



Antibiotic usage practice and knowledge on antimicrobial resistance among livestock and poultry farmers of Telangana state, India

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Received: 9 October 2021; Accepted: 29 November 2021

ABSTRACT

Antimicrobial resistance (AMR) is a silent pandemic faced parallel to COVID-19 pandemic, owing to indiscriminate usage of antimicrobial agents by large mass of people as part of self-medication and unsupervised therapy protocols. This similar kind of situation does exist in livestock and poultry farming sector, which has led to AMR issues like Methicillin-resistant *Staphylococcus aureus* (MRSA) mastitis. AMR is really an alarming issue which needs to be addressed or else in near future it would be difficult to treat or control infections in both humans and animals. Reduction in indiscriminate antimicrobial usage and AMR issues in animal husbandry sector requires intervention in animal husbandry practices. In order to devise such intervention practices, first we need to document the field level antibiotic usage and knowledge level on AMR. But unfortunately, data on AMR issues at field level were deficit and poorly documented in India. Hence this cross-sectional study was carried out to explore the knowledge and usage pattern of antibiotics among livestock and poultry farmers of Telangana state of India through direct interview method. Cent per cent of the farmers responded that antibiotics were used mainly for therapeutic purpose followed by prophylactic (32%), metaphylactic purpose (44.5%) and as growth promoters (8.33%). Farmers (78%) responded that they purchase the antimicrobial agents over-the-counter. Oxytetracyclines and Enrofloxacin were the two major antibiotics used abundantly by the livestock farmers. Large proportions of famers (80%) were neither following full dosage regime of antimicrobial used nor the withdrawal period, while antimicrobial usage on their animals owing to lack of awareness and knowledge regarding the AMR. Significant differences were found amongst the livestock and poultry farmers with respect to their knowledge level on antimicrobial usage and AMR in animals.

Keywords: Antibiotic usage knowledge, Antibiotic usage practices, Antibiotic resistance, Livestock and poultry farmers

Antibiotic resistance has become a global problem, making it difficult to treat and control infections in both human and animals. World Health Organization (WHO) has also pointed out in recent reports that humanity is at risk of returning to the pre-antibiotic era, thus there is an urgent need to use all available financial and scientific resources to prevent this risk (WHO 2014, 2015). Excessive and inappropriate use of antibiotics in food animal production is believed to be one of the major contributing factors to the current antimicrobial resistance crisis. Failure to diagnose the disease correctly, livestock owners high demand to get the produce quickly, socio-cultural differences, their knowledge, belief, expectations and attitudes toward antibiotics are some of the responsible factors for facilitating the emergence and spread of

antibiotic-resistant microorganisms (Davey *et al.* 2002, Hulscher *et al.* 2010). Not only this, failure to complete treatment, skipping doses, re-use of residual drugs, misuse of antibiotics in the treatment of viral infections and use of non-rational antibiotics, such as self-treatment are the other reported contributing factors (Nepal and Bhatta 2018). In spite of the increasing burden of AMR in livestock and food animals, it is poorly documented in India. Aside from sporadic, small, localized studies, evidence that can be extrapolated to the national level is lacking. A study to understand the AMR situation and research landscape in India has been carried out in 2017 (Sumanth *et al.* 2017) through research mapping exercise and examined 2,152 papers published by researchers in Indian institutions on AMR between 2012–2017. Surprisingly all were confined to examining resistance profiles of bacteria isolated from food animals and did not cover antibiotic usage pattern and reasons for use in animals by the owners.

