residues contaminated eggs. Hence, there is a need of improving the perception of farmers with negative attitudes and poor practices through proper guidance and awareness programs towards judicious use of antibiotics for combating the prime issue of antibiotic resistance.

Among all the variables undertaken in the present study, farm size was associated with positive attitudes toward antibiotic usage. A high proportion of farmers owning large

farms had positive attitudes similar to the findings of the study carried out in Bangladesh (Hassan *et al.*, 2021). Further, the farmers who used self-made feeds at their farms had better knowledge of antibiotics as compared to the farmers who used commercial feed. In addition, most of the farmers owning small farms used commercial feed in contrast to farmers owning large size farms who preferred self-made feed similar to the findings of Onono *et al.* (2018) in Kenya. An interesting finding of the survey was that the farmers having education level up to 12<sup>th</sup> grade showed better knowledge than graduate farmers. Similar findings were observed by Kalam *et al.* (2021) in Bangladesh, where the study participants were drug sellers. Although educated farmers may have greater accessibility to collect information and resources which can have a positive impact on their practice. However, the possible reason for such findings could be their keenness to learn more, gaining expertise through training and better understanding of antibiotic usage.

Pearson's correlation test revealed no significant correlation between farmer's KAP. Contrary to this, the studies carried out in the past observed a positive correlation and significant association between knowledge and attitudes of farmers towards antibiotic usage in Africa and Bangladesh (Caudell *et al.* 2020 and Hassan *et al.* 2021). Hassan *et al.* 2021 also observed a positive correlation between the knowledge and practices of farmers toward antibiotic usage.

## **Conclusion**

KAP of farmers plays an important role in determining antibiotic usage at farms. Lack of strict legislations, restrictions on antibiotic use and farmer's self-prescription of antibiotics to the flock are highly accountable for the increasing antibiotic resistance and production of residues contaminated foods of animal origin posing a serious threat to public health globally. Hence, for the better understanding of antibiotic usage and antibiotic resistance, there is a need of improving awareness among layer farmers through effective communication,

Commented [A18]: please added study findings

education and training. This study was an attempt to assess the associated factors that mainly influence the KAP of the farmers. It is a remarkable fact that lack of awareness regarding the consequences of the irrational use of antibiotics by layer farmers over a long period is a serious matter of public health concern (Sawadogo *et al.*, 2023). In the view of combating the drivers of antibiotic resistance and ensuring good efficacy of antibiotics used in the treatment of animals and humans, strict regulations should be placed to control the non-prudent use of antibiotics in food producing animals (Chokshi *et al.*, 2019). Also, the judicious antibiotic usage by layer farmers is important to prevent the escalating problem of antibiotic resistance and thus preventing unacceptable health risks to the human and animal population.

#### **Ethical standards**

The study involved no experimentation.

#### **Consent to Participate**

Participation in the study was on a voluntary basis and the farmers were informed in advance about the purpose of the study. The response to the questionnaire constituted the participant's verbal consent.

#### **Appendix-I**

Supplementary file showing detailed questionnaire can be found attached as Appendix-I.

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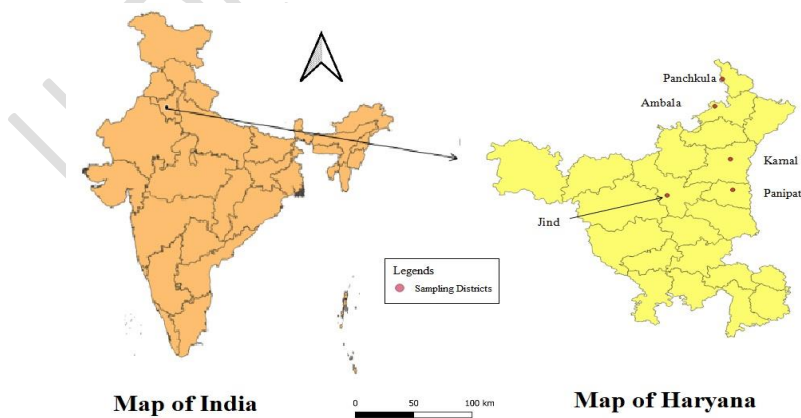
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### Appendix-I



**Fig. 1: Geographical area representing the districts of Haryana State from where the responses of layer farmers were recorded**

**Table 1. Socio-demographic characteristics of the respondents**

Variables		N (%)
Type of birds at the farm	Layers	90 (90%)
	Layers + Breeders	10 (10%)
Farm size	Small ( $\leq 25000$ )	25 (25%)
	Medium(25000-50000)	40 (40%)
	Large( $\geq 50000$ )	35 (35%)

