ASSESSMENT OF KNOWLEDGE, ATTITUDE, AND PRACTICES OF DAIRY FARMERS TOWARDS ANTIBIOTIC USE AND ANTIMICROBIAL RESISTANCE IN NORTH GUJARAT

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ABSTRACT
Imprudent use of antimicrobials for the treatment of livestock disease contributes to the development of antimicrobial resistance (AMR), which has a major impact on animals, human, and environmental health. Understanding dairy farmers' knowledge, attitudes, and practices regarding antibiotic use and AMR is crucial for the development of effective AMR surveillance, control, and prevention strategies. A descriptive cross-sectional survey was carried out across the three randomly selected districts (Banaskantha, Mehsana, and Sabarkantha) of North Gujarat. The pre-tested, structured interview schedule was used to get first-hand information from 180 dairy farmers. Extensive field visit and non-probability convenience sampling method was used for the enrollment of participants in this survey. This survey included personal-social, socio-economical and communicational variables as well as knowledge, attitude, and practices (KAP) towards the use of antibiotics and AMR. The association of independent variables with KAP score was checked using the Pearson correlation coefficient. Multiple regression analysis was done to find out the influence of independent variables on KAP. Kruskal-Wallis H test was done to compare the mean rank difference in the KAP score within the independent variables. The median score of knowledge, attitude and practice toward the use of antibiotic and AMR were 68.5 (45-83), 45 (19-61) and 25 (12-40), respectively. There was significantly moderate positive correlation of the knowledge with the herd size (r=0.588), milk production (r=0.596), annual income (r=0.537), land holding (r=0.422) and training (r=0.394). Similarly, practice had a significantly moderate positive correlation with the herd size (r=0.546), milk production (r=0.505), annual income (r=0.508), and land holding (r=0.354). Whereas the farmers' attitude had a weak positive correlation with landholding, herd size, milk production, annual income, and training received. Significant mean rank ($P<0.05$) was observed for occupation, landholding, herd size, annual income, training, and mass media in KAP scores. Further, landholding, herd size, annual income, training, and mass media had higher values indicated the practical impact of these independent variables on KAP scores. Dunn's post hoc analysis revealed that farmers with more landholding (>4 acres), having more herd size (>20 animals), more annual income (>17 lakh), having more total milk production/day (>86 L) and more media exposure (>8) had high KAP scores ($P<0.001$). Multiple linear regression analysis revealed that independent variables jointly exerted an influence on the KAP ($P<0.001$; $R^2 = 0.638$). Further, among all the predictors, milk production emerged as the only statistically significant independent positive predictor of KAP (B = 0.168; p = 0.003), signifying prudent antibiotic use and antimicrobial resistance. In conclusion, lower herd size, milk production, annual income, training, and mass media exposure had a negative impact on KAP, indicating a greater need of targeted awareness-building interventions to reduce AMR. These findings will be helpful for policymakers enforcing antimicrobial stewardship.

KEYWORDS: Antimicrobial resistant (AMR), Dairy farmers, Knowledge-attitude-practice (KAP)

INTRODUCTION
The discovery of antibiotics revolutionized health, but antimicrobial resistance (AMR) rapidly emerged as a global threat. AMR could cause up to 10 million deaths and $100 trillion in economic loss by 2050 (O'Neill, J. 2016). Animal products such as milk, meat, eggs, fish, and honey often contain antibiotic residues, which may harm consumers through hypersensitivity, gastrointestinal issues, and the spread of resistant bacteria (Sharma et al., 2022). International bodies like WHO, FAO, and OIE have prioritized AMR mitigation under the One Health framework and adopted the Global Action Plan (WHO, 2023). The National Action Plan on AMR was introduced by the Ministry of Health and Family Welfare in India in 2017, and the country's commitment to addressing AMR was reaffirmed in the updated 2023 plan (MHFW, 2023).

Bacteria adapt quickly, making AMR challenging to control; factors include overuse, misuse, over the counter sales, and use of antimicrobials as growth promoters (Martin et al., 2015). India, producing over 230 million tons of bovine milk in 2023-24 (Anonymous, 2024), faces a severe AMR burden, with high rates of antibiotic use in livestock, especially for treating infections in dairy farms (Moudgil et. al. 2018). In dairy farming, antibiotics are commonly used to treat mastitis, contributing to AMR in bacteria that can persist in milk. Every year, 63,151 ± 1,560 tons of antibiotics are given to livestock worldwide (Grout et al., 2020). India is recognized as a hotspot for antimicrobial use (Vishnuraj et al., 2016; Singh B., 2018).

