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Evaluation of livestock farmers' knowledge, attitudes and practices regarding the use of veterinary vaccines in Southwest Ethiopia

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Abstract

Background: The utilization of veterinary vaccines plays a vital role in preventing and managing animal diseases. However, the success of vaccination programmes relies on livestock farmers' understanding, perspectives and behaviours regarding their application. Therefore, this study aims to evaluate the knowledge, attitudes and practices of livestock farmers in Southwest Ethiopia regarding the use of veterinary vaccines.

Methods: The study followed a cross-sectional design conducted between October 2021 and October 2022. A sample of 476 livestock-owning farmers, including those who raise dairy cattle, beef cattle and poultry, were interviewed from the districts of Shei Bench, Semen Bench, Sheko and Yeki.

Results: The findings revealed that participants from Sheko, who had a poultry farm, were college graduates and resided in an urban area, were more likely to have good knowledge of veterinary vaccines. Similarly, participants who were male, from Semen Bench, had a poultry farm and had a high school education, exhibited a positive attitude towards veterinary vaccines. Furthermore, being male, from Semen Bench, having a poultry farm, and having a high school education were associated with increased veterinary vaccine use.

Conclusion: This study highlights the importance of addressing gender differences and tailoring interventions based on geography and farming conditions in the area. These measures are crucial to improve practices related to veterinary vaccines for enhanced animal health and productivity. Prioritizing education, veterinary services and information dissemination is vital. However, further research and targeted interventions are needed to better comprehend underlying factors and implement effective strategies for diverse communities in different areas.

KEYWORDS
attitudes, knowledge, livestock farmers, practices, Southwest Ethiopia, veterinary vaccination

1 | INTRODUCTION

Ethiopia's economy relies on the livestock sector, vital for agricultural gross domestic product and foreign exchange through exports of animals, meat and leather. Animal proteins, notably beef, poultry and dairy, are integral to the Ethiopian diet (Asresie & Zemedu, 2015; Behnke, 2010). Animal products hold vital nutritional, cultural and economic value in Ethiopia. Ethiopia's livestock sector is expected to expand, driven by a rising demand for animal proteins due to population growth and dietary shifts, reflecting wider trends in Africa (Balehegn et al., 2021; Enahoro et al., 2019). Livestock health is upheld via veterinary services and community providers in the country. Veterinarians are trained in one of the veterinary schools in the country, where they acquire the knowledge and skills necessary to provide care for animals. Urban areas use private veterinarians, whereas rural communities depend on local animal health care workers due to limited veterinary access (Gizaw et al., 2021). In rural areas where veterinary care is limited, livestock health depends on traditional knowledge and indigenous expertise provided by local animal health care providers (Asfaw et al., 2022).

However, Ethiopia faces livestock perils from infectious diseases like Foot-and-Mouth Disease, Newcastle Disease, Contagious Bovine Pleuropneumonia, Peste des Petits Ruminants, Anthrax, Blackleg and Infectious Bursal Disease (Duguma & Janssens, 2021; Welay et al., 2018). Tailored species-specific vaccination programmes prevent beef, poultry and dairy animals from contracting these diseases (Girma et al., 2022). Vaccination is widely recognized as a crucial tool in preventing and controlling infectious diseases in livestock. It not only improves animal welfare but also reduces production losses, increases productivity, and ensures the safety of animal-derived products for human consumption (Donadeu et al., 2019; Hoelzer et al., 2018). By identifying the advantages and drawbacks of veterinary vaccines in Southwest Ethiopia, it becomes possible to formulate targeted interventions and educational programmes. These efforts can then be designed to improve livestock vaccination coverage and general animal well-being (Girma et al., 2022).

Several previous studies have highlighted the knowledge gaps and misconceptions among livestock farmers regarding veterinary vaccines in various regions of Ethiopia. For instance, a study by Jemberu et al. (2020) in the Amhara region of Ethiopia reported low awareness and understanding of livestock diseases and vaccines among farmers, leading to inadequate vaccine utilization. Similarly, a study by Gebretnsae et al. (2022) in the northern part of the country revealed that farmers had limited knowledge about vaccination schedules, proper administration techniques and vaccine storage and handling. Furthermore, the attitudes of livestock farmers towards veterinary vaccines significantly impact their willingness to adopt vaccination practices. Barriers, such as cost, accessibility and cultural beliefs, have been identified as major factors influencing farmers' attitudes towards vaccination (Wane et al., 2020; Williams et al., 2022; Win et al., 2021). In terms of vaccination practices, studies have shown variations in the adherence to recommended vaccination schedules and administration protocols among livestock farmers in Ethiopia (Gebretnsae et al., 2022; Hopker et al., 2021). These studies highlight the need for improved training on proper vaccine handling, storage and administration techniques to ensure effective immunization coverage and minimize vaccine wastage.

In Southwest Ethiopia, where livestock rearing is a major agricultural activity (Robi et al., 2023), the use of veterinary vaccines has gained recognition as an essential intervention (Sander et al., 2020). However, the successful implementation of vaccination programmes relies not only on the availability of vaccines but also on the understanding, perspectives and behaviours of livestock farmers towards their use (Duamor et al., 2021). Understanding the level of knowledge, attitudes and practices among livestock farmers is crucial for designing and implementing effective vaccination strategies that can maximize the benefits of vaccines and ensure their sustainable utilization (Girma et al., 2022; Kansiime et al., 2015; Schat, 2014).

This study aims to evaluate the knowledge, attitudes and practices of livestock farmers in Southwest Ethiopia regarding the use of veterinary vaccines. By assessing these key factors, the research seeks to identify gaps in knowledge, potential misconceptions and barriers that hinder the optimal utilization of vaccines. The findings of this study contribute to the development of targeted interventions and educational programmes that address the specific needs and challenges faced by livestock farmers in the area.

2 | MATERIALS AND METHODS

2.1 | Study areas

The study was carried out in four districts located in the Sheka and Bench-Sheko zones situated in the Southwest region of Ethiopia. The districts included Yeki, Semen Bench, Shei Bench and Sheko (Figure 1). The Bench-Sheko and Sheka zones are located 561 and 694 km southwest of Addis Ababa, the capital of Ethiopia, respectively. The Bench-Sheko zone ranges in height from 1200 to 1959 m above sea level and has an average annual temperature of 20 and 40°C and a mean annual rainfall between 1500 and 1800 mm. The Sheka zone has elevations ranging from 1200 to 3000 m above sea level. The Sheka zone experiences an annual average temperature between 15.1 and 27.5°C and a mean annual rainfall between 1201 and 1800 mm. The zones have about 447,000 cattle, 73,700 sheep, 69,200 goats and 254,300 chickens, according to (CSA, 2021). The study areas were categorized into three agro-ecological zones based on elevation: lowland (<1500 masl), midland (1500–2300 masl) and highland (>2300 masl). Yeki was classified as lowland, Sheko as mid-altitude and Semen Bench and Shei Bench as highland. The prevalent management system in the study areas was the extensive system (crop-livestock production), followed by the semi-intensive system (urban production). The Zebu and Sheko breeds were the most common cattle breeds, followed by some Holstein-Friesian crosses. The study area also contained indigenous chicken breeds, along with some exotic breeds (Robi et al., 2023).