<b>Type of feed used at the farm</b>	<b>Self-made</b>	36 (36%)
	<b>Commercial</b>	64 (64%)
<b>Feeding schedule</b>	<b>Twice</b>	86 (86%)
	<b>Thrice</b>	14 (14%)
<b>Age of the farmer</b>	<b>≤40</b>	31 (31%)
	<b>40-50</b>	41 (41%)
	<b>≥50</b>	28 (28%)
<b>Training of poultry farming</b>	<b>Ancestrol</b>	35 (35%)
	<b>Friends</b>	41 (41%)
	<b>Professional institution trained</b>	17 (17%)
	<b>Others</b>	7 (7%)
<b>Experience in poultry farming</b>	<b>≤10 years</b>	25 (25%)
	<b>10-20 years</b>	46 (46%)
	<b>≥20 years</b>	29 (29%)
<b>Main Occupation</b>	<b>Poultry farming</b>	95 (95%)
	<b>Others</b>	5 (5%)
<b>Level of Education</b>	<b>12<sup>th</sup> grade</b>	21 (21%)
	<b>Graduate</b>	79 (79%)

**Table 2: Knowledge of farmers towards antibiotic usage in layer birds**

<b>KNOWLEDGE</b>		
<b>Questions (Correct answer)</b>	<b>Correct response</b>	<b>Incorrect response</b>

1	Do you know about antibiotics? (Yes)	100	0
2	Do you know about antibiotic residues? (Yes)	12	88
3	Do you know about antibiotic resistance? (Yes)	56	44
4	Do you know antibiotics pass in the eggs of treated birds? (Yes)	10	90
5	Do you know about withdrawal period of antibiotics? (Yes)	10	90
6	Do you know frequent use of same antibiotics will decrease their efficacy? (Yes)	21	79
7	Do you know specific antibiotics acts against specific disease? (Yes)	5	95
8	Do you know consumption of antibiotic residue containing eggs causes some side effects in humans? (Yes)	8	92
9	Do you know treatment is needed for whole flock when only some birds are diseased? (No)	11	89
10	Do you know antibiotics are used in feed of poultry for prevention of disease? (No)	35	65
11	Do you know biosecurity and improved hygiene can reduce the use of antibiotics? (Yes)	53	47
12	Do you have any idea that antibiotics are used to cure infections caused by viruses? (No)	0	100

Overall level of knowledge	Frequency (%)
Correct	39 (39%)
Incorrect	61 (61%)

**Table 3: Attitudes of farmers towards antibiotic usage in layer birds**

ATTITUDES		
Questions (Correct answer)	Correct response	Incorrect response
1 Do you think antibiotics should be used as growth promoter any time in the feed /water for a prevention of disease? (No)	100	0
2 Do you think poultry deaths can be reduced through antibiotics usage? (Yes)	31	69
3 Do you think it is possible to reduce antibiotic use and yet achieve maximum production? (Yes)	50	50
4 Do you think any herbal drugs could be alternative to antibiotics? (Yes)	18	82
5 Do you think seasons and diseases have relation? (Yes)	43	57
6 Would you reduce usage of antibiotics if you knew they are harmful in some sense? (Yes)	100	0
7 In your opinion, only veterinarians are eligible to prescribe antibiotics for poultry? (Yes)	81	19

8	Do you think regular vaccination can reduce the use of antibiotics? (Yes)	70	30
9	Do you think inappropriate use or half course of antibiotics leads to antibiotic resistance? (Yes)	21	79
10	Do you think withdrawal period should be followed before selling eggs of treated birds? (Yes)	10	90
11	Do you think good hygiene practices and vaccination can prevent occurrence of diseases? (Yes)	70	30
<b>Overall level of attitude</b>		<b>Frequency (%)</b>	

**Table 4: Practices of farmers towards antibiotic usage in layer birds**

<b>PRACTICES</b>			
<b>Questions (Correct answer)</b>		<b>Correct response</b>	<b>Incorrect response</b>
1	Do you use antibiotic by yourself or with veterinarian consultancy? (No)	19	81
2	Do you check expiry date of drugs? (Yes)	81	19
3	Do you use antibiotics as additives for growth promoter in feed? (No)	34	66
4	Do you follow antibiotic withdrawal period? (Yes)	10	90
5	Do you increase dose of antibiotic by yourself if the birds don't recover? (No)	65	35
6	Do you complete course of antibiotics? (Yes)	81	19

