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Veterinary Drug Utilization Behaviour of Small-scale Dairy Farms in Three Districts of Oromia Region

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Abstract: Small scale dairy farms around the Addis Ababa milk and milk products value chain covers a significant portion of the milk demands of Ethiopian people. The demand for dairy and meat products is rapidly increasing resulting in the expansion of dairy and fattening farms. Likewise, a wide variety of antimicrobials (AMs) have been used for a variety of purposes. This coupled with the poor awareness level of farmers regarding antimicrobial drug residue (AMDR) in animals' products pose a great threat to public health. This study is therefore conducted to assess the current antimicrobial utilization and post-administration management practice of livestock producers in the study area. A cross-sectional study was conducted in 90 purposively selected smallholder dairy farms in 3 districts of the Oromia region. All farms (n=90) reported the use of at least one class of antimicrobial for a variety of purposes. Anthelminthics and antibiotics (87.8% each), antiprotozoals (58.9%), multivitamins and other commercial supplements (42.2%) were the most frequently used veterinary products in the study area. About two-thirds (63.3%) of the respondents purchase and use drugs without prescription. Unrestricted veterinary drug access (X2=9.03, p=0.003) and the perception of high veterinary service costs (X2=11.1, p=0.001) were found to have a strong association with unprescribed drugs use. AMs were used for treatment (49.4%), prophylactic (18.6%), growth promotion (18.6%), and fattening (17.8%) purposes. Most of the respondents (57.8%) have no awareness about antimicrobial resistance (AMR) in milk and milk products. A strong association between the status of training and awareness level was observed, indicating the vital role of training in enhancing awareness level. A small majority (53.3%) of the respondent adhere to the recommended drug withdrawal period (DWP). Similar studies should be conducted in wider areas along the major milk value chain to get a big picture of the drug utilization status of dairy farms. Future works should quantify the level of veterinary drug residue (VDR) in dairy products.

Keywords: Antimicrobial Utilization, Veterinary Drug Residue, Small-scale Dairy Farms, Drug Resistance

1. Introduction

Human health is the product of the environment and safe food [1] since it can be altered by foodborne illnesses that originate from infectious organisms or chemicals like pesticides, food processing chemicals and drug residues [2, 3]. The term drug residue according to the definitions adopted by the Codex Alimentarius Commission is the presence of the parent compounds and/or their metabolites in any edible portion of the animal product, and include residues of associated impurities of the veterinary drug concerned [4].

Antimicrobials (AMs) are used to control, prevent, and treat infection, and to enhance animal growth and feed efficiency [5]. Different classes of antibiotics and anthelmintics are being widely used in food animals, with special mention of dairy cows to treat mastitis [6]. Veterinary drug residues (VDR) become a great concern to dairy farmers, milk processors, regulatory agencies, and consumers [7]. Normally, the administered drug goes through a series of molecular transformations and metabolization to facilitate

absorption and excretion. However, significant portions of antibiotics are released through the milk of dairy animals unaltered while some portions accumulate for a certain period in edible animal products like eggs and meat [7–9]. The presence of VDR can cause (i) direct toxicity on consumers exhibiting allergic reactions; (ii) indirect problems through the generation of resistant strains and pathogenic bacteria; (iii) contamination of manures used in crop productions [10–12]. In the long-term, resistance developed by microorganisms increases reduced productivity, socioeconomic status of many individuals globally; and interfere with the control and eradication processes of diseases [13].

The shifting towards large scale farming to meet the ever-increasing demand for livestock products will increase AMs usage by more than 65% in the next decade [8]. This anticipation coupled with irrational veterinary drugs use will significantly increase the risk of VDR in foods of animal origin. Limited studies have yet been conducted in Ethiopia to assess the awareness level of livestock producers, the drug administration and management practices, and the status of AMR in milk and milk products. This study is therefore aimed to see potential indicators for VDRs in three milk shed districts supplying the capital, Addis Ababa [14, 15].