Data on usage patterns and farmer knowledge about AMR in Indian dairy farms remain limited, and common risky practices include self-medication, delayed veterinary consultation, and improper disposal of contaminated milk. The risk of antibiotic resistance from animal-derived foods has been highlighted in several recent studies, emphasizing the need for prudent antibiotic use in animal health (Moudgil et al., 2018). Although a National Action Plan on AMR has been introduced to optimize antibiotic use, its enforcement at the ground level remains insufficient (Mutua et al., 2020). Furthermore, reliable data on antibiotic use in animal husbandry are generally lacking, particularly in developing countries such as India (Boeckel et al., 2015). Responsible antibiotic use is essential to curb resistance, yet data is lacking. In the face of limited treatment options, mitigation strategies must focus on awareness and proper stewardship among key stakeholders.

Gaining insight into stakeholder knowledge, awareness, attitudes, decision-making, and the translation of intentions into sustained behavior change is increasingly important for policy development (Jones et al., 2015). Studies that investigate the reasons behind current antimicrobial use in the livestock and dairy sectors are essential for designing effective interventions to promote prudent use (Fischer et al., 2019). Monitoring antimicrobial use in livestock alone does not reveal the underlying motivations; therefore, it is crucial to assess the knowledge, attitudes, and practices of key stakeholders regarding antimicrobial use.

MATERIAL AND METHODS

Study Design

A descriptive cross-sectional survey was carried out from Jun-2025 to May-2026 to assess the farmers' knowledge, attitude and practices towards the use of antibiotic and AMR in dairy animal in North Gujarat. Out of seven Districts, three districts were randomly selected; from each selected District, two talukas were randomly selected, and three villages were randomly selected from each taluka. So total 18 villages were selected and from each village 10 dairy farmers (N=180) were enrolled to conduct this study.

A structured questionnaire was prepared with input from veterinary experts of various veterinary colleges of Kamdhenu University, Gandhinagar and from available literatures. Further, it was reviewed and validated by the subject expert. Before finalizing questionnaire, it was pre-tested to detect the ambiguity and short falls and to achieve clarity, relevance, comprehensiveness and practicability by selection of twenty non-sample dairy farmers. Based on pilot tested, necessary modifications were made and the refined questionnaire was used for final data collection (Supplementary Information SI). Dairy farmers were interviewed personally face to face by extensive field visit in regional language (Gujarati) and non-probability convenience sampling method was used. As far as possible, the respondents were contacted during their leisure time.

Selection of the variables

Certain independent variables were selected based on past literature review and to assess the KAP towards the use of antibiotics and AMR in dairy animals. The age, education, occupation and experience in dairy farmers were evaluated as socio-personal variables. Land holding, herd size, milk total production per day and annual incomes were taken as socio-economic variables. The extension participation, mass media exposure and training received were taken as communicational variables (Table 1). All participants were enrolled voluntarily and informed consent was taken. Prior to data collection, respondents were clearly briefed on the study's objectives, and the confidentiality of their personal information was strictly maintained throughout the study.

Table 1: The information of independent variables were classified into different groups

Independent variables		**Criteria/score**
Age (years)	Young age group	< Mean – SD
	Middle age group	Mean ± SD
	Old age group	> Mean + SD
Education		
	Illiterate	Can't read and write - 0
	Literate	can read and write, 1-4 standard - 1
	Primary to middle school	5-8 standard - 2
	High school	9-10 standard - 3
	Higher secondary school	11-12 standard - 4
	Graduation	Graduation - 5
	Above Graduation	Above Graduation- 6
Occupation		

	dairy farming	1
	dairy farming + Agriculture Farming	2
	dairy farming + Agriculture Farming + Any other	3
Experience in dairy farming		
	Low experience	< Mean – SD
	Medium experience	Mean ± SD
	High experience	> Mean + SD
Land Holding		
	Landless labourer	0 hectre- 0
	Marginal farmer	Up to 1 hectare land- 1
	Small farmer	1.01 to 2 hectare land- 1
	Medium farmer	2.01 to 4 hectare land - 3
	Large farmer	Above 4 hectare land - 4
Herd size		
	Small size herd	< Mean – SD
	Medium size herd	Mean ± SD
	Large size herd	> Mean + SD
Milk production		
	Low production	< Mean – SD
	Medium production	Mean ± SD
	High production	> Mean + SD
Annual Income		
	Low income	< Mean – SD
	Medium income	Mean ± SD
	High income	> Mean + SD
Extension participation		
	Up to 4	Regularly- 2
	5 to 17	Occasionally -1
	More than 17	Never- 0
Training received		
	No training received	No training received- 0
	One training received	One training received- 1
	More than one training received	More than one training received- 2