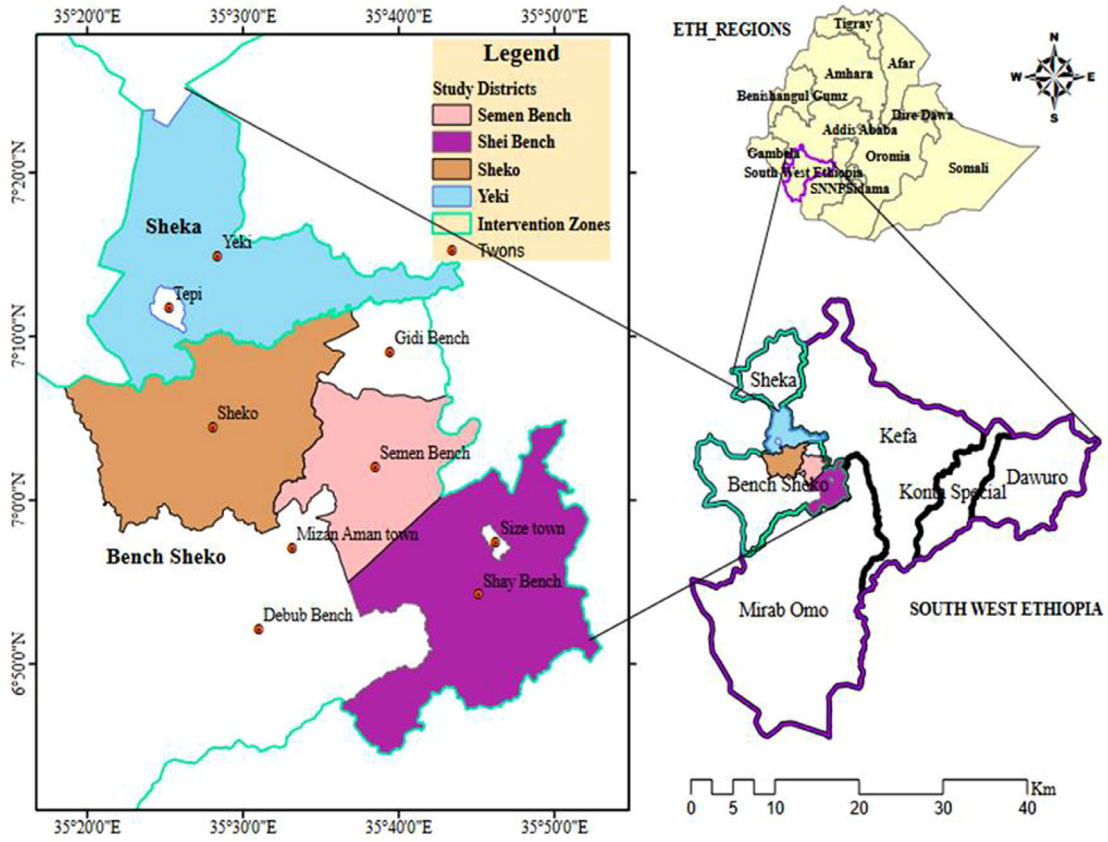

FIGURE 1 Map showing the study districts in Southwest Ethiopia.

2.2 | Study design, sampling technique and sample size determination

The research utilized a cross-sectional study design from October 2021 to October 2022. The research participants possessed various types of animals, such as dairy cattle, beef cattle and poultry. The study strictly considered participants aged 18 years and older, those responsible for controlling the well-being and health of their animals. In this study, participants were categorized into 4 age groups: 18–25-year old, 26–35-year old, 36–45-year old and 46 years and above. The study was conducted in selected zones located in Southwest Ethiopia, and the target population consisted of households that raised these animals in selected districts in the Bench-Sheko and Sheka zones.

A multistage sampling method was used for the study, starting with the zone as the highest level and proceeded down to the farmer level, with the involvement of districts, kebeles and villages in between. Four districts (Shei Bench, Semen Bench, Sheko and Yeki) were randomly selected from the Bench-Sheko and Sheka zones. From these districts, a total of 48 villages and 24 kebeles were selected using simple random sampling. At the village level, the households were then selected through a lottery method. The sample size for this study was determined using the single population proportion formula, taking into account a proportion of 50%, a margin of error of 5%, a confidence level of 95% (Thrusfeild, 2005) and a design effect of 1.24. Initially, the calculated sample size was 384. However, considering the design effect, the sample size was adjusted by multiplying it by 1.24, resulting in a final sample size of 476. Thus, a total of 476 participants were included in the study. The study methodology involved conducting in-person interviews in local languages by a trained professional.

2.3 | Method of data collection

A data collection tool was developed specifically for gathering information about participants' knowledge, attitudes and practices regarding veterinary vaccines. The tool consisted of a questionnaire with 18 items, divided into sections for knowledge (9 items), attitudes (6 items) and practices (3 items). The questionnaire covered a range of subjects concerning livestock and veterinary vaccines. These topics included the intended purpose of vaccination, vaccine costs post-vaccination management of animals, benefits, usage, seasonal considerations and the availability of veterinary vaccines. Moreover, the questionnaire also collected socio-demographic data such as age, gender, educational status, location and marital status of the study participants. The questionnaire underwent a thorough review and assessment by subject experts and the research team to ensure its content, design, validity, relevance and clarity. A pilot survey was conducted with farmers who were not a part of the study, and their feedback and suggestions

were incorporated to slightly modify the contents of the data collection tools.

The evaluation of knowledge and practice involved questions that required a simple 'Yes' or 'No' response. Attitude questions, on the other hand, employed a Likert scale with five points, ranging from 'strongly agree' to 'strongly disagree', allowing participants to express their level of agreement or disagreement with specific statements. Each 'strongly agree' and 'agree' response was assigned one point, whereas 'disagree' and 'strongly disagree' responses received zero points. If a participant responded with 'no opinion', the question was excluded from the overall score calculation for that participant. The responses for knowledge, attitude and practice questions were assessed and graded separately. The scores were then aggregated, and the mean score was computed to determine the participants' levels of knowledge, attitude and practice. The resulting mean scores were 5.6 for knowledge, 4.8 for attitude and 1.7 for practice, with an overall mean score of 10.87. Participants who scored equal to or higher than the mean value for knowledge, attitude and practice were classified as having good knowledge, a positive attitude and good practice, respectively. Conversely, participants who scored below the mean value for knowledge, attitude and practice were categorized as having poor knowledge, a negative attitude and poor practice, respectively.

2.4 | Definition and differentiation of knowledge, attitudes and practices in this study

Knowledge refers to the information, understanding and awareness that farmers possess about veterinary vaccines. It encompasses factual information, theories, techniques and best practices that farmers acquire through education, training, experience and exposure to new information. Attitudes represent the feelings, beliefs, opinions and perceptions that farmers hold regarding veterinary vaccine practices. Attitudes can be positive, negative or neutral and often stem from a combination of personal experiences, cultural influences, social norms and interactions with peers and experts. Practices refer to the actual behaviours, actions and methods that farmers employ in veterinary vaccine practices. Knowledge informs practices: Knowledge provides the information necessary for farmers to make informed decisions and choose appropriate practices.

Attitudes influence practices: Attitudes play a significant role in shaping whether farmers are willing to adopt new practices or change their existing ones. Practices reflect knowledge and attitudes: The practices that farmers implement are a combination of their acquired knowledge and their attitudes. Effective practices are those that align with both their understanding of veterinary vaccine principles and their willingness to embrace change.

2.5 | Data management and analysis

The data were categorized based on the type of information, including socio-demographic factors, knowledge, attitude and management practices. Statistical analysis was performed using IBM Corp's SPSS Ver. 20 software, which was divided into three stages. Initially, descriptive statistics, such as percentages and frequencies, were calculated for each independent variable using univariate analysis. Then, bivariate logistic regression analysis and Chi-square test were carried out to determine the association between each independent variable and the dependent variables, and only potential predictors with a p-value of less than 0.25 were considered for multivariable logistic regression analysis. Before multivariate analysis, three univariable logistic regression models were generated for each category of knowledge, attitude and practice to determine the observed level of knowledge. All significant independent variables were fitted into the univariable logistic regression model for each category to test for multicollinearity using variance inflation factors and tolerance values. Multivariable logistic regression models were then created using variables that remained significant ($p < 0.05$) upon univariable analysis. The stepwise regression method and enter algorithms were used for multivariate analysis, and independent variables with a p-value less than 0.05 were considered significant predictors of veterinary vaccine knowledge. The Hosmer–Lemeshow test and the Omnibus test were used to test the model's goodness of fit and predictability.

3 | RESULTS

3.1 | Characteristics of participants in terms of demographics

Out of the 476 participants, the male participants comprised the majority, accounting for 89.1%, whereas the female participants made up 10.9%. The age distribution of the respondents can be divided into the following categories: 2.7% were aged between 18 and 25, 22.3% were aged between 26 and 35, 44.1% were aged between 36 and 45 and 30.9% were 46 years or older. The majority (53.8%) of females participating in this study were in the age category of 36–45 years, with 23.1% of participants belonging to the age group of 26–35 years. Additionally, 23.1% of female participants were aged 46 years or older. Regarding educational status, the breakdown was as follows: 39.5% were illiterate, 45.4% had completed elementary education, 10.1% had finished high school and 5.0% were college graduates. In terms of the educational status of females, a significant proportion of the participants were illiterate (57.7%), whereas a notable portion had completed elementary education (32.7%). A smaller percentage of female participants had attained high school education (9.6%). In terms of marital status, 88.7% of the participants were married, whereas 11.3% were single. The majority of female participants were married (90.4%), with a smaller proportion being single (9.6%). The study encompassed four districts: Yeki, Semen Bench, Shei Bench and Sheko. Semen Bench had the highest representation, accounting for 28.4% of the participants, followed by Sheko with 26.9%, Shei Bench with 24.2% and Yeki with 20.6%.

