Research Article

Effects of Social Characteristics and Perceived Vaccination Benefits on Beef Cattle Farmers Satisfaction with Foot-and-Mouth Disease Vaccination Services

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Abstract | This study aimed to identify the social factors and perceptions influencing farmers' satisfaction with foot-and-mouth disease (FMD) vaccination services. Using a survey method, data were collected from 120 beef cattle farmers who had participated in the government-led FMD vaccination programme in Sleman Regency. Multiple linear regression analysis was used to assess the determinants of satisfaction. The results showed that participation in informal education ($P < 0.01$), membership in farmer groups ($P < 0.05$), and positive perceptions of vaccination benefits ($P < 0.01$) were significant contributors to higher satisfaction levels. Farmers who actively engaged in livestock-related education, were members of organized farmer groups, and perceived the FMD vaccination as beneficial reported greater appreciation and acceptance of the programme. These findings underscore the importance of strengthening informal education, supporting farmer group networks, and improving communication about vaccination benefits to enhance the effectiveness and acceptance of animal health initiatives in rural communities.

Keywords | Animal disease, Farmer groups, FMD vaccination, Livestock vaccination, Service quality

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INTRODUCTION

Foot-and-mouth Disease (FMD) remains one of the most persistent and economically damaging livestock diseases globally (Knight-Jones and Rushton, 2013; Hopker *et al.*, 2021; Chen *et al.*, 2022), particularly in countries with large populations of smallholder farmers, such as Indonesia (BPS-Statistics, 2023). FMD affects cloven-hoofed animals, including cattle, sheep, and goats, and its highly contagious nature can cause severe production losses, market disruptions, and increased economic vulnerability among rural households that depend on livestock for their livelihoods (Blacksell *et al.*, 2019; Sugema *et al.*, 2023; Triatmojo *et al.*, 2025). In Indonesia, where livestock farming is a cornerstone of rural economies, FMD outbreaks not only threaten animal health but also destabilize food security and farmer income.

The 2022 re-emergence of FMD in Indonesia marked a critical juncture for the country's veterinary and agricultural systems. After decades of being FMD-free, Indonesia experienced a rapid resurgence of the disease, spreading swiftly across multiple provinces (Susila *et al.*, 2023). In the Special Region of Yogyakarta, Sleman Regency reported

one of the highest case numbers in the region, with over 8,000 confirmed infections recorded within a short period (Directorate General of Livestock and Animal Health, 2022). This outbreak triggered an urgent response from the government, including the implementation of strict animal movement controls, intensified surveillance efforts, and the launch of a large-scale vaccination campaign aimed at containing the outbreak and minimizing economic losses.

Although the rapid rollout of the vaccination programme was essential and commendable, its long-term success depends on more than just how many animals are vaccinated. It also relies on the acceptance, cooperation, and satisfaction of the livestock farmers. As Luo and Timothy (2017) note, the success of such programmes largely depends on how well they are implemented and received by those who use them. Farmer satisfaction is a key indicator of a programme's quality, legitimacy, and long-term sustainability (Kassem *et al*., 2021; Rouzaneh *et al*., 2021). Satisfied farmers are more likely to follow recommended practices, join future health initiatives, and encourage others in their community to do the same. In contrast, dissatisfaction can hinder participation and even lead to the programme's failure (Lopus *et al*., 2017).

A growing body of literature has explored the factors that influence farmer satisfactions and behaviors in relation to agricultural interventions. Social characteristics variables such as age, education level (both formal and informal), farming experience, herd size, and percieved of benefits have been shown to play significant roles in shaping attitudes toward agricultural technology, innovation adoption, and service satisfaction (Aydogdu and Yenigun, 2015; Idrissou *et al*., 2020; Khan *et al*., 2018; Li *et al*., 2020; Win *et al*., 2021; Zhang and Yang, 2022). Informal education, particularly through extension services and training, has been found to enhance farmer awareness and decision-making capacity, which in turn affects how they evaluate service delivery (Guntoro *et al*., 2016). Furthermore, social capital that represented by membership in farmer groups has been associated with greater access to knowledge, peer support, and participation in collective action, all of which can influence satisfaction levels (Katungi *et al*., 2007).

Despite widespread recognition of the importance of FMD control, there remains a significant research gap in understanding how social factors and farmer perceptions influence satisfaction with vaccination services, particularly during livestock health emergencies. Existing studies have largely emphasized the biological, epidemiological, financial impacts and policy dimensions of FMD control (Nampanya *et al*., 2016; Yi *et al*., 2020; Kim *et al*., 2021; Krishnaswamy *et al*., 2021). In the Indonesian context, Kedang *et al*. (2025) provided insights into the spatial-temporal distribution and risk factors of FMD outbreaks on Java Island, and Jaenudin *et al*. (2024) evaluated the policy implementation process of FMD vaccination at the institutional level. This lack of farmer-centered research creates a blind spot in policy design, as it overlooks the importance of end-user feedback in determining the success and sustainability of intervention programmes.