Needless to mention that the rational use of antibiotics is always associated with level of education and implementing laws and by-laws concerned with dealing and

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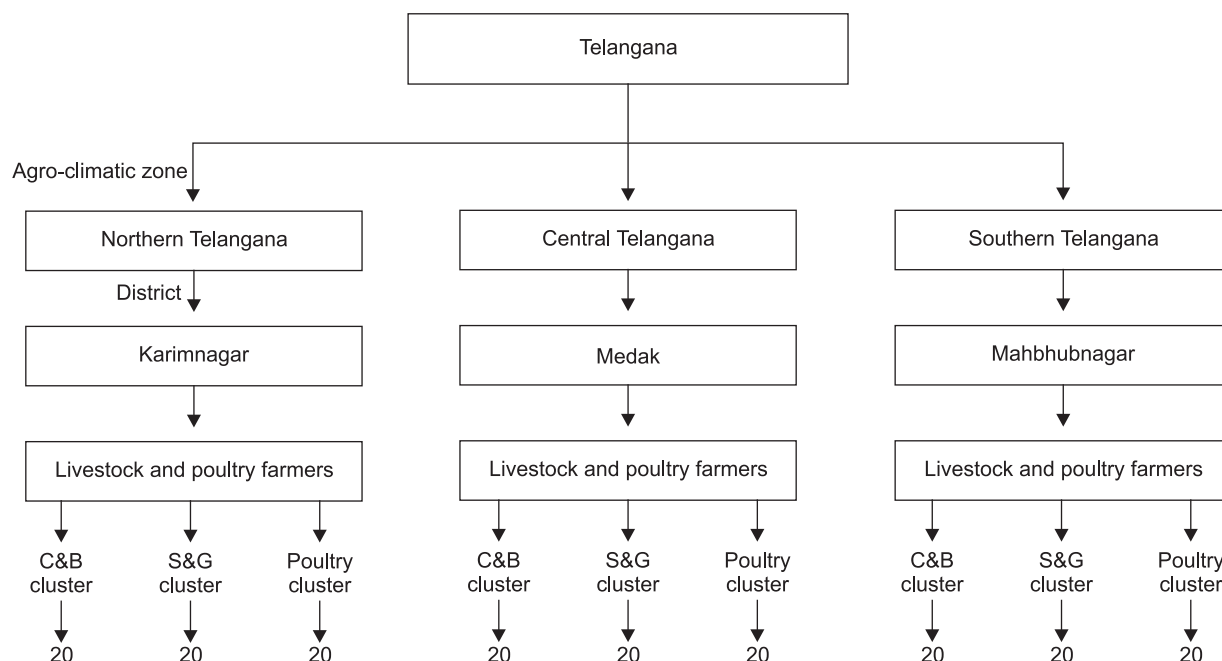


Fig. 1. Sampling procedure.

dispensing of antibiotics. Thus a basic awareness, knowledge and usage pattern of antibiotics used at field level can provide some measures of drug misuse, the magnitude of the risk of disease to introduce other disease control methods.

This knowledge is also necessary for designing, implementing and evaluating regional and local interventions directed at optimizing the use of veterinary drugs and improving farming practices. The current study was therefore carried out to explore usage pattern and knowledge of antibiotics of farmers from Telangana state. Results of the present study may help to promote judicious use of antibiotics and developing different educational models for the livestock and poultry farmers focussing on judicious and safe use of these medications in their animals and also to lessen the risk of developing antimicrobial

resistance in animals.

MATERIALS AND METHODS

This study has been carried out in northern, central, and southern agro-climatic zones of Telangana state in India. Total three districts, one each of the three zones were selected randomly. From each of the selected district, three clusters, one cluster (comprising of 5–6 villages) with dominance of cattle and buffalo, second cluster with dominance of sheep and goat and third with dominance of poultry were selected. Thus, total 9 clusters from the three districts (3 for cattle and buffaloes, another 3 for sheep and goat and rest 3 for poultry) were selected. From each of the selected cluster, 20 cattle and buffalo owners, 20 sheep and goat owners and 20 poultry owners (60 from each district) were selected, making a total of 180 respondents.