7	Do you dispose farm waste near water sources? (No)	81	19
8	Do you sell the eggs of antibiotic treated birds? (No)	5	95
9	Do you use combination of antibiotics? (Yes)	65	35
10	Do you follow vaccination schedules for your flock regularly? (Yes)	17	83
11	Have you ever attended any training to improve the knowledge on antibiotic usage? (Yes)	89	11
12	If flock / some birds get infection, do you use antibiotic in all sheds? (No)	49	51
13	Do you follow proper bio-security measures? (Yes)	100	0
14	Do you maintain records of antibiotics given to flocks in each shed? (Yes)	19	81
<b>Overall level of practices</b>		<b>Frequency (%)</b>	
Good		64(64%)	
Bad		36(36%)	

**Table 5: Test of statistical significance of variation in the knowledge, attitudes and practices of the farmers towards antibiotic usage**

Variables		Knowledge			Attitudes			Practices		
		Correct n(%)	Incorrect n(%)	<i>p</i> - value	Positive n(%)	Negative n(%)	<i>p</i> - value	Good n(%)	Bad n(%)	<i>p</i> - value
<b>District</b>	<b>Ambala</b>	6 (30)	14 (70)	0.61	13 (65)	7 (35)	0.42	16 (80)	4 (20)	0.34
	<b>Panchkula</b>	6 (30)	14 (70)		15 (75)	5 (25)		10 (50)	10 (50)	
	<b>Panipat</b>	10 (50)	10 (50)		10 (50)	10 (50)		12 (60)	8 (40)	
	<b>Karnal</b>	9 (45)	11 (55)		15 (75)	5 (25)		14 (70)	6 (30)	
	<b>Jind</b>	8 (40)	12 (60)		14 (70)	6 (30)		12 (60)	8 (40)	
<b>Farm size</b>	<b>Small (<math>\leq 25000</math>)</b>	10 (40)	15 (60)	0.77	11 (44)	14 (56)	<b>0.01</b>	19 (76)	6 (24)	0.22
	<b>Medium (25000-50000)</b>	14 (35)	26 (65)		28 (70)	12 (30)		26 (65)	14 (35)	
	<b>Large (<math>\geq 50000</math>)</b>	15(42.8)	20(57.14)		28 (80)	7 (20)		19(54.28)	16(45.71)	
<b>Type of feed used at farm</b>	<b>Self-made</b>	17 (47.2)	19 (52.7)	0.20	26 (72.2)	10 (27.7)	0.40	24 (66.6)	12 (33.3)	0.67

	<b>Commercial</b>	22 (34.3)	42 (65.6)		41 (64.06)	23 (35.9)		40 (62.5)	24 (37.5)	
<b>Feeding schedule</b>	<b>Twice</b>	33 (38.3)	53 (61.6)	0.75	57 (66.2)	29 (33.7)	0.70	53 (77.9)	33 (38.3)	0.22
	<b>Thrice</b>	6 (42.8)	8 (57.1)		10 (71.4)	4 (28.5)		11 (78.5)	3 (21.4)	
<b>Age of farmer</b>	<b>≤40</b>	13 (41.9)	18 (58.06)	0.88	20 (65.51)	11 (35.48)	0.93	19 (61.29)	12 (38.7)	0.35
	<b>40-50</b>	16 (30.02)	25 (60.98)		28 (68.28)	13 (31.7)		24 (58.53)	17 (41.46)	
	<b>≥50</b>	10 (35.71)	18 (64.29)		19 (67.85)	9 (32.14)		21 (75)	7 (25)	
<b>Training of poultry farming</b>	<b>Ancestral</b>	16 (45.71)	19 (54.29)	0.31	25 (71.43)	10 (28.57)	0.30	24 (68.57)	11 (31.43)	0.77
	<b>Friends</b>	12	29		29	12		25	16	

		(29.27)	(70.73)		(70.13)	(29.27)		(60.98)	(39.02)	
	<b>Professional institution trained and Others</b>	11 (45.83)	13 (54.17)		13 (54.17)	11 (45.83)		15 (2.50)	9 (37.9)	
<b>Experience in poultry farming</b>	<b>≤10 years</b>	7 (28)	18 (72)	0.31	17 (68)	8 (32)	0.93	18(72)	7 (28)	0.17
	<b>10-20 years</b>	18 (39.13)	28 (60.87)		30 (65.22)	16 (34.78)		25 (54.35)	21 (45.65)	
	<b>≥20 years</b>	14 (48.28)	15 (51.72)		20 (68.97)	9 (31.09)		21 (72.41)	8 (27.59)	
<b>Level of Education</b>	<b>12<sup>th</sup> grade</b>	13 (61.9)	8 (38.10)	<b>0.01</b>	14 (66.67)	7 (33.33)	0.97	11 (52.38)	10 (47.62)	0.21
	<b>Graduate</b>	26 (32.91)	53 (67.09)		53 (67.09)	26 (32.91)		53 (67.09)	26 (32.91)	