In the case of Sleman Regency, where the government, veterinarians, and community stakeholders are collaborating to control the outbreak, understanding the factors that drive farmer satisfaction is especially important. Gaining insights into how farmers perceive vaccination services and identifying the key factors influencing their satisfaction, can help enhance communication strategies, tailor training programs, and improve the responsiveness of veterinary interventions.

This study aims to fill an existing gap by analyzing how farmers' social characteristics and their perceptions of the benefits of FMD vaccination influence satisfaction with vaccination services during the 2022–2023 FMD campaign in Sleman Regency. The findings are expected to offer both theoretical and practical contributions. Theoretically, the study enriches the growing body of literature on farmer-centered evaluations of animal health services, particularly in emergency response contexts. Practically, it provides evidence-based insights for policymakers, veterinarians, and development practitioners to improve the design, implementation, and community acceptance of livestock vaccination programmes. By identifying the key factors that shape farmer satisfaction, this research supports the development of more inclusive, participatory, and effective animal health systems, ones that not only address outbreaks but also foster long-term trust, resilience, and collaboration within farming communities.

MATERIALS AND METHODS

This study was conducted in Sleman Regency, Daerah Istimewa Yogyakarta, which had the highest number of FMD cases, with 8,333 infected cattle and 545 deaths (Ministry of Agriculture, 2023). Primary data were collected through a structured questionnaire designed to meet the research objectives. Respondents were selected from three sub-districts most affected by the outbreak: Cangkringan, Ngaglik, and Sleman (Ministry of Agriculture, 2023). The survey was carried out from July 10 to September 20, 2023.

Sleman Regency is situated between 110° 13′ 00″ and 110° 33′ 00″ East Longitude, and between 7° 34′ 51″ and 7° 47′ 30″ South Latitude. The regency shares its northern boundary with Boyolali Regency in Central Java Province, while to the east, it borders Klaten Regency, also

in Central Java. To the west, it is adjacent to Kulon Progo Regency (Special Region of Yogyakarta) and Magelang Regency (Central Java). Meanwhile, the southern part of Sleman borders Yogyakarta City, as well as the regencies of Bantul and Gunungkidul, all within the Special Region of Yogyakarta. The administrative boundaries are illustrated in Figure 1 (Geospatial Information Agency, 2021), along with the three sub-districts most affected by the FMD outbreak.

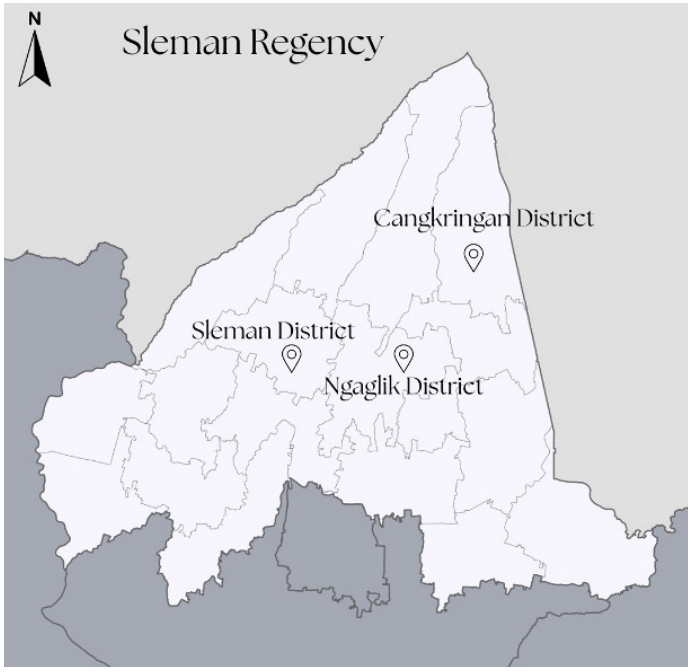

Figure 1: Map of the study area.

Sleman Regency covers a total area of 57,482 hectares or approximately 574.82 square kilometers, accounting for around 18% of the total area of the Special Region of Yogyakarta, which spans 3,185.80 square kilometers. The region extends about 32 kilometers from north to south and 35 kilometers from east to west. Administratively, Sleman is divided into 17 districts, 86 villages, and 1,212 hamlets (Sleman Regency Government, 2024).

A purposive sampling method was used, targeting beef cattle farmers who had received FMD vaccination services. Since the exact number of affected farmers in the area was unknown, the sample size followed the guidelines of Hair *et al.* (2018), which recommend 100 to 200 respondents for reliable analysis. A total of 120 farmers participated in the survey. The questionnaire, which was tested for validity and reliability, included sections on farmers' socio-demographic characteristics, their perceptions of the benefits of FMD vaccination, and their satisfaction with the services provided.