2. Materials and Methods

2.1. Study Area

The present study was conducted in Wolmera, Ejere and Ada Berga districts of the west Shewa zone, the central part of Oromia Regional State, Ethiopia. Wolmera district is located 30 km west of Addis Ababa at an altitude of 2400 meters above sea level. It is geographically located between 8°50' - 9°15'N latitude and 38°25' - 38°45' E longitude. The rainfall pattern is bimodal, with a short rainy period from March to May and a long rainy season from June to September. The annual temperature and rainfall range from 18°C to 24°C and 1000 to 1225 mm, respectively [16]. Adaberga district is located at 9° 16'N latitudes and 38° 23'E longitudes. The area experienced a bimodal rainfall pattern with a short rainy season from February to April and the long rainy season from the middle of June to the end of September. The area gets an annual rainfall of 1000-1100mm and the annual temperature ranges between 18°C to 24°C [17]. Ejere district located at 9°2′ N longitude and 38°24′ E latitude and of with an elevation of about 2360 meters above sea level. The annual average temperature and average rainfalls are 16.9°C and 1099 mm respectively with unimodal rainfall type [18].

2.2. Study Design and Sample Selection

A cross-sectional study was conducted in 90 smallholder dairy farms. Study samples were selected purposively from the three districts. The main criteria for selection were the availability of at least two cows at the time of the study and involvement in the dairy milk chain. Farms that do not sell milk or milk by-products to consumers were omitted from the study.

2.3. Data Collection

Data were collected using a structured questionnaire, pretested before the main survey. It contains open and close-ended questions designed to characterize agroecology, farm type and management practice, the most commonly used drugs, the pattern of self-treatment, practice of dosage determination, and compliance with the recommended DWP. Data was taken by interviewing the owners of selected dairy farms.

2.4. Data Analysis

The collected data were entered, coded, and cleared using Microsoft Excel 2016 Spread Sheet. Descriptive statistical analysis was performed using SAS 9.0. Results are summarized as frequencies, percentages or as a mean for numeric values and presented in tables and figures. Graphs were sketched using prism v8.4 (GraphPad Prism Software Inc., San Diego, USA). The Chi-square test was used to test potential associations between categorical variables when appropriate, and $p<0.05$ was considered statistically significant. Symmetric measures for nominal and numeric variables were measured using Phi- Cramer and Pearson correlation tests, respectively.

3. Results and Discussion

3.1. Respondent's Profile

Socio-demographic and farm characteristics are summarized in Table 1. Each district in the study area was represented by 30 farms (n=90). Most of the owners (68.9%) were male. About 62% of the respondents were illiterate. Most of the farms are located in rural (62.2%) and are managed under an intensive management system.

Table 1. *Sociodemographic and farm characteristics of selected households in the three districts (n=90).*

Characteristics	Categories	Numbers	Percentage
Districts	Adaberga	30	33.3
	Ejere	30	33.3
	Wolmera	30	33.3
Sex	Female	28	31.1
	Male	62	68.9
Education status	Illiterate	56	62.2
	Primary school	27	30.0

Characteristics	Categories	Numbers	Percentage
	Secondary school	7	7.8
	Urban	5	5.6
Farm location	Peri-urban	29	32.2
	Rural	56	62.2
	Intensive	49	54.4
Farming system	Semi-intensive	29	32.2
	Extensive	12	13.3
Farming system	Livestock	16	17.7
	Crop-livestock	74	82.3
	Crop	47	52.2
The main source of income	Livestock	18	20
	Crop and livestock	25	27.8
Breed of cows owned	Crossbreed cows	8	8.9
	Local and cross mixed	82	91.1

3.2. Milking Cows Owned in the Farm

The average number of cows owned in the farms was 7.5±2.7. There were at least 2 (2.53±1.26) milking cows in each farm at the time of the survey. The average number of cows categorized under the different physiological states is presented in Figure 1.