TABLE 1 Types of vaccines used and their routes of administration in different farm types in Southwest Ethiopia.

Farm types	Core vaccines	Routes of administration
Beef cattle	Foot-and-Mouth Disease Vaccine	Subcutaneous injection
	Lumpy Skin Disease Vaccine	Subcutaneous injection
	Contagious Bovine Pleuropneumonia Vaccine	Subcutaneous injection
	Bovine Pasteurellosis Vaccine	Subcutaneous injection
	Anthrax Vaccine	Subcutaneous injection
	Blackleg Vaccine	Subcutaneous injection
Poultry	Newcastle Disease Vaccine	Intraocular, drinking water and intramuscular
	Infectious Bursal Disease Vaccine	Drinking water and intraocular
	Fowl Typhoid Vaccine	Subcutaneous injection
	Fowl Pox Vaccine	Wing web
	Marek's Disease Vaccine	Subcutaneous injection
Dairy cows	Anthrax Vaccine	Subcutaneous injection
	Blackleg Vaccine	Subcutaneous injection
	Foot-and-Mouth Disease Vaccine	Subcutaneous injection
	Lumpy Skin Disease Vaccine	Subcutaneous injection
	Contagious Bovine Pleuropneumonia Vaccine	Subcutaneous injection
	Bovine Pasteurellosis Vaccine	Subcutaneous injection

3.2 | Type of veterinary vaccines utilized in Southwest Ethiopia

Among the core vaccines administered to dairy cows and beef cattle in the study area, the Foot-and-Mouth Disease Vaccine, Lumpy Skin Disease Vaccine, Contagious Bovine Pleuropneumonia Vaccine, Bovine Pasteurellosis Vaccine, Anthrax Vaccine and Blackleg Vaccine have been identified. These vaccines are predominantly administered through the subcutaneous injection route. Similarly, the core vaccines in poultry farms in the study area include the Newcastle Disease Vaccine, Fowl Typhoid Vaccine, Fowl Pox Vaccine, Marek's Disease Vaccine and Infectious Bursal Disease Vaccine. The Fowl Typhoid Vaccine and Marek's Disease Vaccine are mainly administered through subcutaneous injection. The Fowl Pox Vaccine is administered through the wing web. Furthermore, the Newcastle Disease Vaccine is administered through intraocular, oral (drinking water) and intramuscular routes, whereas the Infectious Bursal Disease Vaccine is delivered via oral (drinking water) and intraocular routes (Table 1).

3.3 | Knowledge of participants and its potential factors in veterinary vaccine

A significant number of participants (60.5%) reported not having observed favourable outcomes from veterinary vaccines. The chi-square test revealed a chi-square value of 7.760 with a *p*-value of 0.005, indicating a significant association. The majority of participants (64.08%) considered animal vaccines insignificant in veterinary care. The chi-square test statistic is 17.026 with a *p*-value of 0.001, indicating a significant association between the perception that animal vaccines are insignificant in veterinary care and participants' responses (Table 2).

A relatively low proportion of participants (25.84%) acknowledged that veterinary vaccines are used to prevent diseases in animals. The results of the chi-square test demonstrate a significant association between this knowledge and the participants ($\chi^2 = 7.894$, $p = 0.019$), with statistical significance. A significant majority (64.50%) believed that other remedies were more effective than veterinary vaccines. The chi-square test result indicates a highly significant association between this perception and the participants' responses ($\chi^2 = 32.202$, $p = 0.0001$), as shown in Table 2.

A significant proportion of participants (72.69%) expressed concerns about the potential negative effects of veterinary vaccines on animals. The chi-square test ($\chi^2 = 46.492$) reveals a highly significant association ($p = 0.0001$) between this belief and the participants' responses (Table 2). The majority of participants (81.72%) had limited knowledge about veterinary vaccines. A significant portion (43.70%) mistakenly believed that veterinary vaccines were not administered at all. Furthermore, a majority (69.75%) considered them unnecessary due to the absence of recent disease outbreaks. Moreover, most participants (85.92%) believed that veterinary vaccines were designed to combat uncommon diseases. However, it is important to note that these perceptions did not have a significant impact ($p > 0.05$) on the usage of veterinary vaccines in the study area (Table 2).

The odds ratio (OR) (Exp(B)) of 2.1 suggests that males are 2.1 times more likely to have good knowledge than females. The districts of Yeki, Sheko, Semen Bench and Shei Bench all exhibit varying levels of knowledge. The ORs indicate that participants from Sheko, Semen Bench

TABLE 2 Knowledge of participants about veterinary vaccine in Southwest Ethiopia.

Variables	Categories	Frequency	Proportion (%)	Chi-square (χ^2)	*p*-Value
Are you familiar with veterinary vaccines?					
	Yes	87	18.28	0.251	0.616
	No	389	81.72		
Veterinary vaccines are not administered by anyone					
	Yes	208	43.70	0.205	0.650
	No	268	56.30		
Due to the absence of disease outbreaks in this area, veterinary vaccines are deemed unnecessary					
	Yes	332	69.75	0.885	0.347
	No	144	30.25		
There have been no favourable outcomes observed with the use of veterinary vaccines					
	Yes	288	60.5	7.760	0.005
	No	188	39.50		
Veterinary vaccines target uncommon diseases that do not impact your animals					
	Yes	409	85.92	3.030	0.0220
	No	67	14.08		
Animal vaccines were considered insignificant in veterinary care					
	Yes	305	64.08	17.026	0.001
	No	171	35.92		
Veterinary vaccines are utilized to prevent diseases in animals					
	Yes	123	25.84	7.894	0.019
	No	353	74.16		
Other remedies prove more efficacious compared to veterinary vaccines					
	Yes	307	64.50	32.202	0.0001
	No	169	35.5		
Animals can be negatively affected by veterinary vaccines					
	Yes	346	72.69	46.492	0.0001
	No	130	27.31		

and Yeki have significantly higher odds of possessing good knowledge compared to the Shei Bench district (Table 3). The ORs reveal that individual with a college education (OR = 4.1, 95% CI: 1.47–6.57), those with elementary education (OR = 7.1, 95% CI: 3.51–18.84) and those with a high school education (OR = 3.6, 95% CI: 1.71–9.11) are more likely to possess good knowledge compared to illiterate individuals. The *p*-values for all educational status categories are less than 0.05, indicating a significant association between educational status and knowledge level. Participants involved in poultry farming have higher odds (OR = 2.8, 95% CI: 1.25–6.32) of having good knowledge about veterinary vaccines compared to those in dairy farming (Table 3). The association between residence and knowledge of veterinary vaccines suggests that participants living in urban areas have higher odds (OR = 2.8, 95% CI: 1.54–5.08) of possessing good knowledge compared to those residing in rural areas (Table 3).

3.4 | Attitude of participant and its potential factors in veterinary vaccine

In terms of the accessibility of veterinary vaccines, 182 participants (38.24%) agreed that these vaccines are easily accessible, whereas 294 participants (61.76%) disagreed. The chi-square test indicates a statistically significant association ($\chi^2 = 12.576$, $p < 0.006$) between participants' attitudes towards the accessibility of veterinary vaccines and their attitudes towards using veterinary vaccines (Table 4). A significant proportion of participants (70.17%) disagreed with the notion that all vaccines are given once and provide animals with lifelong immunity. Only 19.33% of participants agreed, and 10.50% were unsure. The chi-square test revealed a highly significant association ($\chi^2 = 49.176$, $p < 0.001$) between the variables. The belief that a single vaccine type can protect animals from all diseases also demonstrated a significant

TABLE 3 Factors influencing participants' knowledge of veterinary vaccines in Southwest Ethiopia.