Table 1. Purposes of using antibiotics in livestock and poultry farms

Particulars	Livestock and poultry farmers								χ^2 value
	Cattle and buffalo (n=60)		Sheep and goat (n=60)		Poultry (n=60)		Total (N=180)		
	Yes	No	Yes	No	Yes	No	Yes	No	
Usage of antibiotics for animals	60 (100)	–	60 (100)	–	60 (100)	–	180 (100)	–	
<i>Purposes</i>									
Therapeutic	60 (100)	–	60 (100)	–	60 (100)	–	180 (100)	–	–
Prophylactic	3 (5.00)	57 (95.00)	10 (16.70)	50 (83.30)	46 (76.60)	14 (23.40)	59 (32.77)	121 (67.23)	79.19**
Metaphylactic	10 (16.70)	50 (83.30)	22 (36.70)	38 (63.30)	48 (80.00)	12 (20.00)	80 (44.44)	100 (55.56)	49.91**
Growth promotion	4 (6.70)	56 (93.30)	2(3.33)	58 (96.67)	9 (15.00)	51 (85.00)	15 (8.33)	165 (91.67)	7.07*

Figures in parentheses indicate percentage. *Significant at 5% level ($p<0.05$); **Significant at 1% level ($p<0.01$); and NS, Statistically non-significant.

Table 2. Sources of obtaining antibiotics

Source	Livestock and poultry farmers							
	Cattle and buffalo (n=60)		Sheep and goat (n=60)		Poultry (n=60)		Total (N=180)	
	TMS	Rank	TMS	Rank	TMS	Rank	TMS	Rank
Pharmacy on veterinarian prescription	2.00	II	2.10	IV	2.25	I	2.12	I
Pharmacy on Para-veterinarian prescription	2.22	I	2.15	III	1.53	IV	1.97	II
Over-the-counter	1.72	III	2.30	I	1.78	III	1.93	III
On suggestions by pharmacy shop owner	1.70	IV	2.20	II	1.87	II	1.92	IV
On suggestions by friends, family members and neighborhoods	1.33	VI	1.48	VI	1.43	V	1.42	VI
On suggestions by progressive farmer	1.43	V	1.77	V	1.30	VI	1.50	V

TMS, total mean score.

Initially a pilot study was carried out by interviewing 30 livestock and poultry farmers in non-sample area in similar field situation to test the clarity, reliability, and validity of the questionnaire. Final data was collected personally after suitable modification in interview schedule. Suitable and appropriate statistical methods were used for analysing the data collected to study each variable. Chi-square test was used to test potential associations between categorical variables and a $p < 0.05$ was considered as statistically significant.

For the purpose of present study, to measure the knowledge level of livestock and poultry farmers about antibiotics and antimicrobial resistance, a test was developed by following collection of items/statements, calculating item difficulty and discrimination index and validity and reliability of test protocols.

RESULTS AND DISCUSSION

Purpose of administering antibiotics to animals: Respondents were asked to mention the name of antibiotic along with purpose of administering to their animals. The major purposes of using antibiotics were therapeutic, prophylactic, metaphylactic and growth promotion. Irrespective of the species, cent per cent respondents were using antibiotics for therapeutic purposes to treat their animals. More than 76% of poultry farmers were using antibiotics for prophylactic purposes followed by goat and sheep owners (16.60%) and dairy owners (5%). Similarly, 80% poultry farmers were using antibiotic for metaphylactic purposes against 36.70% of sheep and goat farmers and 16.70% of dairy farmers. Use of antibiotics for growth promotion purpose was revealed only by 8.33% of livestock and poultry farmers and was found more amongst poultry farmers. Chi-square test revealed significant differences between the livestock and poultry farmers regarding the purposes of using antibiotics at their farm (Table 1).

Kumar and Gupta (2018) also reported therapeutics as one of the major purpose of using antibiotics revealed by

dairy farmers in eastern Haryana region in India. Earlier studies carried out by Mahmoud (2010) in Sudan, Redding *et al.* (2014) in Peru also reported therapeutics as major purpose followed by prophylactic purposes. The purpose of using antibiotics more by poultry farmers may be to combat the transportation stress or prevent infection of the gut in day-old chicks for few days. The results reported by Brower *et al.* (2017) confirmed the use of antimicrobials while transporting the broilers or prior to slaughter, to tolerate stress in poultry as revealed by farmers of Punjab.