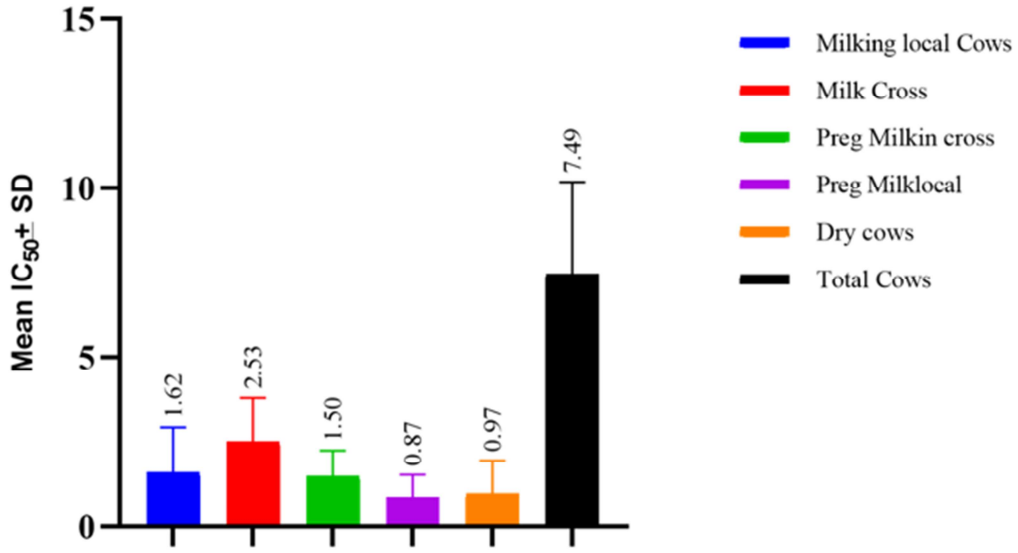

Figure 1. *The average number of lactating and dairy cows owned in the study farms.*

Table 2. *Drug usage behaviour, source of drugs and reason for unprescribed drug purchase.*

Questions	Response category	Frequency (n=90)	Percent
Have you ever used AMs previously?	Yes	90	100
	Antibiotics	79	87.78
	Anthelminthic	71	78.89
What kind of AMs do you use?	Antiprotozoal	37	41.11
	Acaricides	28	31.11
	Multi-Vitamin others supplements	38	42.22
How do you purchase the drug	With prescription	33	36.67
	Without a prescription	57	63.33
	Asking Drug dispensers	18	31.58
If without prescription, how do you select the drug	Based on previous experience	19	33.33
	Peer recommendations	13	22.81
	Based on drug availability in the store	7	12.28
	Veterinary pharmacies/drug store	30	52.6
Source of unprescribed drugs	Open market/ Black markets	15	26.2
	Private/government veterinary clinics	12	21.1
	To save money and time	20	35.1
Reason for unprescribed purchase	Previous exposure for similar diseases condition	11	19.3
	Easily Availability of unprescribed drugs	10	17.5
	Advice from families and friends	16	28.1

3.3. Previous Use of Antimicrobials

All respondents (n=90) reported the use of at least one kind of antimicrobial for managing illness in the farm. Anthelminthics and antibiotics (87.8%) were the most frequently used veterinary drugs followed by antiprotozoals (58.9%) and multivitamins and other commercial supplements (42.2%).

About one-third (36.7) of the farmers get drugs using prescriptions, the rest rely on unprescribed drugs. Most of the farms purchase drugs from private and government veterinary pharmacies, open markets and veterinary clinics. The drug choice is mainly governed by previous drug usage (33.3%), advice from drug dispensers (31.6%), a recommendation from non-professionals (neighbours and relatives) (22.8%), and based on drugs available in the pharmacy (Table 2).

The current finding revealed the use of different kinds of antibiotics, anthelmintics, antiprotozoals, multivitamins (injectables) together with other supplements in the study area. Gemeda et al. [19], reported antibiotics usage (24%) and acaricides usage (4.7%) in the highland mixed crop-livestock system; the corresponding proportion (87.8 and 31.1%) noted in our study is higher. The difference might have resulted from agroecology, diseases epidemiology differences and management practices. Both studies noted high (95% and 78.4%) anthelmintics utilization. Which might suggest the use of anthelmintics for therapeutic, prevention and fattening purposes. Most of the drugs were purchased and used without prescription. Which suggests irrational use of antimicrobials for various medical and non-medical conditions. The rate of unprescribed drug use (63%) noted in this survey is high. Unprescribed drug use often leads to over-prescription, omission, the use of inappropriate dosage, incorrect duration, incorrect selection, and unnecessary risk by using unnecessary drug formulation [20]. The issue is a two-dimensional problem since veterinary pharmacies (professionals) are also implicated in the matter. A study conducted by Koji et al. [21] revealed that about (70%) of pharmacies interviewed admitted sell of veterinary drugs without prescription.

The main driven force for unprescribed veterinary drug use as described by farm owners are time and financial constraints (35%) and peer advice (28%). Other reasons include previous exposure to similar disease conditions (19%) and easy accessibility of unprescribed veterinary drugs (18%). Unprescribed drug purchase was found to have no significant association with district sex, farm location, management system, education status, and awareness. Rather unrestricted veterinary drug access (X^2=9.03, p=0.003) and the perception of high veterinary service costs (X^2=11.1, p=0.001) were found to have a strong association.