Variable	Category	Knowledge		COR 95% CI	AOR 95% CI	*p*-Value
		Good (%)	Poor (%)			
Gender	Male	285 (67.2)	139 (32.8)	1.2 (0.64–2.27)	2.1 (1.04–4.35)	0.025
	Female	37 (71.2)	15 (28.8)	–	–	–
Age	18–25 years	6 (46.2)	7 (53.8)	2.1 (0.66–6.48)		
	26–35 years	78 (73.6)	28 (26.4)	0.6 (0.37–1.10)		
	36–45 years	144 (68.6)	66 (31.4)	0.5 (0.52–1.27)		
	≥46 years	94 (63.9)	53 (36.1)	–		
Educational status	College graduate	105 (55.9)	83 (44.1)	4.0 (1.30–12.01)	4.1 (1.47–6.57)	0.002
	Elementary	163 (75.5)	53 (24.5)	1.6 (0.53–4.97)	7.1 (3.51–18.84)	0.001
	High school	34 (70.8)	14 (24.2)	2.1 (0.60–7.12)	3.6 (1.71–9.11)	0.001
	Illiterate	20 (83.3)	4 (16.7)	–	–	–
Marital status	Married	286 (67.8)	136 (32.2)	1.1 (0.58–1.91)		
	Single	36 (66.7)	18 (33.3)	–		
Districts	Yeki	75 (76.5)	23 (23.5)	1.4 (0.71–2.67)	3.1 (1.47–6.57)	0.003
	Sheko	90 (70.3)	72 (53.3)	1.9 (1.03–3.47)	8.1 (3.51–18.84)	0.0001
	Semen Bench	63 (46.7)	72 (53.3)	5.1 (2.86–9.15)	3.9 (1.71–9.11)	0.001
	Shei Bench	94 (81.7)	21 (18.3)	–	–	–
Type of farm	Dairy	225 (75.3)	74 (24.7)	–	–	–
	Beef	36 (87.8)	5 (12.2)	0.4 (0.16–1.12)	0.3 (0.11–0.84)	0.022
	Poultry	61 (44.9)	75 (55.1)	3.7 (2.44–5.74)	2.8 (1.25–6.32)	0.023
Residence	Rural	152 (74.1)	53 (25.9)	–	–	–
	Urban	170 (62.7)	101 (37.3)	1.7 (1.14–2.54)	2.8 (1.54–5.08)	0.001

Abbreviations: AOR, adjusted odds ratio; COR, crude odds ratio.

association with participants' attitudes ($\chi^2 = 81.630, p < 0.001$). A large proportion of participants (56.72%) disagreed with this statement, whereas 29.62% agreed (Table 4).

The cost of veterinary vaccines was another factor associated with participants' attitudes ($\chi^2 = 43.520$, $p < 0.001$). A substantial proportion of participants (50.84%) agreed that veterinary vaccines come at a high cost, whereas 32.98% disagreed. Furthermore, attitudes towards vaccinating only certain animals within a herd to achieve general protection exhibited a significant association with participants' responses ($\chi^2 = 6.544, p = 0.038$). The majority of participants (81.93%) disagreed that all herds can be adequately protected if only some animals are vaccinated, whereas only 11.97% agreed (Table 4). The responsibility for funding veterinary vaccines was found to be significantly associated with participants' attitudes ($\chi^2 = 14.224$, $p = 0.001$). The majority of participants (82.77%) disagreed that the government should assume responsibility for funding veterinary vaccines, whereas only 6.09% agreed (Table 4).

Males exhibited a positive attitude in 58.5% of cases, whereas 41.5% had a negative attitude. The crude OR (COR) indicated a potential association (COR = 1.8; 95% CI = 0.93–3.29); however, after adjusting for other variables, this association became statistically significant adjusted odds ratio (AOR = 2.3; 95% CI = 1.16–4.56, $p = 0.018$). College graduates exhibited a more positive attitude (83.3%) compared to other educational groups. This positive attitude was further supported by the COR (4.9; 95% CI = 1.61–14.87) and remained statistically significant even after adjusting for confounding variables (AOR = 3.9; 95% CI = 1.02–6.73, $p = 0.015$). Participants from different districts demonstrated varying attitudes. Notably, participants from Sheko and Semen Bench districts exhibited strong positive associations with attitudes, as indicated by high AORs of 3.1 (95% CI: 1.64–5.67) and 3.8 (95% CI: 1.42–9.97), respectively. The Yeki district also showed a significant positive association (AOR = 1.9, 95% CI: 1.02–3.73). Participants involved in dairy farming showed a positive attitude in 66.2% of cases, whereas beef and poultry farmers exhibited positive attitudes in 58.5% and 37.5% of cases, respectively. The associations remained significant after adjusting for other variables, with AORs of 0.2 (95% CI = 0.07–0.56) for beef and 3.2 (95% CI = 1.56–6.34) for poultry. Participants engaged in different types of farming exhibited varying attitudes. Participants in the beef farming category had significantly lower odds of having a positive attitude compared to dairy farmers (AOR = 0.2, 95% CI: 0.07–0.56, $p = 0.002$), whereas poultry farmers had significantly higher odds of positive attitudes (AOR = 3.2, 95% CI: 1.56–6.34, $p = 0.001$) as indicated in Table 5.

TABLE 4 Attitude of participant towards using of veterinary vaccine to control livestock disease in Southwest Ethiopia.

Variables	Categories	Frequency	Proportion (%)	Chi-square (χ^2)	*p*-Value
Veterinary vaccines are easily accessible					
	Agree	182	38.24		
	Disagree	294	61.76	12.576	0.006
	No sure	0	0		
All vaccines are given once and animals get lifelong immunity?					
	Agree	92	19.33		
	Disagree	334	70.17	49.176	0.0001
	No sure	50	10.50		
One vaccine type protects animals from all disease?					
	Agree	141	29.62		
	Disagree	270	56.72	81.630	0.0001
	No sure	65	13.66		
Veterinary vaccines come at a high cost					
	Agree	242	50.84		
	Disagree	157	32.98	43.520	0.0001
	No sure	77	16.18		
All herds can be protected if some of the animals are vaccinated and some left?					
	Agree	57	11.97		
	Disagree	390	81.93	6.544	0.038
	No sure	29	6.09		
Government should assume responsibility for funding veterinary vaccines					
	Agree	29	6.09		
	Disagree	394	82.77	14.224	0.001
	No sure	53	11.13		

3.5 | Management practice and its potential factors in veterinary vaccine

Out of the total number of participants, 146 (30.67%) responded affirmatively, indicating that they had used vaccines in their herds. Conversely, 330 participants (69.33%) reported not having used vaccines for their animals. A significant association exists between participants using vaccines and not using vaccines (χ^2 = 334.203, *p*-value = 0.0001). Among the participants, 233 (48.95%) reported vaccinating their animals at the start and end of the rainy season. A total of 118 participants (24.79%) mentioned vaccinating during the rainy season, whereas 125 participants (26.26%) indicated vaccinating during the sunny season. A statistically significant association was observed (χ^2 = 30.580, $p < 0.0001$) between the participants' vaccination practices and the seasons in which they chose to vaccinate their animals. A total of 71 participants (14.92%) reported isolating sick animals. Meanwhile, 98 participants (20.59%) mentioned revaccinating animals that became sick after vaccination. The majority of participants (64.50%), 307 in total, reported consulting veterinarians when their vaccinated animals displayed signs of disease. The chi-square test of independence was conducted on this variable (Table 6).

This result shows that males had a higher percentage of good practices compared to females (60.1% vs. 71.2% for good practices, respectively). The COR was 1.8, suggesting a moderate association, but the AOR increased to 2.3. The OR for good practices among college graduates, compared to illiterate participants, was 1.6 (95% CI: 1.42–5.82), indicating a significant association (*p*-value = 0.021). The ORs for good practices among elementary graduates and high school graduates, compared to illiterate participants, were 2.9 (95% CI: 1.97–8.91) and 2.1 (95% CI: 1.60–7.12), respectively, both demonstrating significant associations (Table 7).

The participants are from four (Yeki, Sheko, Semen Bench and Shei Bench) different districts. Yeki and Sheko districts exhibit relatively higher percentages of good practices compared to Semen Bench and Shei Bench. The adjusted ORs reveal statistically significant associations for the Yeki, Sheko and Semen Bench districts. Specifically, participants from Yeki are 1.9 times more likely to demonstrate good practices, those from Sheko are 3.1 times more likely, and participants from Semen Bench are 3.8 times more likely. The *p*-values corresponding to Yeki, Sheko and Semen Bench affirm the statistical significance of these associations (Table 7).

Participants with different types of farms (dairy, beef and poultry) exhibited varying proportions of good and poor practices. The ORs

TABLE 5 Factors influencing attitude of participant about veterinary vaccines in Southwest Ethiopia.