Assessment of knowledge, attitude and practice of dairy farmers

The knowledge, attitude, and practice of dairy farmers towards antibiotic use and AMR were quantified by assigning the scores (Supplementary file 1). Knowledge and practice scores were grouped into low (<Mean - S.D), medium (Mean ± S.D) and high (> Mean + S.D). Attitude score was categorized into less (<Mean - S.D), moderate (Mean ± S.D) and high (> Mean + S.D) favourable. KAP index was calculated using the below formula

$$\text{KAP index} = \frac{(\text{Knowledge score obtained} + \text{attitude score obtained} + \text{practice score obtained})}{(\text{Possible knowledge score} + \text{Possible attitude score} + \text{possible practice score})} \times 100$$

Statistical analysis

The data were tabulated; frequency and percentage was calculated. Descriptive statistics was done for independent and dependent variables. The association of independent variables with KAP score was checked using the Pearson correlation coefficient. Kruskal-Wallis H test was done to compare the mean rank difference in the KAP score within the independent variables as the data were not normally distributed evidence by the by the Shapiro–Wilk test ($p < 0.001$). Post hoc pairwise comparisons were performed using Dunn's post hoc test with Bonferroni adjustment. Effect sizes were calculated to assess the magnitude of differences, and were interpreted using Tomczak and Tomczak's (2014) recommendations for epsilon-squared. Multiple regression analysis was done to find out the influence of independent variables on KAP. Statistical analysis was done using R version 4.6.0. p-values ≤ 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

Characteristics of dairy farmers is given in table 2. The majority of the respondents were from the middle age group as this age group assumed the family responsibilities very competently, hence ,commonly engaged in dairy farming activities. Similar observation were also recorded by several previous studies (Oztruk et al., 2019, Gemeda et al., 2020; Gebeyehu et al., 2021; Dhangar et al., 2023). The educational status revealed that most of the dairy farmers gained higher secondary education, followed by graduation, high school level and primary to middle school. The findings showed that respondents had educational access and understood its importance, likely due to a supportive environment and their own awareness. These observations agreed with the findings of Rehman et al. (2021) and Dhangar et al. (2023). Dairy farming is a traditional livelihood activity in the study area and is commonly practiced alongside agriculture, serving as an important supplementary source of income. Hence, majority (90 per cent) of the dairy farmer were engaged in dairy farming along with agriculture farming in the present study. Most of the respondents were in the middle age group; hence their experience was directly proportional to the age group. Majority of the farmers had 2.01 to 4 hectares. 70.56 % farmers have medium herd size (7-20 animals) because majority of the farmers in this area undertaking the dairy husbandry along with agriculture as source of income. Similar findings were also reported by Dhangar et al. (2023). In contrary to the present finding, Wavhal et al. (2026) noticed that 85.1% farmers had <9 animals. The farmers having the medium herd size had medium milk production and income.

Table 2: Frequency distribution of different Characteristics of dairy farmers.

Independent variables		Frequency	Percentage
Age (years)	Young age group (Up to 32)	34	18.89
	Middle age group (33 to 50)	127	70.56
	Old age group (>50)	19	10.56
Education	Illiterate	22	12.22
	Literate (can read and write, 1-4 standard)	8	4.44
	Primary school to middle school(5-8 standard)	28	15.56
	High school (9-10 standard)	31	17.22
	Higher secondary school(11-12 standard)	51	28.33
	Graduation	38	21.11
	Above Graduation	2	1.11
Occupation	dairy farming	13	7.22
	dairy farming + Agriculture Farming	162	90.00
	dairy farming + Agriculture Farming + Any other	5	2.78
Experience in dairy farming	Low experience	Up to 10	32
	Medium experience	11 to 22	128
	High experience	More than 22	20
Land Holding (hectare)	Landless labourer (No land)	0	0.00
	Marginal farmer (Up to 1)	7	3.89
	Small farmer (1.01 to 2)	50	27.78
	Medium farmer (2.01 to 4)	108	60.00
	Large farmer (>4)	15	8.33
Herd size (number of animal)	Small size herd (up to 7)	28	15.56
	Medium size herd (7-20)	127	70.56
	Large size herd (>20)	25	13.89
Milk production (L/day/total animal)	Low production (up to 28)	20	11.11
	Medium production (29-86)	131	72.78
	High production (>86)	29	16.11
Annual Income (Rs.)	Low income (Up to 5,26,060)	20	11.11
	Medium income (5,26,061 to 17,94,939)	134	74.44
	High income (>17,94,939)	26	14.44
Extension participation	Up to 4	41	22.78
	5 to 17	105	58.33
	More than 17	34	18.89
Mass media exposure	Up to 3	26	14.44
	4 to 8	122	67.78