Table 3. *Level of association between use of prescription, drug access and cost of veterinary service.*

Factors	Category	Prescription		Chi-sq	Sig	r
		Yes (%)	No (%)			
Easy drug access	Yes	11.1[a]	40.0[b]	9.03	0.003	0.32
	No	25.6[a]	23.3[b]			
Cost of treatment in clinics	Expensive	11.1[a]	42.2[b]	11.1	0.001	0.35
	Fair/cheap	25.6[a]	21.1[b]			

1symmetric measures for nominal and numeric variables were measured using Phi- Cramer and Pearson correlation tests, respectively; alphabetical superscripts represent significant differences within levels, r=correlation coefficient.

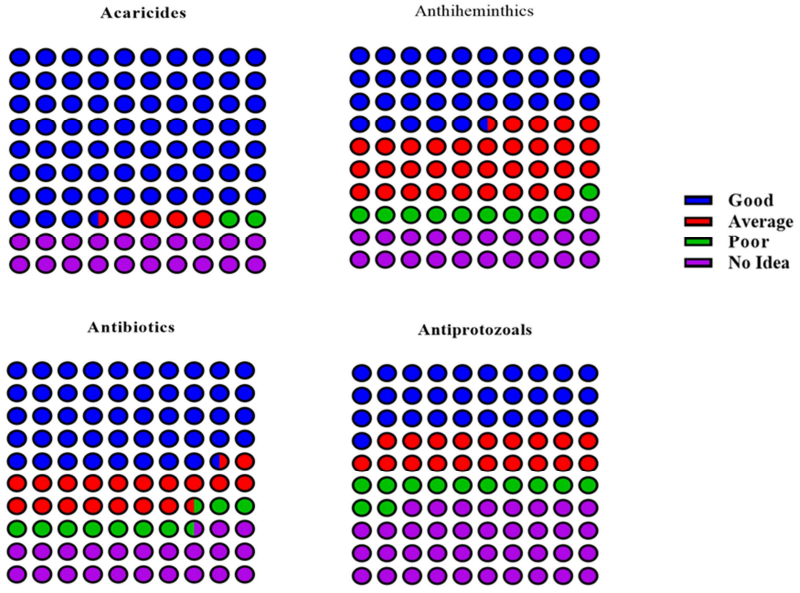

Figure 2. *Showing 10 x 10 plots for post-treatment response as complained by respondents (Each unit in percentage is represented by circular dots).*

The Source of unprescribed veterinary drugs mentioned by farm owners were also reported previously by Koji et al. [21]. The proportion of farm owners who purchased drugs from veterinary pharmacies/drug stores (52.2%) is higher than the 33% magnitude mentioned, while the other findings are consistent.

3.4. Owners' Opinion on the Efficacy of Antimicrobials

The multiple response score for most commonly used AMs (antibiotics, anthelmintics, acaricides and antiprotozoals) good efficacy was selected 161 times (47.1%) while average efficacy and poor efficacy were selected 68 (18.9%) and 31 (8.6%) times, respectively. The efficacy score for each type of antimicrobials is presented in Figure 2.

3.5. Reason for Antimicrobial Use

AMs were mainly used to treat sick animals 178 (47.34%), followed by prophylactic use and growth promotors 67 (17.8%) each, and fattening 64 (17.02%). Drug dosage was mainly determined by age, body condition and weight of the animal (Table 4).

Table 4. *Reason for antimicrobial use and dose determination by farmers.*

Questions	Response category	Frequency	Percent (%)
Reason for use of AMs	To cure disease	67	74.4
	To increase production	28	31.11
	For fattening purpose	5	5.56
	To promote growth	10	11.11
If yes, how do you determine the dose?	Age	25	27.78
	Body condition	15	16.67
	Body Weight	20	22.22
	Age + Body condition	18	20.00
	Age + Body Weight + body weight	12	13.33

Farms used antibiotics mainly for treatment purposes (28.7%), whereas anthelmintics were used for both treatments (28.7%) and fattening purposes (44.4%). From the possible 360 responses in the multiple response analysis, treatment (curative) was selected as the most common use of AMs 178 (49.4%), followed by prophylactic 67 (18.6%), growth promotion 67 (18.6%), and fattening 64 (17.8%). Dosage was mainly determined by age, body condition and weight of the animal (Table 5).