The first part of the survey gathered social characteristics information, including gender, age, level of formal and informal education, herd size, farming experience, and membership in farmer groups. The second and third sections measured perceived benefits and satisfaction, respectively, using multiple statements on a 5-point Likert scale (1= Strongly Disagree to 5= Strongly Agree). The perceived benefits construct was informed by behavioral and economic theories that emphasize how value judgments shape individual decisions and attitudes. In this context, perceived benefits refer to farmers' evaluations of the effectiveness and relevance of the FMD vaccination program. Prior studies show that perceived value is one of the most immediate factors influencing attitude formation (Li *et al.*, 2020), while perceived economic return is a key determinant of satisfaction in agricultural programs (Elias *et al.*, 2016). Furthermore, both personal and career-related benefits are positively associated with satisfaction levels (Hallmann and Zehrer, 2016). In this study, perceived benefits were operationalized into five key dimensions: (1) reduction in FMD risk, (2) compliance with policy changes, (3) financial protection, (4) adaptability to disease management innovation, and (5) long-term livestock sustainability. Integrating these dimensions allows for a more structured and predictive understanding of how perceived benefits influence farmers satisfaction through an integrated theoretical lens.

The satisfaction component of the questionnaire was adapted from the instrument developed by Syihabuddin *et al.* (2025), which operationalized the 14 public service quality principles outlined in the Minister of Administrative and Bureaucratic Reform Decree No. 63/KEP/M.PAN/7/2003 (Ministry of Administrative and Bureaucratic Reform, 2003). These principles include procedures, requirements, clarity, discipline, responsibility, competence, speed, fairness, courtesy, cost fairness, cost certainty, schedule certainty, comfort, and security. Each principle was translated into a satisfaction statement relevant to livestock vaccination services and rated by farmers using a 5-point Likert scale ranging from Very Dissatisfied (1) to Very Satisfied (5). This measurement approach ensures that the evaluation of satisfaction aligns with Indonesia's standardized benchmarks for public service delivery. However, in this study, the questionnaire is applied from a different point of view, specifically to examine how social characteristics and perceived benefits influence farmers satisfaction.

The Likert scale was used as it is one of the most widely adopted and fundamental tools for measuring attitudes in social science research (Joshi *et al.*, 2015). The data were processed using SPSS version 30.0 and Microsoft Excel 2019. To address the research objectives related to the factors influencing farmers satisfaction with FMD vaccination services, a multiple linear regression (MLR) analysis was employed. The MLR model includes a dependent variable (Y) and several independent variables (X), and can be represented as follows:

Table 1: Variable definition.

Variables	Definition
Dependent variable: Beef cattle famers' satisfaction	The evaluation of Beef cattle farmers compares the outcomes they receive with their desired expectations (likert scale).
Independent variable	
Age	Age of beef cattle farmer (years)
Formal education	Beef cattle farmer education level (1=primary school, 2=secondary school, 3=high school, 4=bachelor)
Informal education	Participation in non-formal learning activities related to livestock health, specifically FMD vaccination. It is categorised into two groups: attended vaccination training and did not attend training.
Farming experience	Years of farming experience
Cattle herd size	The total number of beef cattle owned and managed by the respondent (heads)
Farmers' group membership	The status of whether or not a beef cattle farmer is part of a farmer group (1=yes, 0=not yet)
Perceptions of vaccination benefits	Beef cattle farmers level of agreement with statements regarding the advantages of the FMD vaccination programme (likert scale)

Table 2: Social characteristics of beef cattle farmers.

No.	Variables	Percentage
1.	Age (%)	
	<15	0
	15-64	80
	>64	20
2.	Gender (%)	
	Male	95
	Female	5
3.	Formal education (%)	
	No formal education	0
	Elementary school	29.10
	Junior high school	27.50
	Senior high school	37.50
	Higher education	5.80
4.	Informal education (%)	
	Attended vaccination training	41.7
	Did not attend training	58.3
5.	Farming experience (%)	
	1-10 years	20.83
	11-20 years	45.83
	>20 years	33.33
6.	Cattle herd size (heads)	
	1-3	82.50
	4-10	17.50
	>10	0
7.	Farmer group membership (%)	
	Member of farmer group	83.3
	Not a member	16.7

Source: Primary data (2024).

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + \varepsilon$$

Where Y is the beef cattle farmers' satisfaction towards FMD vaccination services, as dependent variable, β_0 refers to as constant, X_i is the vector of independent variables such as age (X_1), formal education (X_2), informal education (X_3), farming experience (X_4), cattle herd size X_5), farmers group membership (X_6), and perceptions of vaccination benefits (X_7). βi refers to parameter estimate for the i^{th} independent variable, ε represents the error term or residual in the regression model. An explanation of the variable definitions used in this study can be seen in full in Table 1.