Variable	Category	Attitude		COR 95% CI	AOR 95% CI	*p*-Value
		Positive (%)	Negative (%)			
Gender	Male	248 (58.5)	176 (41.5)	1.8 (0.93–3.29)	2.3 (1.16–4.56)	0.018
	Female	37 (71.2)	15 (28.8)	–	–	–
Age	18–25 years	6 (46.2)	7 (53.8)	1.4 (0.44–4.23)		
	26–35 years	70 (66.0)	36 (34.0)	0.6 (0.36–1.00)		
	36–45 years	130 (61.9)	80 (38.1)	0.7 (0.47–1.10)		
	≥46 years	79 (53.7)	68 (46.3)	–		
Educational status	College graduate	20 (83.3)	4 (16.7)	4.9 (1.61–14.87)	3.9 (1.02–6.73)	0.015
	Elementary	136 (63.0)	80 (37.0)	2.9 (0.97–8.91)	3.1 (1.98–9.81)	0.025
	High school	34 (29.2)	14 (29.2)	2.1 (0.60–7.12)	2.9 (1.80–10.69)	0.014
	Illiterate	95 (50.5)	93 (49.5)	–	–	–
Marital status	Married	253 (60.0)	169 (40.0)	1.1 (0.58–1.83)		
	Single	32 (59.3)	22 (40.7)	–		
Districts	Yeki	68 (69.4)	30 (30.6)	1.1 (0.63–2.07)	1.9 (1.02–3.73)	0.035
	Sheko	81 (63.3)	47 (36.7)	1.5 (0.87–2.59)	3.1 (1.64–5.67)	0.001
	Semen Bench	53 (39.3)	82 (60.7)	4.0 (2.35–6.85)	3.8 (1.42–9.97)	0.008
	Shei Bench	83 (72.2)	32 (27.8)	–	–	–
Type of farm	Dairy	198 (66.2)	101 (33.8)	–	–	–
	Beef	24 (58.5)	17 (41.5)	0.3 (0.10–0.72)	0.2 (0.07–0.56)	0.002
	Poultry	51 (37.5)	85 (62.5)	3.3 (2.14–4.98)	3.2 (1.56–6.34)	0.001
Residence	Urban	126 (61.5)	79 (38.5)	1.1 (0.78–1.63)		
	Rural	159 (58.7)	112 (41.3)	–		

Abbreviations: AOR, adjusted odds ratio; COR, crude odds ratio.

TABLE 6 Participants practice and management of livestock disease using veterinary vaccine.

Variables	Categories	Frequency	Proportion (%)	Chi-square (χ^2)	*p*-Value
Have you ever used any vaccine in your herd?					
	Yes	146	30.67	334.203	0.0001
	No	330	69.33		
In which season of the year do vaccinate your animal?	Start and end rainy	233	48.95		
	During rain	118	24.79	30.580	0.0001
	Sunny season	125	26.26		
What do you do if animals get sick after being vaccinated?					
	Isolated	71	14.92		
	Revaccinated	98	20.59	26.056	0.0001
	Consult veterinarians	307	64.50		

indicate statistically significant associations for both beef and poultry farms. Specifically, beef farms are 0.2 times as likely to have good practices compared to dairy farms, whereas poultry farms are 3.1 times more likely to have good practices. The *p*-values for beef and poultry further support the notion that these associations are statistically significant (Table 7).

4 | DISCUSSION

In this study, the majority of participants did not observe favourable outcomes from veterinary vaccines. This perception could be due to limited access to information or misinformation about the benefits of vaccines in preventing and controlling animal diseases. Providing

TABLE 7 Factors influencing participants' practice and management veterinary vaccines in Southwest Ethiopia.

Variable	Category	Practice		COR 95% CI	AOR 95% CI	*p*-Value
		Good (%)	Poor (%)			
Gender	Male	255 (60.1)	169 (39.9)	1.8 (0.93–3.29)	2.3 (1.16–4.56)	0.018
	Female	37 (71.2)	15 (28.8)	–	–	–
Age	18–25 years	6 (46.2)	7 (53.8)	1.4 (0.44–4.23)		
	26–35 years	76 (71.7)	30 (28.3)	0.6 (0.36–1.01)		
	36–45 years	126 (60.0)	84 (40.0)	0.7 (0.47–1.10)		
	≥46 years	84 (57.1)	63 (42.9)	–		
Educational status	College graduate	100 (53.2)	88 (46.8)	4.9 (1.61–14.87)	1.6 (1.42–5.82)	0.021
	Elementary	148 (68.5)	68 (31.5)	2.9 (1.97–8.91)	3.1 (1.98–9.81)	0.031
	High school	34 (70.8)	14 (29.2)	2.1 (1.60–7.12)	2.9 (1.80–10.69)	0.014
	Illiterate	10 (41.7)	14 (58.3)	–	–	–
Marital status	Single	259 (61.4)	163 (38.6)	1.1 (0.58–1.83)		
	Married	33 (61.1)	21 (38.9)	–		
Districts	Yeki	54 (55.1)	44 (44.9)	1.1 (0.63–2.07)	1.9 (1.02–3.73)	0.035
	Sheko	86 (67.2)	42 (32.8)	1.5 (0.87–2.59)	3.1 (1.64–5.67)	0.001
	Semen Bench	58 (43.0)	77 (57.0)	4.0 (2.35–6.85)	3.8 (1.16–4.56)	0.018
	Shei Bench	94 (81.7)	21 (18.3)	–	–	–
Type of farm	Beef	36 (87.8)	5 (12.2)	0.3 (0.10–0.72)	0.2 (0.07–0.56)	0.002
	Poultry	56 (41.2)	80 (58.8)	3.3 (2.14–4.98)	3.1 (1.56–6.34)	0.001
	Dairy	200 (66.8)	99 (33.1)	–	–	–
Residence	Rural	155 (57.2)	116 (42.8)	1.1 (0.78–1.63)		
	Urban	137 (66.8)	68 (33.2)	–		

Abbreviations: AOR, adjusted odds ratio; COR, crude odds ratio.

evidence-based information on the positive outcomes of veterinary vaccines, such as reduced disease incidence and improved animal health, may help change this perception (Girma et al., 2022; Nuvey et al., 2023; Sander et al., 2020). Similarly, the majority of participants in this study indicated that animal vaccines are not significant in veterinary care. This perception may result from a lack of knowledge about the role of vaccines in preventing diseases and promoting animal health. It is crucial to emphasize the importance of vaccines as a fundamental component of veterinary care and their contribution to disease prevention and general animal well-being (Chambers et al., 2016; Meeusen et al., 2007). A statistically significant difference in knowledge among participants suggests a lack of awareness about the preventive aspects of vaccines and their role in maintaining animal health. Educating participants about the purpose and benefits of vaccination programmes can help improve their understanding and acceptance of veterinary vaccines (Lubroth et al., 2007; Williams et al., 2022).

A small percentage of participants recognized that veterinary vaccines are employed for the purpose of preventive care in animals. This perception may arise from cultural or traditional practices that are perceived to be more effective in managing animal health. However, it is essential to promote evidence-based information and scientific research demonstrating the effectiveness of veterinary vaccines in preventing and controlling diseases (Chambers et al., 2016; Sander et al., 2020). Most of the respondents also indicated that veterinary vaccines have adverse impacts on animals. This perception may stem from misconceptions or misinformation about veterinary vaccine safety. Providing accurate information about vaccine safety, potential side effects and the rigorous testing and approval processes can help address these concerns and alleviate fears (Chambers et al., 2016; Hoelzer et al., 2018).

There is a noticeable correlation between participants' attitudes towards the accessibility and use of veterinary vaccines. This association suggests that there might be challenges or barriers related to the availability or accessibility of veterinary vaccines (Williams et al., 2022). The participants' attitudes were also associated with the cost of veterinary vaccines. This finding highlights the economic considerations that individuals may consider when deciding whether to utilize veterinary vaccines, as cost can be a barrier to implementation (Donadeu et al., 2019; Williams et al., 2022). Similarly, participants' attitudes towards government responsibility for funding veterinary vaccines were found to be significantly related to their usage of these vaccines. This suggests a preference among participants for alternative funding mechanisms, potentially indicating concerns about government resources or a desire for more private-sector involvement in the provision of veterinary vaccines (Donadeu et al., 2019).