	More than 8	32	17.78
Training received	No training received	88	48.89
	One training received	70	38.89
	More than one training received	18	10.00

Association of knowledge, attitude and practice (KAP) with Independent variables

There was positive and highly significant ($P < 0.01$) correlations of knowledge level, attitude and practices of the dairy farmers with land size, herd size, milk production, annual income and training received (Table 3). Participation in training programs was strongly linked to higher farmers' knowledge of antibiotic use, veterinary prescriptions, antimicrobial resistance, and animal healthcare. Trained farmers showed more accurate scientific understanding than those without training, highlighting the value of formal education in livestock. Farmers with more experience, higher income, larger enterprises, and training had a better attitude toward responsible antibiotic use and preventing antimicrobial resistance. Annual income was most positively associated with attitude, followed by land holding and milk production, indicating well-resourced farmers are more likely to adopt best practices. Additionally, economic resources and larger operations correlated with greater recognition of veterinary advice and proper antibiotic dosages. Training participation promoted positive attitudes toward scientific animal health, while experienced farmers gained favourable perspectives through practical management exposure.

Table 3: Association of independent variables with knowledge, attitude and practice level of dairy farmers (N=180) towards antibiotics use and antimicrobial resistance

Sr. No.	Independent Variable	Knowledge		Attitude		Practice	
		Pearson's correlation coefficient (r)	P value	Pearson's correlation coefficient (r)	P value	Pearson's correlation coefficient (r)	P value
1	Age (years)	-0.153	0.070	0.135	0.070	-0.153*	0.040
2	Education	0.016	0.829	-0.036	0.631	0.120	0.109
3	Occupation	-0.078	0.299	-0.074	0.323	-0.103	0.168
4	Experience (years)	-0.097	0.196	0.150*	0.044	-0.050	0.503
5	Land Holding (hectare)	0.422**	0.001**	0.223**	0.003	0.354**	0.003
6	Herd size (no. of animals)	0.588**	0.001**	0.190*	0.011	0.546**	0.011
7	Milk production (L/day/total animals(	0.596**	0.001**	0.214**	0.004	0.565**	0.004
8	Annual Income (Rs.)	0.537**	0.001**	0.260**	0.001**	0.508**	0.001**
9	Extension Participation	-0.090	0.232	0.103	0.169	0.059	0.431
10	Mass media exposure	0.027	0.716	0.004	0.958	0.040	0.594
11	Training received	0.394**	0.000**	0.186*	0.012	0.272**	0.012

(Significant at p<0.05, ** significant at p<0.01)*

KAP index of dairy farmers regarding antibiotic use and antimicrobial resistance

The mean (±SD) KAP index of dairy farmers regarding antibiotic use and antimicrobial resistance was 66.56±6.02. Most of the dairy farmers had a medium KAP level (68.33 per cent), followed by high KAP level (16.67 per cent) and low KAP level (15.00 per cent) regarding antibiotics, their use and antimicrobial resistance.

There was positive and highly significant ($P < 0.01$) correlations of KAP index of the dairy farmers with land holding, herd size milk production, annual income and training received (Table 4). Larger land resources, better economic status generally support better fodder production, and improved livestock management practices

(Kumar and Tripathi, 2011; Winsten et al., 2012; Dhangar et al., 2023). Higher milk production is also associated with improved farm management, frequent veterinary consultation and greater awareness of scientific livestock practices (Kumar and Tripathi, 2011; Masuku, 2014; Dhangar et al., 2023). Trained farmers possessed significantly better knowledge, more positive attitudes and more appropriate practices regarding antibiotic use and antimicrobial resistance (Sharma et al., 2014).