Results of the present study as well as earlier reports indicated that prophylactic and metaphylactic purposes for using antibiotics were more at poultry farms as compared to dairy and sheep farm. It might be due to fast transmission of disease in poultry compared to other animal species. High susceptibility to stress and other external factors in poultry may be other reasons for higher usage of antibiotics.

Source of obtaining antibiotics: Respondents were asked to mention their responses on three point continuum against the various sources of obtaining antibiotics. Ranks were calculated based on the total mean score against each source. Veterinary pharmacy on para-veterinarian prescription was the most preferred and trustworthy source to obtain antibiotics revealed by cattle and buffalo farmers followed by veterinarian prescription (Ranked II) and over-the-counter as Ranked III. Sheep and goat farmers however preferred over-the-counter (Rank I) as most preferred source followed by pharmacy shop owner suggestions (Ranked II) and para-veterinarian prescription (Ranked III). In the case of poultry farmers, veterinarian prescription (Ranked I) was the first choice followed by pharmacy shop owner (Ranked II) and over-the-counter (Ranked III). It indicates that different animal/poultry owners followed different sources based on extent of trustworthiness towards a particular source.

The major reasons of high usage of antibiotics over-the-counter sale may be due to easy availability, sometimes even without prescription/reusing old prescriptions or

Table 3. Reasons for storing antibiotics at farm

Reason	Livestock and poultry farmers			
	Cattle and buffalo (n=60)	Sheep and goat (n=60)	Poultry (n=60)	Total (N=180)
Emergency use	16 (26.67)	8 (13.33)	10 (16.66)	34 (18.89)
Distant location of veterinary pharmacy	18 (30.00)	21 (35.00)	9 (15.00)	48 (26.66)
Treatment by self	10 (16.66)	15 (25.00)	24 (40.00)	49 (27.23)
For improving production and growth of animal	4 (6.67)	2 (3.33)	9 (15.00)	15 (8.33)
Insufficient availability of qualified veterinarians at doorstep	12 (20.00)	14 (23.37)	8 (13.34)	34 (18.89)

Figures in parentheses indicate percentage.

Table 4. Distribution of the respondents on the basis of their type of antibiotics used in their farm

Antibiotics	Livestock and poultry farmers			
	Cattle and buffalo (n=60)	Sheep and goat (n=60)	Poultry (n=60)	Total (N=180)
Oxytetracycline	32 (53.33)	46 (76.66)	31 (51.66)	109 (60.55)
Enrofloxacin	26 (43.33)	42 (70.00)	36 (60.00)	104 (57.77)
Levofloxacin	11 (18.33)	22 (36.66)	30 (50.00)	63 (35.00)
Tylosin	15 (25.00)	13 (21.66)	23 (38.33)	51 (28.33)
Amoxicillin	19 (31.66)	15 (25.00)	19 (31.66)	53 (29.44)
Ceftriaxone	17 (28.33)	4 (6.66)	9 (15.00)	30 (16.66)
Strepto-penicillin	29 (48.33)	26 (43.33)	11 (18.33)	66 (36.66)
Cefalexin	17 (28.33)	6 (10.00)	8 (13.33)	31 (17.22)
Trimethoprim + sulfamethoxazol	21 (35.00)	19 (31.66)	24 (40.00)	64 (35.55)

Figures in parentheses indicate percentage.

informal consent of para-veterinarians or on suggestions of pharmacy shop owners.

Reasons for storing antibiotics at farm: The reasons for storing antibiotics at farm were explored through open ended questions by the respondents. Five reasons were reported by the respondents for storing the antibiotics at their farm. About 27% farmers stored it for treating their animal/bird by self without consulting a veterinarian/para-veterinarian followed by distant location of veterinary pharmacy shop. Reasons revealed by dairy animal owners and poultry owners were different. The major purpose of storing and use of antibiotics by cattle/buffalo, sheep/goat owners was the distant location of veterinary pharmacy while for poultry farmers, it was treatment by self.