Most participants believed that animals attain lifelong immunity with a single vaccine dose. This finding suggests a lack of awareness or understanding among participants regarding the need for regular veterinary vaccination schedules and booster doses to maintain immunity in animals. This result contradicts the scientific understanding that most vaccines require booster doses to provide effective and long-lasting protection (Tuppurainen et al., 2021). The conviction that a single type of vaccine can provide immunity to animals against all diseases also displayed a significant association with the attitudes of the participants. This suggests a general understanding among participants that multiple vaccines may be necessary to protect livestock from various diseases, which could impact their perceptions of the practicality and effectiveness of vaccination programmes (Hoelzer et al., 2018). The participants' responses showed a notable association between their attitudes towards vaccinating specific animals in a herd to achieve overall protection. This implies that participants recognize the importance of comprehensive vaccination coverage for effective disease control in livestock populations (Hopker et al., 2021).

This study shows that the majority of participants are not using veterinary vaccines, and the association is statistically significant. The reason for this association could be attributed to factors such as awareness, accessibility, affordability or beliefs about the effectiveness of veterinary vaccines among the participants (Hopker et al., 2021). A significant association was also observed between the vaccination practices of the participants and their choice of animal vaccination timing, which was based on different seasons. Similar findings were also reported by Terfa et al. (2015) and Gizaw et al. (2021), indicating a significant correlation between the participants' choice of vaccination season and their practice and management of livestock diseases using veterinary vaccines. Furthermore, diverse reactions to vaccinated animals underscore the complex nature of making decisions in disease control, as a significant number of participants seek advice from veterinarians, whereas others opt for re-vaccination or isolating the animals. This disparity in opinions could stem from differences in perceived vaccine efficacy, individual experiences or levels of trust in veterinary expertise. The proportions of participants following different actions are significantly distinct, suggesting variations in their approaches to handling sick animals after vaccination, which is in agreement with the findings of Hopker et al. (2021).

Male respondents were more likely to possess a better understanding, have a positive attitude, and properly use vaccines compared to females. This could be attributed to various factors, such as differences in educational opportunities, cultural beliefs, access to information, or variations in exposure to veterinary vaccines (Acosta et al., 2022; Morris et al., 2021; Mutua et al., 2019; Omondi et al., 2022; Serra et al., 2022). Furthermore, societal expectations or traditional gender roles may result in males being more involved in animal husbandry practices, leading to increased exposure and understanding of veterinary vaccines (McKune et al., 2021). It is possible that males in Southwest Ethiopia have better access to educational resources or have more exposure to information about veterinary vaccines, thus resulting in higher knowledge levels. Previous studies have highlighted gender differences in knowledge-seeking behaviours and access to educational resources, which might explain the disparity in knowledge levels between males and females (Girma et al., 2022; Lindahl et al., 2019; Nuvey et al., 2023; Ochieng et al., 2012). The association found in this study between being male and exhibiting good practices in veterinary vaccination was consistent with the findings of studies conducted by Acosta et al. (2022), Campbell et al. (2018) and Williams et al. (2022). Furthermore, studies conducted by Colverson et al. (2020) and Serra et al. (2022) have also found that gender differences can influence attitudes and behaviours related to animal health care practices.

The educational status of participants was significantly associated with good knowledge, proper management practices and positive attitudes towards veterinary vaccines. This result suggests that higher levels of education have a positive influence on knowledge, management practices and attitudes towards veterinary vaccines. Furthermore, higher levels of education grant individual better access to information, critical thinking skills and the ability to comprehend scientific concepts. This, in turn, contributes to a higher level of knowledge, improved management practices and more positive attitudes (Amemiya et al., 2023; Tufa et al., 2023). This finding is consistent with previous studies (McKune et al., 2021; Terfa et al., 2015) that found an association between educational level and knowledge of veterinary vaccines. A study conducted by Tufa et al. (2023) in Ethiopia also highlighted the positive impact of education on veterinary practices, including vaccine management. Furthermore, studies conducted by Acosta et al. (2022) and Campbell et al. (2018) have examined the influence of education on health care practices. They have found that education can have a positive impact on knowledge and attitudes, but effecting behavioural change may necessitate additional interventions.

The present study has found that the type of farm significantly influences knowledge, attitudes and management practices towards veterinary vaccines. This variation may be attributed to differences in the level of veterinary care, the economic importance of the livestock type, knowledge about vaccine efficacy, historical experiences with disease outbreaks and variations in knowledge and experience in managing specific livestock (Morris et al., 2021; Seifu et al., 2023). This result corresponds with a study conducted by Nuvey et al. (2023), which emphasized the importance of farm type in determining the level of knowledge, attitudes and implementation of veterinary vaccination protocols. Furthermore, a study conducted by Asfaw et al. (2021) also explored the differences in health care practices across different types of farms and found that farm-specific factors, such as resources, attitudes, management practices and infrastructure, can contribute to variations in health care practices. Poultry farming might require more attention to animal health and diseases, leading to better knowledge, attitudes and management practices of veterinary vaccines (Asfaw et al., 2021). On the other hand, beef farming may involve different aspects of animal husbandry that prioritize factors other than vaccines, potentially leading to relatively poorer knowledge, negative attitudes and poor management practices of veterinary vaccines (Hafez & Attia, 2020; Nuvey et al., 2023).

The associations between different districts and the knowledge, attitudes and management practices of veterinary vaccines could be influenced by factors such as access to veterinary services,

educational programmes, cultural beliefs, differences in the prevalence of diseases affecting livestock, or awareness campaigns focused on veterinary vaccines (Kalam et al., 2022). These factors can shape the knowledge, attitudes and management practices of veterinary vaccines within the communities residing in each district (Acosta et al., 2022). In agreement with this finding, several studies (Donadeu et al., 2019; Girma et al., 2022; Smith et al., 2022) have shown that the availability and accessibility of veterinary services and educational resources are major factors influencing the knowledge, attitudes and management practices of veterinary vaccines in different locations. Moreover, variations in agricultural practices, livestock management and community engagement in each district could also contribute to differences in the knowledge, attitudes and management practices of veterinary vaccines (Gizaw et al., 2021). To provide additional support, a study conducted by Gizaw et al. (2021) in Ethiopia emphasized the influence of geographical factors on veterinary practices, knowledge and attitudes, including variations in accessibility to veterinary services and resources across different districts. Furthermore, the studies conducted by Abera et al. (2021) and Areru et al. (2022) also indicate that geographical location influences health care practices, knowledge and attitudes.

In the present study, residence has a significant influence on knowledge of veterinary vaccines. The urban–rural disparity in knowledge may be influenced by factors, such as access to educational resources, exposure to veterinary services and differences in socioeconomic status (Amemiya et al., 2023). Urban areas often have better educational facilities, including schools, libraries, health services, information dissemination channels and training programmes, which can contribute to higher levels of knowledge. Furthermore, the availability of veterinary clinics and professionals in urban areas might provide more opportunities for learning and information exchange. On the other hand, rural residents may face challenges in accessing these resources, leading to comparatively lower levels of knowledge (Morris et al., 2021; Smith et al., 2022).

It is essential to acknowledge potential limitations of this study. The cross-sectional design only offers a snapshot of the farmers' knowledge, attitudes and practices at a specific point in time. This design does not permit the establishment of causal relationships or the capturing of changes over time. Longitudinal studies would provide a more comprehensive understanding of the dynamics and changes in farmers' knowledge, attitudes and practices related to veterinary vaccines. Furthermore, factors not explored in this study might also influence farmers' perceptions and behaviours towards veterinary vaccines, warranting further investigation.

5 | CONCLUSION

This study focused on evaluating the knowledge, attitudes and practices of livestock farmers in Southwest Ethiopia regarding the use of veterinary vaccines. The results demonstrate that gender, educational status, districts and the type of farm were potential factors influencing knowledge, attitudes and management practices regarding veterinary vaccines in Southwest Ethiopia. However, residence was the only factor influencing knowledge of veterinary vaccines in the study area. This study highlights the importance of addressing gender disparities, promoting education and tailoring interventions based on geographical and farming contexts to improve knowledge, attitudes and practices related to veterinary vaccines in study area. Efforts to improve access to education, veterinary services and information dissemination may contribute to bridging the gaps and improving animal health and productivity in the area. However, further research and targeted interventions are needed to better understand the underlying factors and implement effective strategies to improve knowledge, attitudes and practices related to veterinary vaccines among diverse communities in the area.

AUTHOR CONTRIBUTIONS

Conceptualization; formal analysis; investigation; methodology and writing – original draft: Dereje Tulu Robi. *Conceptualization; data curation; formal analysis; investigation; methodology; writing – original draft; writing – review and editing*: Ararsa Bogale. *Funding acquisition; project administration; resources; software; supervision; validation; visualization; writing – review and editing*: Shiferaw Temteme. *Investigation; methodology; validation; visualization*: Melkam Aleme. *Formal analysis; funding acquisition; project administration; resources; validation; writing – review and editing*: Beksisa Urge.