Table 4: Association of independent variables with KAP (knowledge, attitude and practice) of dairy farmers towards antibiotics use and antimicrobial resistance

N=180

Sr. No.	Independent Variable	Pearson's correlation coefficient (r)	P value
1	Age (years)	-0.089	0.236
2	Education	0.051	0.495
3	Occupation	-0.136	0.068
4	Experience (years)	0.012	0.876
5	Land Holding (hectare)	0.557**	0.000**
6	Herd size (no. of animals)	0.758**	0.000**
7	Milk production (L/day/total animals(	0.783**	0.000**
8	Annual Income (Rs.)	0.742**	0.000**
9	Extension Participation	0.049	0.518
10	Mass media exposure	0.092	0.220
11	Training received	0.460**	0.000**

(Significant at p<0.05, ** significant at p<0.01)*

Significant mean rank (P<0.05) was observed for occupation, landholding, herd size, annual income, training, and mass media in KAP index (Table 5). Further, landholding, herd size, annual income, training, and mass media had higher values indicated the practical impact of these independent variables on KAP index. Dunn's post hoc analysis revealed that farmers with more landholding (>2.01-4 hectare), having more herd size (>20 animals), more annual income (>17 lakh), having more total milk production/day (>86 L) and more media exposure(>8) had high KAP index (P<0.001).

Table 5: The mean rank KAP index of subcategories of independent variable of dairy farmers towards antibiotic use and antimicrobial resistant.

Independent variables	Subcategories	N	Mean Rank	H or Z	df	p-value	Effect size (ε²)
Age (Years)	Up to 32	34	85.94	5.26	2	0.071	0.018
	33 to 50	127	95.26				
	More than 50	19	66.78				
Education	Illiterate	22	85.65	10.27	6	0.113	0.024
	Literate (can read and write, 1-4 standard)	8	108.00				
	Primary school to middle school (5-8 standard)	28	89.58				
	High school (9-10 standard)	31	68.74				
	Higher secondary school (11-12 standard)	51	102.40				
	Graduation	38	90.03				
	Above Graduation	2	129.00				
Occupation	dairy farming	13	99.57a	6.29	2	0.042	0.024

	dairy farming + Agriculture Farming	162	91.50a				
	dairy farming + Agriculture Farming + Any other	5	34.20b				
Land holding (Hectare)	Marginal farmer (Up to 1.00)	7	4.00b	52.23	3	<0.001	0.279
	Small farmer (1.01–2.00)	50	25.5a				
	Medium farmer (2.01–4.00)	108	54.5a				
	Big farmer (4.00 above)	15	8.00c				
Herd size (No. of animals)	Up to 7	28	35.51c	79.70	2	<0.001	0.439
	8to 20	127	88.37b				
	More than 20	25	162.88a				
Annual income (Rs.)	Up to 5,26060	20	30.42c	71.79	2	<0.001	0.394
	5,26,061 to 17,94,939	134	86.27b				
	More than 17,94,939	26	158.48a				
Milk production (L/day/total animals)	Up to 28	20	22.97c	86.982	2	<0.001	0.480
	29 to 86	131	85.35b				
	More than 86	29	160.29a				
Training	No training received	92	67.02c	48.93	2	<0.001	0.265
	One training received	78	108.54b				
	More than one training received	18	165.75a				
Extension Participation	Up to 4	41	95.96	5.57	2	0.06	0.020
	5 to 17	105	83.27				
	More than 17	34	106.23				
Mass Media	UP TO 3	26	70.11b	33.52	2	<0.001	0.178
	4 to 8	122	82.39b				
	More than 8	32	137.96a				
Experience (Years)	Up to 10	32	77.60	3.80	2	0.149	0.010
	11 to 22	128	95.30				
	More than 22	20	80.37				

Dairy farming requires regular interaction with veterinarians, dairy cooperatives, and extension personnel, thereby increasing farmers' exposure to information on disease prevention, antimicrobial therapy, and withdrawal periods. Farmers engaged in several occupations may devote less time to livestock management, resulting in lower awareness and adoption of recommended antibiotic practices (Caudell et al., 2020). Farmers with larger landholdings and bigger herds generally maintain commercial dairy enterprises, possess greater financial resources, and have better access to veterinary services, diagnostic facilities, and quality inputs (Wavhal et al., 2026). Consequently, they are more likely to receive professional advice regarding appropriate antibiotic use and AMR. Prabhu et al. (2025) reported that herd size and farm income were positively associated with farmers' adoption of responsible antimicrobial use practices. Higher milk production farms generally adopt improved feeding, breeding, and health management practices and maintain regular veterinary supervision, which enhances awareness regarding prudent antimicrobial use. These farms are also more likely to participate in milk quality assurance programmes that emphasize withdrawal periods, residue avoidance, and disease prevention (Winsten et al., 2012; Masuku, 2014).