Table 5. *Group of AMs use categorized by the purpose of AMs usage.*

AMs used by farms	Reason for AM use (N=90)							
	To cure disease		For prophylaxis		For fattening purpose		To promote growth	
	N	%	N	%	N	%	n	%
Anthelminthic	51	56.7	22	24.4	40	44.4	8	8.9
Antiprotozoals	27	30.0	12	13.3	2	2.2	5	5.6
Acaricides	21	23.3	10	11.1	3	3.3	2	2.2
Antibiotics	51	56.7	12	13.3	9	10.0	12	13.3
Multivitamins and other supplements	28	31.1	11	12.2	10	11.1	40	44.4
Total	178	49.4	67	18.6	64	17.8	67	18.6

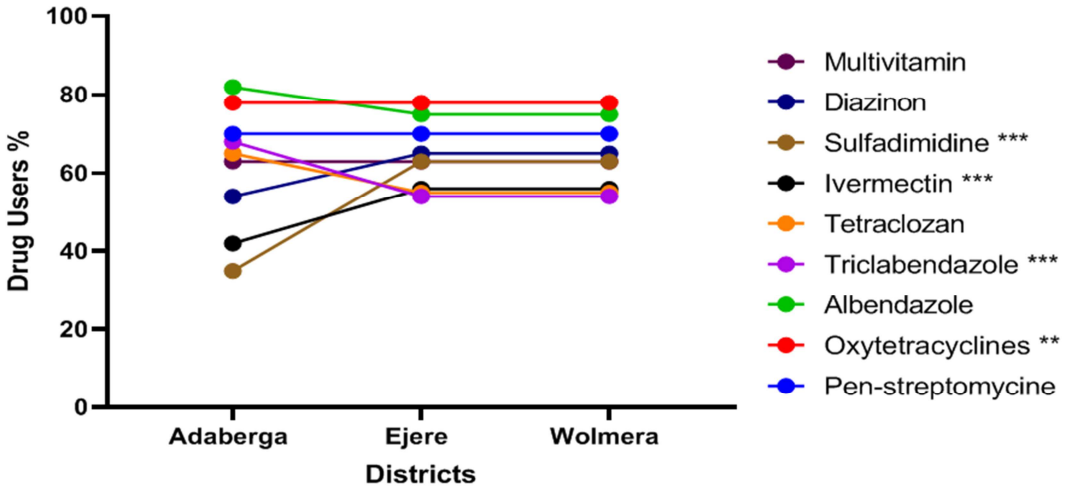

Figure 3. *Types of AMs used in the study districts.*

3.6. Type of Antimicrobials Used

The most common classes of veterinary products used in the study area are antibiotics, anthelmintics, acaricides multivitamins and different formulations of supplements. From anthelminthics, benzimidazoles (Albendazole and triclabendazole), imidazothiazole (tetraclozan and tetramisole/levamisole) and macrocyclic lactone (Ivermectin) classes were common in all districts. The most frequently used antibiotics are Tetracycline (Oxytetracycline), βlactams (Penicillin-streptomycin), and Sulphonamides (Sulfadimidine). Among the different classes of acaricides, organophosphates (Diazinon) were widely used.

Chi-Square test for trend analysis of the types of AMs used across districts showed a statistically significant association between types of drugs used and districts, for oxytetracycline (X^2=9.234, p=0.0099), triclabendazole (X^2=21.83, p<0.0001), ivermectin (X^2=19.60, p<0.0001) and Sulfadimidine (X^2=27.88, p<0.0001). Anthelminthics were widely used in Adaberga compared to other districts. This might be due to the marshy nature of grazing lands and the high prevalence of fasciolosis in the area. On the contrary, sulfadimidine, ivermectin and diazinon were used less frequently suggesting less distribution of infectious bacterial and viral diseases compared to other districts. Ejere and Wolmera districts have similar trends of antimicrobial use.

3.7. Awareness About Antimicrobial Residue

About 42.2% (38/90) have awareness of the risk of AMR in milk. These individuals also happened to be trained on the rational use of AMs by different organizations. The training was provided by agricultural offices 21 (55.26%) and research Centre 17 (44.74%).