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CONFLICT OF INTEREST STATEMENT

The authors claim to have no competing interests.

ETHICS STATEMENT

This study adhered to ethical standards and received approval from the research ethics committee of the Ethiopian Institute of Agricultural Research (EIAR) with reference number EIAR-2662/2010. Informed consent was obtained from all participants, guaranteeing their voluntary participation, protection of their rights and confidentiality of their data. The ethical approval and consent procedures implemented in this study demonstrate our dedication to responsible and ethical research practices, ensuring the welfare and well-being of the participants.

DATA AVAILABILITY STATEMENT

The corresponding author will provide the data used in the current study upon reasonable request.

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PEER REVIEW

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REFERENCES

Abera, A., Yirgu, T., & Uncha, A. (2021). Determinants of rural livelihood diversification strategies among Chewaka resettlers' communities of southwestern Ethiopia. *Agriculture and Food Security*, *10*, 1–19. https://doi.org/10.1186/s40066-021-00305-w

Acosta, D., Ludgate, N., McKune, S. L., & Russo, S. (2022). Who has access to livestock vaccines? Using the social-ecological model and intersectionality frameworks to identify the social barriers to peste des petits ruminants vaccines in Karamoja, Uganda. *Frontiers in Veterinary Science*, *9*, 831752. https://doi.org/10.3389/fvets.2022.831752

Amemiya, Y., Inoue, S., Maeda, K., & Nishiura, H. (2023). Epidemiological associations between rabies vaccination and dog owner characteristics. *Vaccines (Basel)*, *11*, 352. https://doi.org/10.3390/vaccines11020352

Areru, H. A., Dangisso, M. H., & Lindtjørn, B. (2022). Large local variations in the use of health services in rural southern Ethiopia: An ecological study. *PLOS Global Public Health*, *2*, e0000087. https://doi.org/10.1371/journal.pgph.0000087

Asfaw, A., Lulekal, E., Bekele, T., Debella, A., Debebe, E., & Sisay, B. (2022). Medicinal plants used to treat livestock ailments in Ensaro district, North Shewa Zone, Amhara regional state, Ethiopia. *BMC Veterinary Research*, *18*, 235. https://doi.org/10.1186/s12917-022-03320-6

Asfaw, Y. T., Ameni, G., Medhin, G., Gumi, B., & Wieland, B. (2021). Poultry health services in Ethiopia: Availability of diagnostic, clinical, and vaccination services. *Poultry Science*, *100*, 101023. https://doi.org/10.1016/j.psj.2021.101023

Asresie, A., & Zemedu, L. (2015). Contribution of livestock sector in Ethiopian economy: A review. *Advances in Life Science and Technology*, *29*, 79–90.

Balehegn, M., Kebreab, E., Tolera, A., Hunt, S., Erickson, P., Crane, T. A., & Adesogan, A. T. (2021). Livestock sustainability research in Africa with a focus on the environment. *Animal Frontiers*, *11*, 47–56. https://doi.org/10.1093/af/vfab034

Behnke, R. (2010). *The contribution of livestock to the economies of IGAD member states: Study findings, application of the methodology in Ethiopia and recommendations for further work*. IGAD Livestock Policy Initiative.

Campbell, Z. A., Marsh, T. L., Mpolya, E. A., Thumbi, S. M., & Palmer, G. H. (2018). Newcastle disease vaccine adoption by smallholder households in Tanzania: Identifying determinants and barriers. *PLoS ONE*, *13*, e0206058. https://doi.org/10.1371/journal.pone.0206058

Chambers, M. A., Graham, S. P., & La Ragione, R. M. (2016). Challenges in veterinary vaccine development and immunization. In *Methods in molecular biology* (pp. 3–35). Humana Press Inc. https://doi.org/10.1007/978-1-4939-3389-1_1

Colverson, K. E., Harris, L. C., Galie, A., Moore, E. V., Munoz, O., McKune, S. L., Singh, N., & Mo, R. (2020). Evolution of a gender tool: WEAI, WELI and livestock research. *Global Food Security*, *26*, 100375. https://doi.org/10.1016/j.gfs.2020.100375

CSA. (2021). *Livestock and livestock characteristics, agricultural survey sample*. CSA.

Donadeu, M., Nwankpa, N., Abela-Ridder, B., & Dungu, B. (2019). Strategies to increase adoption of animal vaccines by smallholder farmers with focus on neglected diseases and marginalized populations. *PLOS Neglected Tropical Diseases*, *13*, e0006989. https://doi.org/10.1371/journal.pntd.0006989

Duamor, C. T., Hampson, K., Lankester, F., Sambo, M., Kreppel, K., Wyke, S., & Cleaveland, S. (2021). Use of lay vaccinators in animal vaccination programmes: A scoping review. *PLOS Neglected Tropical Diseases*, *15*, e0009691. https://doi.org/10.1371/journal.pntd.0009691

Duguma, B., & Janssens, G. P. J. (2021). Assessment of livestock feed resources and coping strategies with dry season feed scarcity in mixed crop–livestock farming systems around the Gilgel Gibe catchment, southwest Ethiopia. *Sustainability (Switzerland)*, *13*, 10713. https://doi.org/10.3390/su131910713

Enahoro, D., Njiru, N., Thornton, P., & Staal, S. S. (2019). *A review of projections of demand and supply of livestock-derived foods and the implications for livestock sector management in LSIL focus countries. Mid-Project Research Report of the feed the future innovation lab for livestock systems (LSIL) futures foresight component, module I (Quantitative Scenario Modelling)* (CCAFS Working Paper No. 262). CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Gebretnsae, H., Hadgu, T., Ayele, B., Gebre-Egziabher, E., Woldu, M., Tilahun, M., Abraha, A., Wubayehu, T., & Medhanyie, A. A. (2022). Knowledge of vaccine handlers and status of cold chain and vaccine management in primary health care facilities of Tigray region, Northern Ethiopia: Institutional based cross-sectional study. *PLoS ONE*, *17*, e0269183. https://doi.org/10.1371/journal.pone.0269183

Girma, A., Workineh, C., Bekele, A., Tefera, D., Gelana, H., Gebisa, D., Chalchisa, T., & Pal, M. (2022). Assessment of farmers knowledge and attitude on vaccination of livestock and its implications in Ejere district of West Shewa Zone, Oromia, Ethiopia. *Acta Scientific Microbiology*, *5*, 03–11. https://doi.org/10.31080/asmi.2022.05.1170

Gizaw, S., Woldehanna, M., Anteneh, H., Ayledo, G., Awol, F., Gebreyohannes, G., Gebremedhin, B., & Wieland, B. (2021). Animal health service delivery in crop-livestock and pastoral systems in Ethiopia. *Frontiers in Veterinary Science*, *8*, 601878. https://doi.org/10.3389/fvets.2021.601878

Hafez, H. M., & Attia, Y. A. (2020). Challenges to the poultry industry: Current perspectives and strategic future after the COVID-19 outbreak. *Frontiers in Veterinary Science*, *7*, 516. https://doi.org/10.3389/fvets.2020.00516

Hoelzer, K., Bielke, L., Blake, D. P., Cox, E., Cutting, S. M., Devriendt, B., Erlacher-Vindel, E., Goossens, E., Karaca, K., Lemiere, S., Metzner, M., Raicek, M., Collell Suriñach, M., Wong, N. M., Gay, C., & Van Immerseel, F. (2018). Vaccines as alternatives to antibiotics for food producing animals. Part 1: Challenges and needs. *Veterinary Research*, *49*, 64. https://doi.org/10.1186/s13567-018-0560-8

Hopker, A., Pandey, N., Bartholomew, R., Blanton, A., Hopker, S., Dhamorikar, A., Goswami, J., Marsland, R., Metha, P., & Sargison, N. (2021). Livestock vaccination programme participation among smallholder farmers on the outskirts of National Parks and tiger reserves in the Indian states of Madhya Pradesh and Assam. *PLoS ONE*, *16*, e0256684. https://doi.org/10.1371/journal.pone.0256684

Jemberu, W. T., Molla, W., Dagnew, T., Rushton, J., & Hogeveen, H. (2020). Farmers' willingness to pay for foot and mouth disease vaccine in different cattle production systems in Amhara region of Ethiopia. *PLoS ONE*, *15*, e0239829. https://doi.org/10.1371/journal.pone.0239829