Common antibiotics in use by the animal/poultry owner at farm: Respondents were asked to name the antibiotics used at farm for animal/bird treatment or other non-therapeutic purposes. Data were collected on particular variable by observation at the farm for drug vials or antibiotic labels, etc. and also through direct question by livestock farmers.

Oxytetracycline followed by Enrofloxacin were the two major antibiotics being used by 61% and 58% respondents irrespective of the locale as well as type of species owned

Table 5. Different farm records maintained by livestock and poultry farmers

Type of record	Livestock and poultry farmers			
	Cattle and buffalo farmers (n=60)	Sheep and goat farmers (n=60)	Poultry farmers (n=60)	Total (N=180)
Herd/flock health record	12 (20.00)	9 (15.00)	22 (36.66)	43 (23.88)
Individual animal health card	2 (3.33)	—	—	2 (1.12)
Antibiotics used in farm record	4 (6.66)	3 (5.00)	14 (23.33)	21 (11.66)
Production and disposal record	21 (35.00)	4 (6.66)	34 (56.66)	59 (32.77)

Figures in parentheses indicate percentage.

by them (Table 4). Oxytetracyclines, Strepto-penicillin and Enrofloxacin were the most common antibiotics being used by the cattle and buffalo farmers. In sheep and goat farm, Oxytetracyclines and Enrofloxacin were most common antibiotics used by shepherds and Enrofloxacin, Levofloxacin and Oxytetracyclines were being used at higher level at the poultry farms by the owners. Results of the study are well supported by the earlier studies covered out at various corners in India (CSE 2014, Lalawmpuia 2015, Pallavi 2017, Ramesh 2017, Patnaik 2019).

Record maintenance at farm: Livestock and poultry farmers were asked to mention the different kind of records maintained by them because such data is essentially needed to understand animal health history, resistance to antimicrobials earlier treatment, etc. at the farm before selecting an antibiotic. Majority of the cattle and buffalo farmers (35%) were maintaining production and disposal records followed by herd health records. Except 15% sheep and goat farmers, rest were not maintaining flock health records. Poultry farmers still showed better picture than cattle/buffalo and sheep/goat owners in this direction and about 37% were maintaining production and disposal records followed by flock health record (36.66%) and antibiotic usage records (23.33%) which enabled them to

identify the areas of their business for benefit and additional investments. Pallavi (2017) and Kolhe (2018) also reported that majority of dairy and sheep farmers were not maintaining the animal health records in Punjab and Maharashtra. Thus, there is scope to educate farmers about the importance of record maintenance and its benefits for improving farm profitability, risk management and reduction of dependency on antibiotics.

Antibiotic usage practices followed by livestock and poultry farmers for treatment of animals/birds: Respondents were asked to mention the antibiotic usage practices followed by them at their farm. It included purchase of antibiotics over-the-counter, procedure used for identifying the antibiotics, checking expiry dates on antibiotics label before administering, follow of full dose regimen, follow-up treatment and awareness about withdrawal period through Yes/No type of questions.

Purchase of antibiotics over-the-counter: Majority (78%) of respondents purchased antibiotics over-the-counter at some point of time. Individually, 75% of cattle and buffalo farmers, 93.33% of sheep and goat farmers and 68.33% of poultry farmers purchased antibiotics over-the-counter.

Lack of door step services and insufficient qualified animal health service provider were found the top most reasons revealed by respondents for purchase of antibiotics over-the-counter followed by lack of awareness, distantly located animal health centre, etc. Lack of awareness regarding importance of antibiotic prescription, allows them to purchase substandard antibiotics and follow inappropriate administration practices.

Probably low cost, readily availability in veterinary pharmacy and easy access to farmers by themselves without any restrictions may be the other reasons behind over-the-counter purchase of antibiotics, that needs to be looked with the policy support to check the purchase and use of antibiotics without proper prescription given by a qualified veterinarian.