Training improves farmers' understanding of disease diagnosis, appropriate antibiotic selection, dosage, treatment duration, withdrawal periods, and the public health implications of AMR. Repeated training also reinforces behavioural change and promotes adherence to veterinary recommendations (Redding et al., 2014; Caudell et al., 2020). Mass media serves as an important channel for disseminating information on disease prevention, vaccination, responsible antibiotic use, and AMR awareness. Increased exposure enables farmers to access updated information from government agencies, veterinary universities, dairy cooperatives, and scientific organizations (Priya et al., 2019). Further, public awareness campaigns through mass media is a critical component of global AMR containment strategies (WHO, 2023). The inconsistent relationships between farmers' age or experience and antimicrobial stewardship behaviour was reported by Masuku (2014). Farmers often continue traditional treatment practices unless exposed to updated scientific information through veterinarians, extension programmes, or formal training. The extension participation did not significantly influence the KAP index. This may indicate that the existing extension activities attended by farmers were either limited in frequency or did not specifically emphasize antibiotic stewardship and AMR. General livestock extension programmes often focus primarily on feeding, breeding, and disease management, with comparatively less attention given to prudent antimicrobial use. Therefore, strengthening extension curricula by incorporating comprehensive AMR awareness and responsible antibiotic use could substantially improve farmers' knowledge and practices.

The multiple linear regression model showed a strong relationship between the independent variables and farmers' KAP regarding antibiotics ($F = 26.872$; $p < 0.001$, $R^2 = 0.638$; Table 6). Milk production, annual income, herd size, and land holding also had positive effects in simple linear regression (Table 6). However, milk production was only significant independent variable in the multiple regression model.

Training improved KAP in simple linear regression, but its effect was unclear in the multiple model because training exposure was measured broadly without detail. Mass media exposure contributed positively to KAP, particularly when combined with training and veterinary guidance, although its effect was weak overall. Occupation, age, education, farming experience, and extension participation showed little or no impact on KAP. Overall, milk production emerged as the strongest determinant of KAP, supporting the importance of improving dairy productivity, targeted training, and effective information dissemination to promote responsible antibiotic use and address antimicrobial resistance. Regression analysis identified age, education, and herd size as key determinants, explaining 56.9% of the variance in KAP outcomes (Wavhal et al., 2026). Wavhal et al. (2026) also showed higher education and herd sizes were associated with improved, whereas, age was negatively associated with KAP. Adebowale et al. (2020) highlighted the socio-economic constraints and veterinary access in shaping antimicrobial practices.

Table 6: Regression analysis of individual factors affecting KAP

Sr. No.	Independent variable	Simple Linear Regression				Multiple regression analysis#		
		Regression Equation	R²	F-value	p-value	Regression Coefficient (b)	t-value	p-value
1	Age	KAP = 69.02 − 0.060 (Age)	0.008	1.413	0.236	-0.016	-0.242	0.809
2	Education	KAP = 65.97 + 0.189 (Education)	0.003	0.469	0.495	0.016	0.070	0.945
3	Occupation	KAP = 71.66 − 2.609 (Occupation)	0.019	3.360	0.068	-1.597	-1.691	0.093
4	Experience	KAP = 66.37 + 0.012(Experience)	0.000	0.024	0.876	-0.011	-0.107	0.915
5	Land Holding	KAP = 56.27 + 3.921 (Land Holding)	0.415	126.214	<0.001	0.129	0.140	0.889
6	Herd Size	KAP = 56.85 + 0.701 (Herd Size)	0.575	240.538	<0.001	-0.166	-0.792	0.429
7	Milk Production	KAP = 57.26 + 0.162 (Milk Production)	0.613	281.972	<0.001	0.000001	0.448	0.655
8	Annual Income	KAP = 58.39 + 0.000007 (Income)	0.551	218.279	<0.001	0.168	3.051	0.003
9	Extension Participation	KAP = 65.96 + 0.056 (Extension)	0.004	0.642	0.424	0.024	0.414	0.680
10	Mass Media Exposure	KAP = 61.09 + 0.887 (Media)	0.152	31.996	<0.001	0.248	1.932	0.055
11	Training Received	KAP = 63.87 + 5.519 (Training)	0.211	47.716	<0.001	-0.403	-0.549	0.584

 # constant= 59.969

CONCLUSION:

The improvements in dairy productivity, together with scientifically designed training programmes and effective information dissemination through mass media and veterinary extension services, are likely to enhance farmers' awareness and promote the judicious use of antibiotics for mitigating antimicrobial resistance. Further, policy frameworks should address economic obstacles to safe practices, especially non-compliance with milk withdrawal periods, by offering pilot compensation programs, cooperative incentives, and support for safe milk disposal.