Table 6. *Respondents' awareness on VDR and adherence level with DWP.*

Question	Response category	Frequency	Percent
Do you know About AMR in milk	**Yes**	**38**	**42.22**
	No	**52**	**57.78**
Have you ever taken any training on the rational use AMs?	Yes	38	42.22
	No	52	57.78
Who gave you the training?	Agricultural offices	21	55.26
	Research centres	17	44.74
Do you know about drug DWP?	Yes	48	53.33
	No	42	46.67
Do you follow drug DWP?	Yes	48	53.3
	No	42	46.7
DWP followed after Drug administration	0 day	33	36.67
	1 day	13	14.44
	2 days	21	23.33
	3 days	23	25.56
Are veterinary drugs easily accessible in your area?	Yes	46	51.1
	Not accessible	44	58.9
Do you think treatment cost is expensive	Yes, expensive	48	53.3
	No, fair or cheap	42	46.7

All the respondents that have awareness of AMR in milk and milk products have taken training on AMs management practices. There was a strong association between the status of training and awareness level, indicating the vital role of training in enhancing awareness level. The role of non-government organizations interventions in creating awareness on antimicrobial drug management, AMR, rational use of AMs was insignificant as all the training was given by research centres (45%) and agricultural offices (55%).

A relatively higher awareness level (66.1%) was reported in a study conducted in Holetta [22]. Considering the well-developed dairy farming system in the area as well as the presence of Ethiopian biggest dairy research Centre in the area, the awareness level is expected to be high. The current study covered a relatively larger area with mixed farm locations which might cause a lower awareness level. A relatively lower (30%) awareness level was also reported from mixed highland crop-livestock agroecology [19]. Moreover, Agmas and Adugna [23] report a total absence of awareness regarding VDR and recommended DWP in and around Bahirdar and Debretabor cities of the Amhara region.

A small majority (53.3%) of the respondent reported adherence to the recommended DWP. Since all AMs claim at least 3 days for drug withdrawal, it can be said that only 25% who said 3 days of WP adheres to the recommendation (Table 6).

3.8. Factors Affecting Compliance with the Withdrawal Period

District, compliance with drug withdrawal periods after administration was associated with training and awareness (p<0.05). But no statistical association was observed with owners' sex, education level, farm Location, M=management System, prescription use, market access, stock size, herd breed composition.

Table 7. *Association between adherence to withdrawal periods and other variables.*

Factors	Category	Follow WP		Chi-sq	P-value	r
		Yes (%)	No (%)			
Sex	Male	33.3	35.6	3.105	.078	.186
	Female	8.9	22.2			
District	Wolmera	22.2[b]	11.1[a]	13.482[a]	.001	.387
	Ejere	6.7	26.7			
	Adaberga	13.3	20.0			
Education level (school completed)	Secondary	3.3	4.4	2.580	.275	.169
	Primary	8.9	21.1			
	Illiterate	30.0	32.2			
Location	Rural	22.2	40.0	2.976	.226	.182
	Peri-urban	17.8	14.4			
	Urban	2.2	3.3			
Management system	Extensive	6.7	6.7	1.153	.562	.113
	Semi-intensive	11.1	21.1			
	Intensive	24.4	30.0			
Training	Yes	42.2[a]	5.6[b]	71.887	<0.0001	.894
	No	0.0[a]	52.2[b]			
Awareness	Yes	13.3[a]	28.9[b]	6.015	.014	.259
	No	33.3[a]	24.4[b]			

symmetric measures for nominal and numeric variables were measured using Phi- Cramer and Pearson correlation tests, respectively; alphabetical superscripts represent significant difference within levels; r=correlation coefficient.

4. Conclusion and Recommendation

This study noted excessive use of AMs for prevention, treatment, fattening and growth promotion in the studied dairy farms. In most of the study areas, drugs were easily accessible for unprescribed purchase and use. More than half of the respondents have poor knowledge about drug withdrawal periods and poor awareness concerning the health impact of AMR. A high proportion of farms contradict the recommended withdrawal period. Unrestricted veterinary drug access and high treatment cost complaint were considered as factors for unprescribed veterinary drug purchase and use. The observed irrational use of AMs may lead to the presence of VDRs which letter result in antimicrobial and anthelmintic resistance.

Therefore, unprescribed drug purchase and use should be discouraged by raising awareness among livestock producers, veterinary professionals, Para-veterinarians, and other stakeholders, on an ongoing basis regarding rational AMs use, proper application, and administration of AMs in food animals. The use of AMs outside the intended therapeutic purpose can contribute to the emergence of drug resistance. Thus, responsible authorities should begin to take action to address the non-medical use of controlled prescription drugs. This can be achieved by periodical monitoring of AMs utilization status and detection of VDR in dairy and dairy products to maintain safe milk supply and safeguard public health; enforcing punishment on indiscriminate usage. To this effect, regulatory authorities should be capacitated with modern equipment and adequately trained manpower to undertake periodical monitoring and evaluation of VDRs.

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