Procedure used for identifying the antibiotics: Livestock and poultry farmers were also asked to mention the methods used by them to identify the antibiotics (Table 6). About 54% of cattle and buffalo owners were identifying antibiotics through vial followed by 35% by generic name. Majority of sheep and goat farmers (58.34%) also identify antibiotics by vial and about 27% depended on colour of antibiotic vial. Poultry farmers (55%) however identify antibiotics by generic name followed by 26.66% by vial. It indicates that prevailing practices of the respondents regarding identification practices have probability of wrong antibiotic usage due to similar colour and vial structure. This practice ultimately ends with inappropriate use of antibiotic which is one of the aggregating factors for AMR in livestock.

Checking expiry dates on antibiotics label before administering: About 63% of respondents never look for expiry dates before administering antibiotics to animal/birds. Category wise data showed that 70% of cattle/buffalo

farmers and 81.66% of sheep/goat farmers never observed the expiry dates on antibiotic label whereas 63.33% of poultry farmers positively answered and looked for expiry dates before using it to their birds (Table 6).

Full dose of regimen of antibiotic: Majority of respondents (80%) were not following full dose regimen of antibiotics while treating their animals. Appearance of recovery signs, financial burden, lack of time, ineffective antibiotics and side effects were the other major reasons expressed by respondents during the discussion behind stopping of antibiotic therapy and not following the full dose regimen of antibiotics. Sawant *et al.* (2005) also reported that only 24% of the dairy producers in Pennsylvania gave complete course of treatment with antibiotic.

Follow-up treatment: Table 6 further reveals that majority of cattle and buffalo farmers (45%) never take up the follow-up treatment after antibiotic therapy followed by about 37% who sometimes follow, and rest 18.34% followed completely. Amongst sheep and goat farmers, only 15% followed completely, 42% sometimes and rest 44% never went for follow-up after the treatment with antibiotics. The scenario of adopting complete follow-up was different amongst poultry farmers wherein about 78% had undergone for follow up treatment with varied frequency and only 21% did not follow the same after treating their birds with antibiotics. The reasons for poultry farmers following follow-up treatment might be timely information that were being given to them about importance of follow-up treatment by their animal health service providers which may be lesser in other species. It clearly indicated that educating the farmers regarding these practices is highly required to follow good antibiotic practices to combat silent pandemic.

Withdrawal period: Respondents were also enquired regarding their awareness for withdrawal periods. Surprisingly only 20% respondents were aware about the withdrawal periods. Amongst them only 10% were following the withdrawal periods of antibiotics after treatment. It might be due to fear of financial losses, lack of awareness, insufficient extension activities and inadequate usage guidelines from manufacturers and service providers leading to misuse and overuse of the drug and possibly failure to observe withdrawal periods, thus leading to the presence of high levels of antibiotic residues in livestock products. Our findings of the study are supported by Mahmoud (2010), Alla *et al.* (2011) and Kumar *et al.* (2021) who also reported that majority of the dairy farmers and poultry farmers did not have the knowledge about withdrawal period and rules and regulations of antibiotic usage. They were continuing selling of eggs and beef even during and immediately after the use of antibiotics.

Knowledge of livestock and poultry farmers about antibiotics and antimicrobial resistance: The knowledge of the livestock and poultry farmers was studied with the help knowledge test developed for the study which consisted 18 knowledge statements. Further the scores of set of 18