REFERENCES

1. Adebowale, O. O., Adeyemo, F. A., Bankole, N., Olasoju, M., Adesokan, H. K., Fasanmi, O., Adeyemo, O., Awoyomi, O., Kehinde, O., & Fasina, F. O. (2020). Farmers' perceptions and drivers of antimicrobial use and abuse in commercial pig production, Ogun State, Nigeria. International Journal of Environmental Research and Public Health, 17(10), Article 3579. https://doi.org/10.3390/ijerph17103579
2. Anonymous, (2024). Ministry of Fisheries, Animal Husbandry & Dairying. Year and review 2024. Department of Animal Husbandry and Dairying. Posted on: 19 Dec. 2024 4:31 PM by PIB Delhi. Release ID: 2086052.
3. Boeckel, T. P., Brower, C., Gilbert, M., Grenfell, B. T., Levin, S. A., Robinson, T. P., & Laxminarayan, R. (2015). Global trends in antimicrobial use in food animals. Proceedings of the National Academy of Sciences, 112(18), 5649–5654. https://doi.org/10.1073/pnas.1503141112
4. Caudell MA, Dorado-Garcia A, Eckford S, Creese C, Byarugaba DK, Afakye K, et al. (2020) Towards a bottom-up understanding of antimicrobial use and resistance on the farm: A knowledge, attitudes, and practices survey across livestock systems in five African countries. PLoS ONE 15(1): e0220274. https://doi.org/10.1371/journal.pone.0220274
5. Dhangar, M., Kolhe, S., Waskar, V., Khanvilkar, A., Sonawane, G. and Kolhe, R. (2023). Assessment of dairy farmer's knowledge, attitude and practices on antibiotics and antimicrobial resistance. The Haryana Veterinarian 62(SI-2): 6-11.
6. Fischer, K., Sjöström, K., Stiernström, A., & Emanuelson, U. (2019). Dairy farmers' perspectives on antibiotic use: A qualitative study. Journal of Dairy Science, 102(3), 2724–2737. https://doi.org/10.3168/jds.2018-15015
7. Gebeyehu, D. T., Bekele, T., Mulate, B., Gugsa, G., & Tintagu, T. (2021). Knowledge, attitude and practice of animal producers towards antimicrobial use and antimicrobial resistance in Oromia Zone, northeastern Ethiopia. PLoS ONE, 16(5). https://doi.org/10.1371/journal.pone.0251596
8. Gemeda, B. A., Amenu, K., Magnusson, U., Dohoo, L., Hallenberg, G. S., Alemayehu, G., & Wieland, B. (2020). Antimicrobial use in extensive smallholder livestock farming systems in Ethiopia: Knowledge, attitudes, and practices of livestock keepers. Frontiers in Veterinary Science, 7, Article 55. https://doi.org/10.3389/fvets.2020.00055
9. Grout, L., Baker, M. G., French, N., & Hales, S. (2020). A review of potential public health impacts associated with the global dairy sector. GeoHealth, 4(2). https://doi.org/10.1029/2019GH000213
10. Jones, P. J., Marier, E. A., Tranter, R. B., Wu, G., Watson, E., & Teale, C. J. (2015). Factors affecting dairy farmers' attitudes towards antimicrobial medicine usage in cattle in England and Wales. Preventive Veterinary Medicine, 121(1–2), 30–40. https://doi.org/10.1016/j.prevetmed.2015.05.010
11. Kumar, R., & Tripathi, H. (2011). Profitability of cross breeding among the dairy farmers. Indian Research Journal of Extension Education, 11(1), 32–38.
12. Martin, M. J., Thottathil, S. E., & Newman, T. B. (2015). Antibiotics overuse in animal agriculture: A call to action for health care providers. American Journal of Public Health, 105(12), 2409–2410. https://doi.org/10.2105/AJPH.2015.302870
13. Masuku, B. B., & Belete, A. (2014). Economic efficiency of smallholder dairy farmers in Swaziland: An application of the profit function. Journal of Agricultural Studies, 2(2), 132–146.
14. Ministry of Health and Family Welfare. (2023, February 3). National Action Plan on containment of antimicrobial resistance (Press Release ID: 1896028). Press Information Bureau, Government of India.
15. Moudgil, P., Bedi, J. S., Moudgil, A. D., Gill, J. P. S., & Aulakh, R. S. (2018). Emerging issue of antibiotic resistance from food producing animals in India: Perspective and legal framework. Food Reviews International, 34(5), 447–462. https://doi.org/10.1080/87559129.2017.1326934
16. Mutua, F., Sharma, G., Grace, D., Bandyopadhyay, S., Shome, B., & Lindahl, J. (2020). A review of animal health and drug use practices in India, and their possible link to antimicrobial resistance. Antimicrobial Resistance & Infection Control, 9, Article 103. https://doi.org/10.1186/s13756-020-00760-3
17. O'Neill, J. (2016). Tackling drug-resistant infections globally: Final report and recommendations. Review on Antimicrobial Resistance. Wellcome Collection
18. Ozturk, Y., Celik, S., Sahin, E., Acik, M. N., & Cetinkaya, B. (2019). Assessment of farmers' knowledge, attitudes and practices on antibiotics and antimicrobial resistance. Animals, 9(9), Article 653. https://doi.org/10.3390/ani9090653
19. Prabhu, S., Das, R., Kharate, A., Nayak, A. M., & Vyas, N. (2025). Antimicrobial usage assessment and the factors associated among small-scale household dairy farms in a district of southern India. Journal of Advanced Veterinary and Animal Research, 12(2), 445–453. https://doi.org/10.5455/javar.2025.l911
20. Priya, M. K., Thilakar, P., Kumar, G. S., & Kumar, K. S. (2019). Comparative demographic profile of dairy farmers using social media and not using social media in Coimbatore district of Tamil Nadu. Indian Journal of Social Research, 60(5), 627–633.