Kalam, M. A., Rahman, M. S., Alim, M. A., Shano, S., Afrose, S., Jalal, F. A., Akter, S., Khan, S. A., Islam, M. M., Uddin, M. B., Islam, A., Magalhães, R. J. S., & Hassan, M. M. (2022). Knowledge, attitudes, and common practices of livestock and poultry veterinary practitioners regarding the AMU and AMR in Bangladesh. *Antibiotics*, *11*, 80. https://doi.org/10.3390/antibiotics11010080

Kansiime, C., Atuyambe, L. M., Asiimwe, B. B., Mugisha, A., Mugisha, S., Guma, V., Rwego, I. B., & Rutebemberwa, E. (2015). Community perceptions on integrating animal vaccination and health education by veterinary and public health workers in the prevention of brucellosis among pastoral communities of south western Uganda. *PLoS ONE*, *10*, e0132206. https://doi.org/10.1371/journal.pone.0132206

Lindahl, J. F., Young, J., Wyatt, A., Young, M., Alders, R., Bagnol, B., Kibaya, A., & Grace, D. (2019). Do vaccination interventions have effects? A study on how poultry vaccination interventions change smallholder farmer

knowledge, attitudes, and practice in villages in Kenya and Tanzania. *Tropical Animal Health and Production*, *51*, 213–220. https://doi.org/10.1007/s11250-018-1679-3

Lubroth, J., Rweyemamu, M. M., Viljoen, G., Diallo, A., Dungu, B., & Amanfu, W. (2007). Veterinary vaccines and their use in developing countries. *Revue Scientifique et Technique*, *26*, 179–201.

McKune, S., Serra, R., & Touré, A. (2021). Gender and intersectional analysis of livestock vaccine value chains in Kaffrine, Senegal. *PLoS ONE*, *16*, e0252045. https://doi.org/10.1371/journal.pone.0252045

Meeusen, E. N. T., Walker, J., Peters, A., Pastoret, P. P., & Jungersen, G. (2007). Current status of veterinary vaccines. *Clinical Microbiology Reviews*, *20*(3), 489–510. https://doi.org/10.1128/CMR.00005-07

Morris, A., Wu, H., & Morales, C. (2021). Barriers to care in veterinary services: Lessons learned from low-income pet guardians' experiences at private clinics and hospitals during COVID-19. *Frontiers in Veterinary Science*, *8*, 764753. https://doi.org/10.3389/fvets.2021.764753

Mutua, E., De Haan, N., Tumusiime, D., Jost, C., & Bett, B. (2019). A qualitative study on gendered barriers to livestock vaccine uptake in Kenya and Uganda and their implications on Rift valley fever control. *Vaccines (Basel)*, *7*, 86. https://doi.org/10.3390/vaccines7030086

Nuvey, F. S., Fink, G., Hattendorf, J., Mensah, G. I., Addo, K. K., Bonfoh, B., & Zinsstag, J. (2023). Access to vaccination services for priority ruminant livestock diseases in Ghana: Barriers and determinants of service utilization by farmers. *Preventive Veterinary Medicine*, *215*, 105919. https://doi.org/10.1016/j.prevetmed.2023.105919

Ochieng, J., Owuor, G., Omedo, & Bebe, B. (2012). Determinants of adoption of management interventions in indigenous chicken production in Kenya. *African Journal of Agricultural and Resource Economics*, *7*, 1–12.

Omondi, I., Galiè, A., Teufel, N., Loriba, A., Kariuki, E., & Baltenweck, I. (2022). Women's empowerment and livestock vaccination: Evidence from peste des petits ruminants vaccination interventions in Northern Ghana. *Animals*, *12*, 717. https://doi.org/10.3390/ani12060717

Robi, D. T., Bogale, A., Urge, B., Aleme, M., & Temteme, S. (2023). Neglected zoonotic bacteria causes and associated risk factors of cattle abortion in different agro-ecological zones of southwest Ethiopia. *Veterinary Immunology and Immunopathology*, *259*, 110592. https://doi.org/10.1016/j.vetimm.2023.110592

Sander, V. A., Sánchez López, E. F., Mendoza Morales, L., Ramos Duarte, V. A., Corigliano, M. G., & Clemente, M. (2020). Use of veterinary vaccines for livestock as a strategy to control foodborne parasitic diseases. *Frontiers in Cellular and Infection Microbiology*, *10*, 288. https://doi.org/10.3389/fcimb.2020.00288

Schat, K. A. (2014). Vaccines and vaccination practices: Key to sustainable animal production. In *Encyclopedia of agriculture and food systems* (pp. 315–332). Elsevier. https://doi.org/10.1016/B978-0-444-52512-3.00189-3

Seifu, K., Muluneh, A., Getachew, Y., Jibril, Y., & Negussie, H. (2023). Epidemiological study and dairy farmers' knowledge, attitudes, and practices on foot and mouth disease in central Ethiopia. *Heliyon*, *9*, e15771. https://doi.org/10.1016/j.heliyon.2023.e15771

Serra, R., Ludgate, N., Dowhaniuk, K. F., McKune, S. L., & Russo, S. (2022). Beyond the gender of the livestock holder: Learnings from intersectional analyses of PPR vaccine value chains in Nepal, Senegal, and Uganda. *Animals*, *12*, 241. https://doi.org/10.3390/ani12030241

Smith, S. M., George, Z., Duncan, C. G., & Frey, D. M. (2022). Opportunities for expanding access to veterinary care: Lessons from COVID-19. *Frontiers in Veterinary Science*, *9*, 804794. https://doi.org/10.3389/fvets.2022.804794

Terfa, Z. G., Garikipati, S., Dessie, T., Lynch, S., Wigley, P., Bettridge, J. M., & Christley, R. M. (2015). Farmers' willingness to pay for a village poultry vaccine service in Ethiopia: Prospect for enhancing rural livelihoods. *Food Security*, *7*, 905–917. https://doi.org/10.1007/s12571-015-0482-5

Thrusfeild, M. (2005). *Veterinary epidemiology* (3rd ed.). Blackwell.

Tufa, T. B., Regassa, F., Amenu, K., Stegeman, J. A., & Hogeveen, H. (2023). Livestock producers' knowledge, attitude, and behavior (KAB) regarding antimicrobial use in Ethiopia. *Frontiers in Veterinary Science*, *10*, 1167847. https://doi.org/10.3389/fvets.2023.1167847

Tuppurainen, E., Dietze, K., Wolff, J., Bergmann, H., Beltran-alcrudo, D., Fahrion, A., Lamien, C. E., Busch, F., Sauter-louis, C., Conraths, F. J., De Clercq, K., Hoffmann, B., & Knauf, S. (2021). Review: Vaccines and vaccination against lumpy skin disease. *Vaccines (Basel)*, *9*(10), 1136. https://doi.org/10.3390/vaccines9101136

Wane, A., Dione, M., Wieland, B., Rich, K. M., Yena, A. S., & Fall, A. (2020). Willingness to vaccinate (WTV) and willingness to pay (WTP) for vaccination against peste des petits ruminants (PPR) in Mali. *Frontiers in Veterinary Science*, *6*, 488. https://doi.org/10.3389/fvets.2019.00488

Welay, G. M., Tedla, D. G., Teklu, G. G., Weldearegay, S. K., Shibeshi, M. B., Kidane, H. H., Gebrezgiabher, B. B., & Abraha, T. H. (2018). A preliminary survey of major diseases of ruminants and management practices in Western Tigray province, northern Ethiopia. *BMC Veterinary Research*, *14*(1), 293. https://doi.org/10.1186/s12917-018-1621-y

Williams, S., Endacott, I., Ekiri, A. B., Kichuki, M., Dineva, M., Galipo, E., Alexeenko, V., Alafiatayo, R., Mijten, E., Varga, G., & Cook, A. J. C. (2022). Barriers to vaccine use in small ruminants and poultry in Tanzania. *Onderstepoort Journal of Veterinary Research*, *89*(1), 2007. https://doi.org/10.4102/ojvr.v89i1.2007

Win, T. T. Z., Campbell, A., Soares Magalhaes, R. J., Oo, K. N., & Henning, J. (2021). What drives small-scale farmers to vaccinate their multiple livestock species animals against common infectious diseases in Myanmar? *PLoS ONE*, *16*, e0258765. https://doi.org/10.1371/journal.pone.0258765

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