Table 6. Practices followed for antibiotic usage for treatment of animals

Practices	Livestock and poultry farmers			
	Cattle and buffalo farmers (n=60)	Sheep and goat farmers (n=60)	Poultry farmers (n=60)	Total (N=180)
<i>Purchased over-the-counter antibiotics (OTC)</i>				
Yes	45 (75.00)	56 (93.33)	41 (68.33)	142 (78.88)
No	15 (25.00)	4 (6.67)	19 (31.66)	38 (28.12)
<i>Reasons for purchasing antibiotics over the counter</i>				
Insufficient qualified animal health service provider	32 (71.11)	48 (85.71)	29 (70.73)	109 (76.76)
Distantly located animal health center	21 (46.66)	43 (76.78)	36 (87.80)	79 (55.63)
Lack of door-step services	28 (62.22)	51 (91.07)	40 (97.56)	119 (83.80)
Socio-economic factors	23 (51.11)	29 (51.78)	16 (39.02)	68 (47.88)
Insufficient availability of medicines at veterinary hospital	19 (42.22)	43 (76.78)	38 (92.68)	64 (45.07)
Lack of information and awareness	25 (45.55)	36 (64.28)	21 (37.50)	82 (57.74)
Emergency situation	16 (35.55)	7 (12.50)	9 (21.95)	32 (22.53)
<i>Practices used for identifying the antibiotics</i>				
By colour	7 (11.66)	16 (26.66)	11 (18.34)	34 (18.88)
By vial	32 (53.34)	35 (58.34)	16 (26.66)	83 (46.12)
By generic name	21 (35.00)	9 (15.00)	33 (55.00)	63 (35.00)
<i>Checking expiry dates on antibiotics label before administrating</i>				
Yes	18 (30.00)	11 (18.34)	38 (63.33)	67 (37.22)
No	42 (70.00)	49 (81.66)	22 (36.67)	113 (62.73)
<i>Follow of full dose regimen</i>				
Yes	13 (21.66)	9 (15.00)	15 (25.00)	37 (20.55)
No	47 (78.34)	51 (85.00)	45 (75.00)	143 (79.45)
<i>Reasons for not following full dose regimen</i>				
Financial burden	11 (23.04)	14 (27.45)	5 (11.11)	30 (20.97)
Lack of time	2 (4.25)	4 (7.84)	2 (4.44)	8 (6.00)
When animal shows recovery signs	19 (40.42)	22 (43.13)	25 (55.55)	66 (46.15)
Ineffective antibiotic	4 (8.51)	5 (9.80)	2 (4.44)	11 (7.69)
Animal production falls	6 (12.76)	-	8 (17.77)	14 (9.80)
When animal shows side effects	2 (4.25)	2 (3.92)	1 (2.22)	5 (3.49)
On the advice of friend/neighbours	3 (6.38)	4 (7.84)	2 (4.44)	9 (6.29)
<i>Follow-up treatment</i>				
Always	11 (18.34)	9 (15.00)	15 (25.00)	35 (19.44)
Sometimes	22 (36.66)	25 (41.66)	32 (53.33)	79 (43.88)
Never	27 (45.00)	26 (43.34)	13 (21.67)	66 (36.67)
<i>Withdrawal period</i>				
Aware about withdrawal period	12 (20.00)	10 (6.66)	14 (23.33)	36 (20.00)
Following withdrawal period	3 (5.00)	7 (11.66)	8 (13.33)	18 (10.00)

Figures in parentheses indicate percentage.

statements were pooled and total score attained individually by farmers. These were further grouped into 3 categories; low, medium and high level of knowledge.

Table 7 indicates the limited knowledge of livestock and poultry farmers regarding various antibiotics and antimicrobial resistance. Significant differences ($p < 0.01$) was found amongst the livestock and poultry farmers with respect to their knowledge level on antibiotics usage and antimicrobial resistance in animals. Table 7 further indicates that 80% cattle and buffalo owners had low to medium level

of knowledge and the rest 20% had high level of knowledge over the subject studied. Amongst sheep and goat farmers except 8% respondents, majority (66.66%) fell under low to medium level of knowledge category regarding usage of antibiotics and antimicrobial resistance. Around 56% poultry farmers fell under medium to high level of knowledge category on usage practices of antibiotics in their birds.

Earlier studies also revealed lack of knowledge among the farmers towards antimicrobial resistance in different

Table 7. Knowledge levels of livestock and poultry farmers about antibiotics and antimicrobial resistance

Knowledge level (scores)	Livestock and poultry farmers				Chi square
	Cattle and buffalo farmers (n=60)	Sheep and goat farmers (n=60)	Poultry farmers (n=60)	Total (N=180)	
Low (0–6)	33 (55.00)	40 (66.66)	26 (43.33)	99 (55.00)	28.83**
Medium (7–12)	18 (30.00)	15 (25.00)	20 (33.33)	53 (29.44)	
High (13–18)	9 (15.00)	5 (8.34)	14 (23.34)	28 (15.56)	

Figures in parentheses indicate percentage.

parts of India and globally. According to Chauhan *et al.* (2018) majority of the dairy farmers across three cities in India were unaware of even the word ‘antibiotic’. Vasant (2016) also reported that 88% of dairy farmers in Krishnagiri and Kolar areas did not know about antibiotic usage in their animals and its residues in milk. Small holder dairy farmers have poor knowledge about antibiotics, and they are largely unaware of the concept of antimicrobial resistance in different regions of India (Sharma *et al.* 2020). Jones (2015) reported that cattle farmers in England had some level of awareness for responsible use of medicines in agriculture (RUMA 2004) and guidelines on use of antimicrobials in cattle production, but half of these admitted to incomplete knowledge. Another study conducted by Bloomberg Media Company also reported lack of knowledge on antibiotics in Ranga Reddy district of Telangana. Brower *et al.* (2017) and Lalawmpuia (2015) reported lack of awareness amongst majority of the poultry farmers in Punjab regarding presence of AGPs premix in chicken feed purchased from feed mills and related health hazards associated with the antimicrobial resistance. According to Katakweba *et al.* (2012), 38% of Tanzanian livestock farmers had poor knowledge about antibiotics and antimicrobial resistance and 22.5% never heard even the term withdrawal periods.

The present study revealed an empirical information about the lack of crucial awareness and knowledge in many livestock and poultry farmers. By default, a huge number of farmers were treating the animals by their own experience by using the easily accessible antibiotics available in the nearby veterinary drug stores. A considerable species-specific variation in the inappropriate antibiotic use is evident with improper dose regime of antibiotics and ignoring the withdrawal periods while using them. These circumstances shall however lead to the development of antibiotic resistance in animals. The study clearly implies the need of educational models and specific extension strategies to create awareness among livestock farmers regarding the importance of antibiotics and consequences of their indiscriminate use on human and animal health. It

is also needed to create awareness among the farmers to avail the right services at the right time from the right person. In turn, this will help to mitigate the grave impact of antimicrobial resistance and its effect on health. Considerable species-specific variation were also found in the antibiotic usage practices by the three different groups of farmers; to address these issue species-specific recommendation/policies are needed to combat AMR effectively.

At first instance, a campaign outlined to create awareness by elucidating the beneficial effect of judicious use of antibiotics, adverse effects of their indiscriminate use on animal health, and consequences thereafter on human health should be carried out for the livestock farmers. ‘Antibiotics awareness week’ should be held at the village level at least once in a year that will help in dissemination of the information and serves as a regular caution to the livestock farmers.

After treating the animal, veterinary officers need to educate the livestock owners on withdrawal periods and the effect of livestock products that contain antibiotic traces on human health. In addition, the need of follow-up services to complete the appropriate antibiotic dose regimen should be instructed by the veterinarians to the livestock owners. As a whole, a multi-sectorial and multi-dimensional approach is needed to address the challenge of the AMR and a single organization or discipline cannot solely address its immediate threat. This current situation also demands an imminent convergence of different state animal husbandry departments along with various NGOs, animal welfare associations and veterinary universities is a pre-requisite amount to fight against AMR effectively.

It is anticipated that the findings of this survey may help the policy makers/authorities to prepare way forward to combat this silent pandemic and minimize antibiotic resistance.

ACKNOWLEDGEMENTS

The authors are thankful to the University Grants Commission (UGC), New Delhi, India for providing the financial support for doctoral studies through junior research fellowship program and support from ICAR-IVRI, Izatnagar and the cooperation from Livestock and poultry farmers of Telangana to help conduct this study.

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