$p < 0.05$ - The mean difference was significant at 5% level

**Table 6: Logistic regression analysis of the factors associated with farmer's knowledge, attitudes and practices towards antibiotic usage**

Variables		Knowledge	Attitudes	Practices
		OR, 95% CI, <i>p</i> -value	OR, 95% CI, <i>p</i> -value	OR, 95% CI, <i>p</i> -value
<b>District</b>	<b>Ambala</b>	0.64,0.11-3.81,0.62	0.88,0.17-4.74,0.89	2.43,0.45-13.24,0.31
	<b>Panchkula</b>	0.51,0.09-2.84,0.44	0.71,0.12-4.10,0.70	0.66,0.14-3.18,0.61
	<b>Panipat</b>	5.39,0.91-31.86,0.06	0.59,0.11-3.21,0.54	1.27,0.25-6.43,0.77
	<b>Karnal</b>	3.24,0.65-16.11,0.15	1.17,0.22-6.28,0.85	1.39,0.29-6.78,0.68
	<b>Jind</b>	*	*	*
<b>Farm size</b>	<b>Small (<math>\leq 25000</math>)</b>	1.04,0.23-4.70,0.96	0.12,0.03-0.55, <b>0.01</b>	1.81,0.43-7.67,0.42
	<b>Medium (25000-50000)</b>	0.92,0.25-3.39,0.90	0.53,0.13-2.16,0.38	1.36,0.40-4.63,0.63
	<b>Large (<math>\geq 50000</math>)</b>	*	*	*
<b>Type of feed used at farm</b>	<b>Self-made</b>	5.08,1.49-17.25, <b>0.01</b>	1.19,0.39-3.57,0.76	1.49,0.51-4.34,0.47
	<b>Commercial</b>	*	*	*
<b>Feeding schedule</b>	<b>Twice</b>	0.53,0.13-2.25,0.39	0.70,0.16-3.07,0.64	0.42,0.09-2.00,0.28
	<b>Thrice</b>	*	*	*

<b>Age of farmer</b>	<b>≤40</b>	1.32,0.39-4.51,0.65	0.83,0.24-2.90,0.77	0.44,0.13-1.51,0.19
	<b>40-50</b>	1.15,0.35-3.76,0.82	0.98,0.16-3.07,0.64	0.36,0.11-1.19,0.09
	<b>≥50</b>	*	*	*
<b>Training of poultry farming</b>	<b>Ancestrol</b>	0.63,0.14-2.84,0.55	4.44,0.87-22.72,0.07	1.09,0.24-4.95,0.92
	<b>Friends</b>	0.54,0.13-2.25,0.40	1.82,0.44-7.57,0.41	0.93,0.22-3.82,0.91
	<b>Professional institution trained and Others</b>	*	*	*
<b>Experience in poultry farming</b>	<b>≤10 years</b>	0.27,0.05-1.47,0.13	3.27,0.54-19.83,0.20	0.72,0.13-4.08,0.71
	<b>10-20 years</b>	0.50,0.13-1.89,0.31	1.54,0.39-6.06,0.54	0.37,0.09-1.52,0.17
	<b>≥20 years</b>	*	*	*
<b>Level of Education</b>	<b>12<sup>th</sup> grade</b>	5.65,1.52-20.93, <b>0.01</b>	0.60,0.16-2.27,0.46	0.54,0.16-1.79,0.31
	<b>Graduate</b>	*	*	*

\*- Reference value

$p < 0.05$ - The mean difference was significant at 5% level

**Table 7: Correlations between knowledge, attitudes and practices**

		<b>Knowledge</b>	<b>Attitudes</b>	<b>Practices</b>
<b>Knowledge</b>	<b>Correlation Coefficient</b>	1	-0.049	-0.041
	<b>Sig. (2-tailed)</b>	-	0.626	0.685
<b>Attitudes</b>	<b>Correlation Coefficient</b>	-0.049	1	0.05
	<b>Sig. (2-tailed)</b>	0.626	-	0.624
<b>Practices</b>	<b>Correlation Coefficient</b>	-0.041	0.05	1
	<b>Sig. (2-tailed)</b>	0.685	0.624	-