RESULTS AND DISCUSSION

Social characteristics of beef cattle farmers

The results of social characteristics as presented in Table 2 show that majority of respondents were male (95%) and in their productive age, with an average age of 54.47±12.74 years. Most had completed high school (37.5%), followed by elementary (29.1%) and junior high school (27.5%), with an average of 9.64±2.94 years of formal education. A majority (58.3%) had never attended training or extension programmes related to beef cattle or FMD vaccination. In terms of experience, most had farmed for 11–20 years, with an average of 20±13.19 years. The majority (82.5%) owned 1-3 cattle, with an average herd size of 2.35±1.31. Additionally, 83.33% were members of farmer groups.

Implementation of the FMD vaccination programme in Sleman Regency

The FMD vaccination initiative represents a nationwide effort by the Indonesian government to strengthen the resilience of livestock against infectious disease outbreaks. Referring to history, FMD vaccination in Indonesia successfully helped control the 1983 outbreak (Blacksell, 2019). Seven years later, in 1990, the country was officially declared FMD-free by the World Organisation for Animal Health (WOAH), highlighting the strategic role of vaccination in safeguarding livestock health and sustainability (WOAH, 2018). This preventive strategy is grounded in national regulatory frameworks, specifically Government Regulation No. 47 of 2014 concerning animal disease control, and is operationalized through the Minister of Agriculture's Decree No. 517/KPTS/PK.300/M/7/2022. This regulation updates and refines

previous guidelines to ensure effective implementation of vaccination protocols. The central aim of the programme is to provide protective immunity in cattle populations, thereby minimizing the potential for disease emergence and transmission. Previous experiences, notably during the 1986 outbreak, have demonstrated that timely and coordinated vaccination campaigns are instrumental in managing and containing FMD cases across affected regions (Directorate General of Livestock and Animal Health, 2022).

In Sleman Regency, the FMD vaccination programme was carried out successfully, meeting its initial target. Sixteen vaccination teams were deployed across the district, with each team composed of three core personnel: A veterinarian, a veterinary technician, and a data recorder. These teams operated in coordination with local Animal Health Centers (Puskeswan) and were supported on the ground by members of the military and police (Babinsa and Babinkamtibmas), ensuring both reach and safety in the vaccination process. Although some challenges arose in field data collection, temporary manual records were kept and later digitized into the national iSIKHNAS system.

The first phase of the vaccination campaign concluded on June 30, 2022, with 3,100 vaccine doses successfully administered. This achievement was the result of strong collaboration among various stakeholders. In addition to medical personnel, organizations such as the Indonesian Veterinary Medical Association (PDHI), the FMD Task Force from Gadjah Mada University, and the Indonesian Association of Animal Science Graduates (ISPI) also played key roles. The coordinated efforts between these groups reflect a multisectoral commitment to animal health in the region. Following the first phase, attention shifted to livestock health monitoring in preparation for Eid al-Adha, indicating a proactive and well-structured response.

The FMD vaccination programme, initiated by the Ministry of Agriculture in response to the 2022 outbreak, was implemented centrally through the Sleman Regency Agriculture Office and Puskeswan. Livestock cooperatives or farmer associations were not required to request vaccines independently. The vaccination was delivered in stages, beginning with a primary dose administered to all susceptible animals, followed by a second dose 4 to 5 weeks later, and a booster shot given six months after. This cycle is to be repeated every six months to maintain immunity. Vaccines were administered only to healthy, non-pregnant animals that showed no clinical signs of illness or stress. Infected animals received treatment, while clinically recovered animals were excluded from vaccination to minimize unnecessary risks and maximize coverage effectiveness among the broader livestock population (Directorate General of Livestock and Animal Health, 2022).

The implementation of the FMD vaccination programme begins with the registration of livestock and the preparation of personnel and logistics. This includes veterinarians, veterinary paramedics, syringes, personal protective equipment, and vaccines, which must be stored at a temperature between 2–8 °C. Before entering livestock facilities, all personnel and vehicles undergo biosecurity measures to prevent the spread of disease. Vaccination efforts prioritize areas with low infection rates and target healthy cattle aged two weeks and older. Pregnant cows, sick animals, or those previously infected are excluded from vaccination, with recovered cattle eligible only after six months post-recovery. The vaccination schedule requires a minimum of two doses, spaced four weeks apart, followed by booster doses every six months. Antibody development is expected within 4–7 days post-vaccination. Vaccine stock is managed using the First In, First Out (FIFO) system to ensure potency. After each vaccination session, medical waste is disinfected, used materials are incinerated, and field data is recorded to inform the planning of subsequent vaccinations (Directorate General of Livestock and Animal Health, 2022).

Table 3: Beef cattle farmers' perceptions of vaccination benefits.

No	Indicators	1	2	3	4	5	Mean	SD
1	The risk of foot and mouth disease in beef cattle is reduced through this vaccination programme.	0.00	0.00	5.83	59.17	35.00	4.291	0.571
2	Farmers are supported in adapting to changes in policies and regulations through this vaccination programme.	0.00	2.50	15.00	48.33	34.17	4.141	0.759
3	Financial challenges caused by foot and mouth disease are addressed through this vaccination programme.	0.00	2.50	11.67	50.83	35.00	4.183	0.733
4	Farmers are assisted in adapting to new innovations and disease management practices through this vaccination programme.	0.83	2.50	15.83	50.00	30.83	4.075	0.801
5	The long-term sustainability of livestock farming is supported through this vaccination programme.	0.00	0.83	5.00	62.50	31.67	4.250	0.583
	Overall perceptions						4.188	0.697

Source: Primary data (2024).

Beef cattle farmers' perceptions of vaccination benefits

The results, as presented in Table 3, indicate that the majority of beef cattle farmers had favorable perceptions of the FMD vaccination programme. Notably, 94.17% of respondents either agreed or strongly agreed with the statement that the programme helps reduce the risk of FMD disease, suggesting widespread trust in the vaccine's effectiveness. Similarly, 94.17% also believed that the programme contributes to the long-term sustainability of their livestock farming business, highlighting the perceived value of the vaccination as a long-term investment. Furthermore, 85% of farmers agreed or strongly agreed that the vaccination helps them adapt to policy and regulatory changes, while 85.83% felt it supports them in managing financial risks associated with disease outbreaks. These answers show that farmers are aware of the relevance of programmes for voyage to challenges outside the animal sector, as well as animal health. The lowest agreement was observed in the description of the vaccination programme. This helped farmers adapt to innovation and new disease management practices, with 80.83% responding positively. This remains a strong majority, but this indicates that some farmers may need more support or exposure to understand and adopt new practices introduced by the vaccination initiative.

Overall, a high percentage of contracts for all five indicators reflects strong confidence and viewing of farmers related to the benefits of the FMD vaccination programme. These positive perceptions of the vaccination's benefits are likely influenced by the ongoing support provided by animal health workers (AHWs), including veterinarians and paramedics who have built effective relationships with farmers through consistent services and field presence. This collaboration has made it easier to disseminate new information and adapt practices during the FMD outbreak.

Crucially, the success of vaccination programs also depends on effective communication. In the Indonesian context, one important aspect of FMD policy implementation is the active dissemination of information to farmers, especially smallholders. During emergencies, clear and timely communication is essential to prevent the spread of misinformation and rumors (Antari *et al*., 2024). Productive interactions between farmers and veterinarians have been shown to enhance vaccination outcomes (Hall and Wapenaar, 2012), as they enable farmers to make informed decisions about animal health and disease management.

When farmers are regularly engaged by AHWs, they gain access not only to accurate information but also to practical knowledge on disease prevention and treatment. Studies have emphasized the importance of this engagement, noting that improved communication and education significantly increase farmer awareness and adoption of animal health strategies (Athambawa *et al*., 2021; Guntoro *et al*., 2023). Therefore, strengthening farmer–AHW relationships and information flow remains key to sustaining the success of FMD vaccination programs and broader livestock development efforts.

Beef cattle farmers satisfaction of FMD vaccination

The results as presented in Table 4 show that most beef cattle farmers expressed high levels of satisfaction with various aspects of the FMD vaccination services. Across many indicators, more than 80% of respondents reported being either satisfied or very satisfied. For example, over 90% of farmers were satisfied with how officers explained information related to FMD, the way they carried out their responsibilities professionally, and how they responded to farmer complaints. Notably, 74.17% of farmers were very satisfied with how officers showed concern for livestock comfort, making this the most positively rated indicator overall.

The vaccination process itself has also received good reviews, with over 90% of those surveyed satisfied with the fairness of the treatment and courtesy of the officers, regardless of location. Cost transparency was also actively recognized, with over 90% agreeing that there were no hidden fees and the cost of vaccination was consistent. Regarding communication, 97.5% of farmers said the authorities notified them about the schedule changes and emphasized the strong clarity of the process and respect of the farmers era.

However, there were areas where there was room for improvement. Approximately 66.67% of respondents only a small amount of the way staff handled breeding cattle during vaccination. 65% were the same when using biosecurity procedures. These two indicators had the lowest satisfaction rating. This indicates that technical handling and adherence to health protocols should be strengthened in future vaccination efforts. Overall, the results show that farmers are generally satisfied with FMD vaccination services, particularly in terms of professionalism, communication, equity and comfort. It was addressed to ensure the quality and security of future programmes.

Effects of social characteristics and perceptions on beef cattle farmers satisfaction with FMD vaccination services

The data used has met the classical assumptions, including the tests for normality, multicollinearity, and heteroscedasticity. After meeting the classical assumption

Table 4: Distribution of respondents according to their satisfaction with FMD vaccination services.

No.	Indicators	Very dissatisfied (%)	Dissatisfied (%)	Slightly satisfied (%)	Satisfied (%)	Very satisfied (%)	Mean	SD
1	The procedures for providing services are designed to be easily understandable	1.67	0.00	44.17	38.33	15.83	3.667	0.803
2	The requirements for services are readily fulfilled	3.33	3.33	34.17	45.83	13.33	3.625	0.879
3	Officers utilize language and terminology that are easily comprehensible to farmers	0.00	1.67	11.67	60.83	25.83	4.108	0.658
4	Information related to FMD is communicated clearly	0.00	2.50	6.67	45.83	45.00	4.333	0.714
5	Officers execute their responsibilities with discipline and professionalism	0.00	1.67	2.50	59.17	36.67	4.308	0.605
6	Officers ensure that all farmers receive vaccination services as required	0.00	0.00	14.17	55.83	30.00	4.158	0.648
7	Officers demonstrate proficient skills in administering vaccinations	0.00	1.67	2.50	58.33	37.50	4.136	0.607
8	Officers address farmers' complaints promptly.	0.00	0.83	6.67	55.00	37.50	4.291	0.627
9	The vaccination process is conducted efficiently and without interruptions	0.00	0.83	9.17	47.50	42.50	4.316	0.673
10	Officers deliver equitable and fair treatment to all farmers	0.00	0.00	7.50	56.67	35.83	4.283	0.596
11	Officers do not discriminate based on the locations of farmers' barns	0.00	3.33	15.83	55.00	25.83	4.033	0.743
12	Officers maintain a polite and friendly demeanor towards farmers	0.00	0.00	6.67	55.00	38.33	4.316	0.593
13	There is a guarantee that no hidden fees or non-transparent vaccination rates are applied, ensuring openness	0.00	0.00	9.17	51.67	39.17	4.300	0.629
14	Cost information remains stable and is not subject to sudden changes	0.83	0.83	13.33	55.83	29.17	4.116	0.723
15	Vaccination costs are consistent throughout different FMD vaccination periods	0.00	0.83	5.00	53.33	40.83	4.341	0.614
16	Services are delivered in accordance with the predetermined schedule	0.00	0.00	9.17	60.00	30.83	4.216	0.596
17	Officers inform farmers of any alterations to the service schedule	0.00	0.00	2.50	58.33	39.17	4.366	0.533
18	Officers demonstrate a concern for the comfort of livestock	0.00	0.00	2.50	23.33	74.17	4.716	0.505
19	Officers exhibit expertise in handling livestock during the vaccination process	0.00	10.00	56.67	33.33	0.00	3.233	0.618
20	Officers adhere to biosecurity procedures during vaccinations.	1.67	2.50	65.00	30.83	0.00	3.250	0.583
	Overall Satisfaction						4.12	0.750

tests, multiple regression analysis was conducted. This involved performing the simultaneous test (F-test), the partial test (t-test), constructing the regression model, and testing the coefficient of determination. The F-test assesses the joint effect of independent variables on the dependent variable. If the significance value (Sig.) is less than 0.05, it indicates a significant simultaneous impact of the independent variables on the dependent variable. The t-test assesses each independent variable's effect on the dependent variable. If the significance value (Sig.) is less than 0.05, the variable has a significant partial effect. If the significance value (Sig.) is more than 0.05, the effect is not significant. Coefficient of determination (R^2) Test: measures how well the regression model explains the impact of independent variables on the dependent variable. The R^2 value ranges from 0 to 1; a value closer to 1 indicates a better fit, meaning the model more effectively explains the variation in the dependent variable. Adjusted

R^2 is preferred because it adjusts for the number of predictors in the model. Unlike R^2, which can artificially increase with the addition of more variables, adjusted R^2 provides a more accurate measure of model performance by penalizing the inclusion of irrelevant predictors. This adjustment ensures that the model's explanatory power is assessed more fairly, reflecting only the predictors that genuinely contribute to explaining the dependent variable. The result of the analysis can be shown in Tables 5 and 6.

Table 5: Multiple linear regression analysis (F-test).

Parameter	Sum of squares	df	Mean square	F	Sig.
Regression	1502.121	7	214.589	18.067	0.000
Residual	1330.246	109	11.877		
Total	2832.367	119			

Table 6: Multiple linear regression analysis (t-test).

Variable	Unstandardized coefficients		T	Sig.
	B	Std. Error		
(Constant)	64.185	3.461	18.545	0.000
Age (X_1)	-0.027	0.030	-0.909	0.365
Formal education (X_2)	0.019	0.119	0.159	0.874
Informal education (X_3)	2.810	0.727	3.865	0.000***
Farming experience (X_4)	0.032	0.027	1.204	0.231
Cattle herd size (X_5)	0.115	0.243	0.474	0.636
Farmers' group membership (X_6)	2.515	0.994	2.531	0.013**
Perceptions of vaccination benefits (X_7)	0.737	0.135	5.471	0.000***

Dependent Variable: Beef cattle farmers' satisfaction (Y). Significance levels: * = 10%; ** = 5%; *** = 1%

The F-test results indicated a significance value (Sig.) of 0.000, which is less than 0.05. This demonstrates that age (X_1), formal education (X_2), informal education (X_3), farming experience (X_4), cattle herd size (X_5), farmers' group membership (X_6), and perceptions of vaccination benefits (X_7) collectively have a significant influence on farmers' satisfaction with the FMD vaccination service (Y). The t-test results revealed that participation in informal education (P<0.01), farmers' groups membership (P<0.01), and farmers' perceptions of vaccination benefits (P<0.01) were significant determinants of satisfaction. The regression model based on the result can be shown as follows:

$$Y = 64{,}185 + 2{,}810X_3 + 2{,}515X_6 + 0{,}737X_7 + 3{,}461$$

The positive constant of 64.185 indicates that, when X_3, X_6, and X_7 are constant, the average farmer satisfaction (Y) is 64.185. Each unit increase in informal education (X_3) boosts satisfaction by 2.810, while each unit increase in farmers' group membership (X_6) and perceptions of vaccination benefits (X_7) increases satisfaction by 2.515 and 0.737, respectively. The regression result shows an error value of +3.461, reflecting the average difference between observed and predicted values after the influence of the independent variables is accounted for. Thus, higher values of X_3, X_6, and X_7 lead to greater farmer satisfaction. The coefficient of determination (R^2) is found to be 0.502 indicates that 50.2% of farmer satisfaction (Y) is explained by informal education (X_3), farmers' group membership (X_6), and perceptions of vaccination benefits (X_7) then 49.8% was influenced by other variables not included in the research model.

This discussion adopts a broader analytical perspective to view farmer satisfaction as a construct rooted in knowledge accessibility, community integration, and cognitive evaluation. By doing so, it frames satisfaction not simply as a customer response, but as a reflection of institutional trust, informed engagement, and collective learning (OECD, 2017).

The positive coefficient of informal education (2.810; p<0.01) reflects the strong influence of non-formal learning opportunities such as training and extension on farmers' satisfaction. In Sleman, only 41.7% of respondents had taken part in training activities. Nevertheless, participants in these sessions expressed higher levels of satisfaction, indicating that even minimal access to veterinary education can enhance farmers' capacity to evaluate and value the vaccination services provided. Informal education plays a dual role: first, in closing the knowledge gap related to livestock health and vaccination practices; and second, in empowering farmers to make informed decisions. When farmers receive accurate and accessible information, they are better equipped to evaluate the relevance and benefits of vaccination services, increasing their confidence and satisfaction. This finding supports earlier studies suggesting that informal education is not merely about transferring technical knowledge, but also about promoting behavioral change and fostering proactive engagement (Athambawa *et al.*, 2021; Kassem *et al.*, 2021; Guntoro *et al.*, 2016). Farmers who participate in such programmes are more likely to adopt health innovations, manage livestock risks, and understand the rationale behind government interventions (Ritter *et al.*, 2017). In rural areas where formal education levels may be low, informal education becomes a critical vehicle for building local capacity and bridging the science-practice gap. Thus, policymakers and veterinary service providers must expand and diversify extension programmes. These programmes should not only deliver technical content but also be tailored to the local context, using participatory and farmer-centered methods. Continuous training efforts, embedded in local agricultural calendars, can significantly enhance long-term

satisfaction and cooperation.

Equally important is the role of farmer groups, which was found to have a significant and positive effect (coefficient = 2.515; $p<0.05$) on satisfaction. In this study, 83.3% of farmers reported being part of formal livestock groups. These groups likely played an important role in helping farmers stay informed, organize the vaccination process in their communities, and share their concerns or feedback. Through regular interaction and collective engagement, these groups may have fostered a stronger sense of inclusion and support among members during the implementation of the FMD vaccination program. Farmer groups serve as vital social institutions that foster cooperation, peer learning, and collective voice. Through group membership, farmers gain access to shared knowledge, organize for better resource access, and collectively engage with government services. These groups help decentralize service delivery and increase legitimacy by integrating local actors into the implementation process. From a sociological lens, this finding resonates with theories of social capital where trust and social networks facilitate collective action and improve service outcomes (Gelderblom, 2018). Membership in farmer groups also aligns with goal attainment theory, suggesting that individuals engage in collective structures to achieve shared objectives (Kiresuk *et al*., 2014). Moreover, groups can function as critical channels for monitoring service quality, supporting the implementation of vaccination, and countering disinformation. In contexts where top-down communication may be ineffective or distrusted, peer-to-peer information becomes more persuasive and influential. Empowering and institutionalizing farmer groups can therefore lead to stronger policy acceptance and higher levels of satisfaction with veterinary interventions.

While the coefficient for farmers' perceptions of vaccination benefits (0.737; $p<0.01$) is the smallest among the three predictors, it remains statistically significant and theoretically meaningful. This variable reflects both the cognitive and emotional aspects of satisfaction, how farmers interpret, internalize, and respond to the value they perceive from the vaccination programme. Even if services are technically sound, satisfaction may still be limited if farmers do not personally recognize the practical benefits of the programme. In this study, perception was measured through several statements that capture how farmers view the broader impact of the vaccination programme. Farmers viewed the vaccination as not only reducing the risk of FMD but also helping them adjust to policy changes, manage financial risks, keep up with new practices, and support the long-term success of their farming.

These findings highlight the importance of going beyond technical explanations. Farmers are more satisfied when they understand how vaccination connects to their income, policy changes, and ability to adopt better practices. This underscores the need for clear communication and a well-informed approach before any programme is implemented (Maye *et al*., 2023). Because of this, extension workers and service providers should focus on clear, outcome-based communication. Sharing real examples, involving farmers in programme evaluation, and using trusted voices in the community can help strengthen these positive views (Hopker *et al*., 2021). Perceptions are also closely linked to expectations (De Lange *et al*., 2018). If services do not meet what farmers believe they should offer, or if benefits are not clearly communicated, dissatisfaction may follow, even when service delivery is adequate. Transparent, two-way communication and opportunities for farmers to voice their opinions can help manage expectations, build trust, and create a stronger sense of ownership (Clarke, 2003; Jakku *et al*., 2019). In turn, this reinforces satisfaction and encourages sustained participation in future government initiatives (Jia and Lin, 2025).

A key explanation for this pattern lies in the role of animal health workers (AHWs). In Sleman, AHWs are not only responsible for administering vaccinations but also regularly assist farmers through services such as artificial insemination, pregnancy checks, and routine herd monitoring. These ongoing and trusted interactions create opportunities for two-way communication and knowledge sharing. As a result, farmers, regardless of their age, formal education, farming experience or their cattle herd size, gain access to practical information, understand technical procedures more clearly, and develop positive beliefs toward veterinary services. This relationship likely reinforces their perception of direct benefits and contributes to overall satisfaction with the vaccination program.

The adjusted R^2 value of 0.502 shows that the identified factors explain a good part of farmer satisfaction, but nearly half is influenced by other factors. Even so, the findings offer useful insights. To improve satisfaction with the FMD vaccination programme, it is important to give farmers access to knowledge, strengthen local groups, and ensure that services meet farmers' expectations. Supporting informal education, farmer group participation, and clear communication can also increase trust, participation, and the long-term success of disease control efforts. In short, farmer satisfaction is not only a goal but also a sign of good service quality. When farmers feel informed, supported, and trust the programme, they are more likely to stay involved and improve livestock health.

This study has several limitations that should be taken into account. First, the research was limited to Sleman Regency, which may affect the applicability of the results to other regions with different socio-economic conditions

or institutional settings. Second, because the data were collected at one point in time, the study does not capture changes in satisfaction or perceptions that may occur across seasons or after repeated service exposure. Third, although the survey was grounded in established theoretical frameworks, the use of self-reported data introduces the possibility of bias, such as overreporting satisfaction or incomplete recall. Finally, the study emphasized farmer-level factors and did not assess institutional aspects of service delivery, such as administrative capacity, resource allocation, or stakeholder coordination. Future research could benefit from a broader geographic scope, longitudinal data, and a more integrated approach that includes both user and provider perspectives, along with an examination of stakeholder coordination in service delivery.

CONCLUSION

This study highlights that farmer satisfaction with FMD vaccination services is significantly influenced by informal education, membership in farmer groups, and farmers' perceptions of vaccination benefits. These findings suggest that satisfaction is not solely a function of technical service delivery, but also a product of knowledge accessibility, social participation, and cognitive understanding. Strengthening informal education opportunities, empowering farmer groups, and improving communication about the tangible benefits of vaccination can enhance satisfaction and foster greater trust in government-led animal health programmes. By focusing on these social and behavioral dimensions, policymakers and service providers can design more responsive and inclusive strategies that not only improve uptake but also ensure the long-term success of vaccination initiatives in rural livestock communities.

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NOVELTY STATEMENT

Theoretically, this study extends the application of public service evaluation frameworks into animal health services. Its novelty lies in adapting Indonesia's public service quality framework to assess livestock vaccination and linking it with farmers' social characteristics and perceived benefits, thereby offering a farmer-centered perspective in FMD research.

AUTHOR'S CONTRIBUTION

The contributions of the authors are as follows: the conception and design of the study were undertaken by MYS, SA, and BG; data acquisition was performed by MYS and ATA; data analysis and interpretation were conducted by MYS; the manuscript was drafted by MYS and ATA; critical review and revision were provided by SA, BG, and ARSP; and the English translation was prepared by MYS.

Generative AI and AI-assisted technology statement

In preparing this manuscript, we made use of Grammarly, DeepL, and ChatGPT to aid in grammar correction, English translation, and paraphrasing. All content generated with the assistance of these tools was carefully reviewed, verified, and revised by all authors, who collectively take full responsibility for the accuracy and integrity of the final publication

Conflict of interest

The authors have declared no conflict of interest.

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