21. Rahman, M. S., Ape, T., Islam, M., & Chowdhury, S. (2021). Perception of dairy farmers regarding antibiotic use and antimicrobial resistance in Bangladesh. Sarhad Journal of Agriculture, 37(4), 1238–1243.
22. Redding, L. E., Cubas-Delgado, F., Sammel, M. D., Smith, G., Galligan, D. T., Levy, M. Z., et al. (2014). The use of antibiotics on small dairy farms in rural Peru. Preventive Veterinary Medicine, 113(1), 88–95. https://doi.org/10.1016/j.prevetmed.2013.10.012
23. Sharma, A., Kumar, A., & Sharma, N. (2022). Occurrence of antibiotic residues in milk: Detection and public health concerns. Journal of Animal Feed Science and Technology, 10(1), 23–29.
24. Sharma, M., Singh, G., & Keshava, J. (2014). Impact evaluation of training programmes on dairy farming in Punjab state. Indian Research Journal of Extension Education, 14(1), 105–108.
25. Singh, B. R. (2018). Who is responsible for emergence and spread of AMR? How to handle it? In Proceedings of the 17th Convocation of the National Academy of Veterinary Sciences (India) and Scientific Seminar on Livestock Sector Towards One Health, Food Security and Safety, during 19-20 december 2018 organised by Odisha University of Agriculture and Technology, Bhubaneswar, India. Pp 34-47
26. Tomczak, M., & Tomczak, E. (2014). The need to report effect size estimates revisited: An overview of some recommended measures of effect size. Trends in Sport Sciences, 21(1), 19–25.
27. Vishnuraj, M. R., Kandeepan, G., Rao, K. H., Chand, S., & Kumbhar, V. (2016). Occurrence, public health hazards and detection methods of antibiotic residues in foods of animal origin: A comprehensive review. Cogent Food & Agriculture, 2(1). https://doi.org/10.1080/23311932.2016.1235458
28. Wavhal, N., Kaur, S., Dhaka, P., & Bedi, J. S. (2026). Knowledge, attitudes, and practices of dairy farmers toward antibiotic use and antimicrobial resistance in Punjab, India. Discover Animals, 3, Article 53. https://doi.org/10.1007/s44338-026-00208-9
29. Winsten, J. R., Parsons, R. L. and Hanson, G. D. (2012). A profitability analysis of dairy feeding systems in the Northeast. Agricultural and Resource Economics Review. 29(2): 220-228.
30. World Health Organization. (2023). Antimicrobial resistance. https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance