



Evaluating Foot and Mouth Disease Vaccination Services through Assessment of Beef Cattle Farmers' Satisfaction in Sleman Regency

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ABSTRACT

The study aimed to evaluate the satisfaction of beef cattle farmers towards Foot and Mouth Disease (FMD) vaccination services in Sleman Regency. A survey method was employed, involving 120 farmers who participated in the FMD vaccination program. Beef cattle farmers' satisfaction levels were assessed using the Customer Satisfaction Index (CSI) method, which revealed that 82.25% of farmers were highly satisfied with various indicators of the vaccination services. To identify areas for improvement, the Importance-Performance Analysis (IPA) was utilized. The IPA highlighted several attributes as top priorities for performance enhancement, including: The priority indicators for performance improvement include service procedures that are easy to understand, vaccination officers not discriminating based on farm location, the handling skills of the officers, and the application of biosecurity measures according to procedures. Beef cattle farmers' perceptions of the benefits of the vaccination program were 83.8%, indicating a rating of 'very good'. These insights offer a foundation for policymakers to optimize FMD vaccination services, increase beef cattle farmers' satisfaction, and promote livestock health.

Keywords: customer satisfaction index; foot and mouth disease; importance performance analysis; vaccination services

INTRODUCTION

Foot and mouth disease (FMD) is an acute and highly contagious viral infection that affects cloven-hoofed animals. Foot and mouth disease (FMD) is caused by the foot-and-mouth disease virus (FMDV), a single-stranded positive-sense RNA virus that belongs to the genus Aphthovirus in the family Picornaviridae (Jamal & Belsham, 2013). There are seven recognized serotypes of the Foot and Mouth Disease Virus (FMDV): O, A, C, SAT 1, SAT 2, SAT 3, and Asia 1 (Jamal & Belsham, 2013; World Organization for Animal Health, 2018). Foot and mouth disease (FMD) can lead to significant economic losses, particularly for smallholder farmers in low and middle income countries (LMICs) (Thomson, 2003; Rodriguez & Grubman, 2009; Jamal & Belsham, 2013; Food and Agriculture Organization, 2017; Santos *et al.*, 2017; Adjid, 2020; Hopker *et al.*, 2021). This vulnerability arises from factors such as the close proximity of animals on neighboring farms, overcrowded markets, limited access to vaccinations, and inadequate biosecurity measures (Campbell *et al.*, 2019; Sargison, 2020; Hopker *et al.*, 2021; Win *et al.*, 2021). In Indonesia, smallholder farms account for over 90% of livestock operations (Matondang & Rusdiana, 2014; Widiati *et al.*, 2019). The effects on these households are compounded by declining incomes, increased time and

costs related to caring for sick animals, challenges in sourcing replacement livestock, and emotional distress from losing animals that are often valued as integral parts of their families (Hopker *et al.*, 2021).

Indonesia has experienced multiple outbreaks of FMD since the disease was first introduced in 1887 through the importation of cattle from the Netherlands. The last major outbreak occurred on the island of Java in 1983, which was successfully eradicated through a mass vaccination campaign. Indonesia was officially declared FMD-free in 1986 by Minister of Agriculture Decree No. 260/Kpts/TN.510/5/1986, a status later recognized by the Office International des Epizooties (OIE) in Resolution No. XI of 1990, following an evaluation by teams from the OIE, FAO/APHCA, and ASEAN (Directorate General of Livestock and Animal Health, 2022). However, in Indonesia, a new outbreak of FMD emerged in April 2022, which quickly spread across the country (Food and Agriculture Organization, 2018; World Organization for Animal Health, 2018; Directorate General of Livestock and Animal Health, 2022).

Efforts to control FMD and achieve a disease-free Indonesia require effective strategies (Directorate General of Livestock and Animal Health, 2022). Established control measures include animal destruction, outbreak tracing, quarantine, movement restric-

tions, vaccination, import/export controls, and sanitation (Kodituwakku, 2000). Vaccination is crucial for preventing large-scale epidemics, promoting herd immunity, and protecting both individual animals and populations (Rodriguez & Grubman, 2009). These initiatives enhance the prosperity and food security of rural communities in low and middle income countries (LMICs) by ensuring healthier livestock, which increases agricultural productivity and improves livelihoods (Fernando, 1969; Campbell *et al.*, 2019; Hopker *et al.*, 2021).

Despite these efforts, vaccination services often face challenges such as limited coverage, accessibility, inconsistent quality, and costs to vaccination programs (Yemeke *et al.*, 2021; Nuvey *et al.*, 2023), which hinder effective FMD control, especially among smallholders. This study addresses this gap by evaluating these services from the farmers' perspectives to identify areas for improvement. While previous studies on FMD vaccination focus mainly on epidemiological aspects (Cai *et al.*, 2014; Biswal *et al.*, 2020; Brusa *et al.*, 2023), they lack insight into farmer satisfaction and the perceived value of services, particularly in LMICs. By assessing satisfaction as a factor in program success, this study contributes a new, user-centered perspective, providing insights that could improve public health interventions for livestock. This study thus seeks to evaluate FMD vaccination services by assessing beef cattle farmers' satisfaction, identifying areas for improvement, and exploring their perceptions of the program's benefits.

METHODS

This research was conducted in Sleman Regency, Special Region of Yogyakarta, which recorded the highest number of cases, with 8,333 cattle infected and 545 dead (Ministry of Agriculture Indonesia, 2023). Primary data were collected using a structured questionnaire based on the research objectives. Respondents were selected from districts with the highest cases in the Sleman Regency, namely Cangkringan District, Ngaglik District, and Sleman District (Ministry of Agriculture Indonesia, 2023). This survey started from July 10, 2023, to September 20, 2023, to obtain data from cattle farmers during the FMD outbreak period in Sleman Regency. Data collection in this study employed a purposive sampling technique, chosen specifically to allow a targeted selection of respondents who met the criterion of being beef cattle farmers in Sleman Regency, Special Region of Yogyakarta, who had received FMD vaccination services at least once during the vaccination phase. This technique was selected to ensure that only farmers with relevant experience of the vaccination program were included, as their insights would directly relate to the study's objectives. Due to the unknown population of FMD-affected beef cattle farmers in Sleman Regency, the minimum number of respondents was chosen following the theory of Hair *et al.* (2018), where the sample size is in the range of 100 to 200 respondents to obtain more reliable results.

A total of 120 respondents were interviewed face-to-face using a structured questionnaire, which

was validated through expert review in veterinary public health and social research to ensure that items accurately represented the constructs of interest. Pearson correlation was applied to confirm internal consistency and item relationships. The questionnaire covered socio-demographic profiles, perceptions of FMD vaccination benefits, and satisfaction with vaccination services, refined based on established scales and research standards.

First, the survey collected socio-demographic profiles such as gender, age, formal education, informal education, number of livestock, farming experience, and farmer group membership. Second, farmers' perceptions of the benefits of the FMD vaccination program were evaluated with 5 statement items using 5-point Likert scale, namely 1-Strongly Disagree, 2-Disagree, 3-Undecided, 4-Agree, and 5-Strongly Agree, the Likert scale is applied as one of the most basic and frequently used psychometric tools in social science research (Joshi *et al.*, 2015). Third, farmer satisfaction was measured using the Customer Satisfaction Index (CSI) method. The Customer Satisfaction Index (CSI) is a key method for measuring satisfaction levels (customer expectation, perceived service quality, and perceived value), providing quantitative data in the form of percentage scores (Anderson & Fornell, 2000; Hsu, 2008) by applying the 5-point Likert scale starting with 1-Very Unimportant, 2-Unimportant, 3-Neutral, 4-Important, and 5-Very Important to scoring importance/expectation and 1-Very Dissatisfied, 2-Dissatisfied, 3-Neutral, 4-Satisfied, and 5-Very Satisfied to scoring performance/reality. This method follows the approach proposed by a previous study on customer satisfaction (Qazi *et al.*, 2017).

Based on the principles of service delivery outlined in the Minister of Administrative and Bureaucratic Reform Decree No. 63/KEP/M.PAN/7/2003 regarding general guidelines for public service implementation, 14 attributes have been developed as relevant, valid, and reliable components for measuring beef cattle farmers' satisfaction. These attributes, which serve as the minimum standards for evaluating the Public Satisfaction Index, include procedures, requirements, clarity, discipline, responsibility, competence, speed, fairness, courtesy, cost fairness, cost certainty, schedule certainty, comfort, and security, as detailed in Table 1. In conjunction, the Importance-Performance Analysis (IPA), as proposed by Martilla & James (1977), is used to assess the importance and performance of specific program attributes. Customer satisfaction research often examines either the importance of attributes or performance, but not both. Measuring both dimensions was suggested for a more accurate assessment (Martilla & James, 1977; Matzler *et al.*, 2003).

Data were analyzed using SPSS 25.0 and Excel 2019. To calculate the Customer Satisfaction Index (CSI), we apply the following methodological steps:

First, we determine the Mean Importance Score (MIS) and the Mean Satisfaction Score (MSS) for each indicator. The MIS reflects the average importance assigned to each indicator by respondents, calculated by summing the importance scores for a specific

Table 1. The definition of beef cattle farmers' satisfaction attributes

No	Attributes	Definition
1	Procedures	The clarity and simplicity of the steps required to obtain the service. Indicator: (1.1) The procedures for providing services are designed to be easily understandable.
2	Requirements	The ease of fulfilling the necessary conditions for receiving the service. Indicator: (2.1) The requirements for services are readily fulfilled.
3	Clarity	The effectiveness of the officers in providing clear information. Indicators: (3.1) The officers use language and terminology that are easily understandable to farmers, and information related to foot and (3.2) mouth disease (FMD) is communicated clearly.
4	Discipline	The punctuality and orderliness of officers in carrying out their duties. Indicator: (4.1) Officers execute their responsibilities with discipline and professionalism.
5	Responsibility	The accountability and reliability of officers in performing their tasks. Indicator: (5.1) Officers ensure that all farmers receive vaccination services as required.
6	Competence	The ability of officers to carry out their roles efficiently and professionally. Indicator: (6.1) Officers demonstrate proficient skills in administering vaccinations.
7	Speed	The timeliness and promptness in delivering the service. Indicators: (7.1) Officers address farmers' complaints promptly and (7.2) the vaccination process is conducted efficiently and without interruptions.
8	Fairness	Equal treatment for all recipients without discrimination. Indicators: (8.1) Officers deliver equitable and fair treatment to all farmers and (8.2) officers do not discriminate based on the locations of farmers' barns.
9	Courtesy	The politeness and positive attitude shown by officers. Indicator: (9.1) Officers maintain a polite and friendly demeanor towards farmers.
10	Cost fairness	The fairness and transparency of the costs associated with the service. Indicator or: (10.1) There is a guarantee that no hidden fees or non-transparent vaccination rates are applied, ensuring openness.
11	Cost certainty	Assurance that the fees remain fixed and clear. Indicators: (11.1) Cost information remains stable and is not subject to sudden changes and (11.2) vaccination costs are consistent throughout different FMD vaccination periods.
12	Schedule certainty	The reliability of service hours and availability. Indicators: (12.1) Services are delivered in accordance with the predetermined schedule and (12.2) officers inform farmers of any alterations to the service schedule.
13	Comfort	The physical and psychological comfort of the service setting. Indicator: (13.1) Officers demonstrate a concern for the comfort of livestock.
14	Security	The assurance that the service provided is safe from risks or harm. Indicators: (14.1) Officers exhibit expertise in handling livestock during the vaccination process and (14.2) officers adhere to biosecurity procedures during vaccinations.

indicator (n) across all respondents and dividing by the total number of respondents (Y_{ij}). Similarly, the MSS represents the average satisfaction level for each indicator, obtained by summing the satisfaction scores (X_{ij}) across respondents and dividing by n . Formally, MIS and MSS are represented as follows:

$$MIS_i = \frac{\sum_{j=1}^n Y_{ij}}{n}; MSS_i = \frac{\sum_{j=1}^n X_{ij}}{n} \quad (1)$$

Where i is the indicator being evaluated, n is the number of respondents, Y_{ij} is the importance score for indicator i given by respondent j and X_{ij} is the corresponding satisfaction score. After determining the MIS, we calculate the Weight Factor (WF) for each indicator. This factor represents the relative importance of each indicator by calculating the percentage that each indicator's MIS contributes to the sum of all MIS values across indicators and then multiplying by 100% to express it as a percentage. This calculation is expressed as:

$$WFi = \frac{MIS_i}{\sum_{k=1}^p MIS_k} \times 100\% \quad (2)$$

Where p is the total number of indicators and $\sum_{k=1}^p MIS_k$ is the sum of all MIS values. Once the WF is established, the Weight Score (WS) for each indicator is determined by multiplying its WF by the corresponding MSS. This weighted score represents the contribution of each indicator to the overall satisfaction level and is calculated as:

$$WS_i = WFi \times MSS_i \quad (3)$$

Subsequently, the Weight Total (WT) is obtained by summing the WS values of all indicators, providing an aggregate measure of satisfaction that integrates both importance and satisfaction across all indicators under consideration:

$$WT = \sum_{i=1}^p WS_i \quad (4)$$

Finally, the Customer Satisfaction Index (CSI) is calculated by dividing the Weight Total (WT) by the nominal scale used for satisfaction measurement (in this case, a 5-point Likert scale) and then multiplying by 100%. The result is a satisfaction index expressed as a percentage, ranging from 0% to 100%, providing an overall measure of satisfaction based on the

respondents' evaluations, The formula for this step is expressed as:

$$CSI = \frac{WT}{5} \times 100\% \tag{5}$$

The Importance-Performance Analysis (IPA) provides a structured approach to evaluate the relationship between the importance and satisfaction levels for each indicator, facilitating the prioritization of areas for improvement and resource allocation. The analysis is conducted by plotting the Mean Importance Score (MIS) and Mean Satisfaction Score (MSS) for each indicator on a two-dimensional graph. The horizontal axis represents satisfaction (MSS), while the vertical axis represents importance (MIS). The graph is divided into four quadrants based on the average MIS and MSS values, allowing indicators to be categorized into specific priority levels.

Quadrant I (Main Priority) contains indicators with high importance (MIS above the average) but low performance (MSS below the average). These are critical areas where performance does not meet respondents' expectations, making them the top priority for improvement. Quadrant II (Keep Up the Good Work) includes indicators of both high importance and high performance (MIS and MSS are above the average). These areas represent the strengths of the service, and their performance should be maintained to ensure continued satisfaction. Quadrant III (Low Priority) contains indicators with low importance and low performance (MIS and MSS below the average), suggesting that these areas are less concerned to respondents and may not require immediate attention. Finally, Quadrant IV (Possible Overkill) includes indicators with low importance but high performance (MIS below the average, MSS above the average). These areas indicate potential overinvestment, as the performance level exceeds respondents' expectations relative to the importance assigned to the indicators. An

explanation of the variable definitions used in this study can be seen in full in Table 2.

RESULTS

The Description of Demographic Characteristics of Beef Cattle Farmers

The socio-economic characteristics of beef cattle farmers in this study reveal several key insights. The respondents were predominantly male, comprising 95% of the sample, and primarily of productive age, with an average age of 54.47±12.74 years. On the education front, the respondents had an average of 9.64±2.94 years of formal education. The majority of respondents have completed high school (37.50% or 45 individuals), followed by elementary school graduates at 29.10% and junior high school graduates at 27.50%. Notably, 58.30% of the respondents indicated that they had not attended any training related to beef cattle farming or participated in extension programs addressing the FMD outbreak and its vaccination. In terms of farming experience, the respondents averaged 20±13.19 years, with the largest percentage (45.83%) being in the 11-20 year range. The average herd size was 2.35±1.31 cattle, and a significant majority (82.50%) owned between 1 and 3 beef cattle. Furthermore, 100 respondents, representing 83.33%, were members of farmers' groups, while 20 respondents, comprising 16.67%, had not yet joined such groups.

Customer Satisfaction Index (CSI) and Importance-Performance Analysis (IPA)

The average importance and performance scores were analyzed using the Customer Satisfaction Index (CSI) to quantify farmers' satisfaction levels with FMD vaccination services. The CSI results will then be translated into a Cartesian diagram using Importance

Table 2. Operational definition of research

No	Variables	Definition
1	Beef cattle famers' satisfaction	The evaluation of Beef cattle farmers compares the outcomes they receive with their desired expectations. In this study, the Customer Satisfaction Index (CSI) is used to measure overall Beef cattle farmers' satisfaction, encompassing an assessment based on the average scores of both importance and performance across public service indicators. The performance variable is measured using the likert scale: 1=very dissatisfied, 2=dissatisfied, 3=neutral, 4=satisfied, and 5=very satisfied. Meanwhile, the importance variable is assessed using the categories: 1=very unimportant, 2=unimportant, 3=neutral, 4=important, and 5=very important.
2	Demographic characteristics	
	Age	The age of beef cattle farmers from the date of their born to the last birthday.
	Formal education	The education of beef cattle farmers in the school (1=primary school, 2=secondary school, 3=high school, 4=bachelor).
	Informal education	The frequency that beef cattle farmers joined in training, meetings, and conference (1=yes, 0=not yet).
	Farming experience	Experience of the beef cattle farmer in the livestock business in the years.
	Cattle herd size	The number of cattle in farmer's farm.
	Farmers' group membership	The status of whether or not a beef cattle farmer is part of a livestock group (1=yes, 0=not yet).
3	Perception of the benefits of the vaccination program	Beef cattle farmers' views and understanding of the advantages gained from participating in a vaccination program (likert scale).

Performance Analysis (IPA). This analysis will provide deeper insight into how well the actual performance of FMD vaccination services meets farmers' expectations, identifying gaps between these expectations and the perceived service performance. This approach helps pinpoint both areas where the service meets expectations and those requiring improvement. The findings offer valuable guidance for both government regulators and service officers to enhance the effectiveness and relevance of future vaccination programs, ensuring they better meet farmers' needs. The CSI results are presented in Table 3, and the IPA diagram in Figure 1.

Based on Table 3, the Mean Importance Score (MIS) and Mean Satisfaction Score (MSS) for each attribute are identified. The MIS represents the average importance score for an attribute, while the MSS is the average satisfaction score for that attribute. Based on this calculation, the CSI index is 82.25%. According to the satisfaction index criteria by Irawan (2007), an index score of 82.25% falls into the "very satisfied" category.

In the Importance-Performance Analysis (IPA), Quadrant I represents the main priority area, featuring attributes that farmers consider highly important but where performance falls short of their expectations.

Table 3. Customer satisfaction index (CSI) calculation results for beef cattle farmers on the foot and mouth disease vaccination services

Code	Indicators	MIS	MSS	WF	WS
1.1	The procedures for providing services are designed to be easily understandable.	4.23	3.66	5.027	18.391
2.1	The requirements for services are readily fulfilled.	4.19	3.63	4.988	18.080
3.1	Officers utilize language and terminology that are easily comprehensible to farmers.	3.99	4.00	4.750	18.999
3.2	Information related to Foot and Mouth Disease (FMD) is communicated clearly.	4.16	4.33	4.948	21.441
4.1	Officers execute their responsibilities with discipline and professionalism.	4.29	4.31	5.107	22.001
5.1	Officers ensure that all farmers receive vaccination services as required.	4.16	4.16	4.948	20.575
6.1	Officers demonstrate proficient skills in administering vaccinations.	4.26	4.32	5.067	21.872
7.1	Officers address farmers' complaints promptly.	4.14	4.29	4.928	21.150
7.2	The vaccination process is conducted efficiently and without interruptions.	4.15	4.32	4.938	21.316
8.1	Officers deliver equitable and fair treatment to all farmers.	4.34	4.28	5.166	22.128
8.2	Officers do not discriminate based on the locations of farmers' barns.	4.31	4.03	5.126	20.677
9.1	Officers maintain a polite and friendly demeanor towards farmers.	4.26	4.32	5.067	21.872
10.1	There is a guarantee that no hidden fees or non-transparent vaccination rates are applied, ensuring openness.	4.25	4.40	5.057	22.251
11.1	Cost information remains stable and is not subject to sudden changes.	4.11	4.12	4.888	20.124
11.2	Vaccination costs are consistent throughout different FMD vaccination periods.	4.00	4.34	4.760	20.664
12.1	Services are delivered in accordance with the predetermined schedule.	4.21	4.22	5.007	21.115
12.2	Officers inform farmers of any alterations to the service schedule.	4.26	4.37	5.067	22.126
13.1	Officers demonstrate a concern for the comfort of livestock.	4.17	4.72	4.958	23.385
14.1	Officers exhibit expertise in handling livestock during the vaccination process.	4.33	3.23	5.146	16.640
14.2	Officers adhere to biosecurity procedures during vaccinations.	4.25	3.25	5.057	16.435
Weight Total					411.241

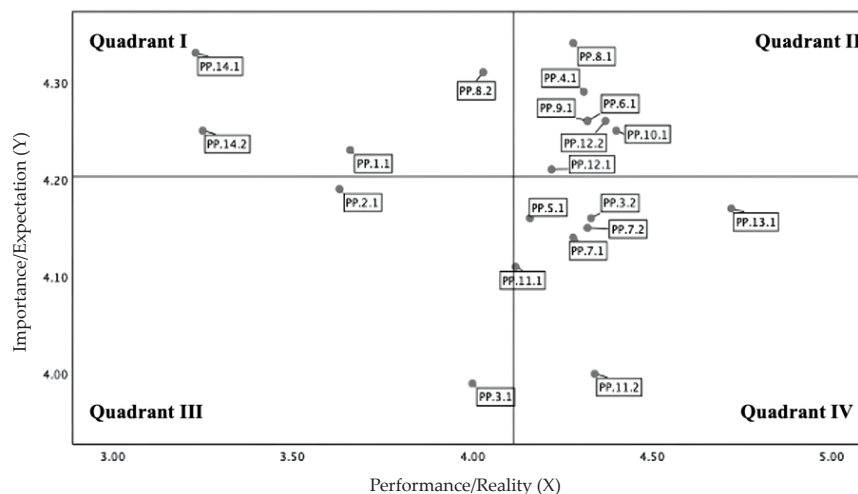


Figure 1. Importance-Performance Analysis (IPA) results of beef cattle farmers' satisfaction with foot and mouth disease vaccination services

Attributes in this quadrant require greater attention and improvement to enhance farmer satisfaction. Based on Figure 1, Quadrant I includes: “the procedures for providing services are designed to be easily understandable”, “officers do not discriminate based on the locations of farmers’ barns”, “officers exhibit expertise in handling livestock during the vaccination process”, and “officers adhere to biosecurity procedures during vaccinations.”

Beef Cattle Farmers’ Perceptions of the Benefits of the FMD Vaccination Program

Beef cattle farmers’ perceptions of the benefits of the FMD vaccination program, as detailed in Table 4 have an index score of 83.8%, indicating a “very good” rating. This positive evaluation is supported by their responses to specific statements: “I believe that this vaccination program can reduce the risk of foot and mouth disease in my beef cattle” (85.8%); “This vaccination program assists me in adapting to changes in policies and regulations related to beef cattle farming” (82.8%); “I believe that this vaccination program helps me address the financial challenges that may arise from foot and mouth disease in my beef cattle” (83.6%); “I feel that this vaccination program aids me in adapting to new innovations and practices in disease management for beef cattle” (81.6%); and “I believe that this vaccination program supports the long-term sustainability of my livestock farming business” (85%). These high ratings reflect beef cattle farmers’ strong understanding and awareness of the benefits of FMD vaccination. Their recognition of the program’s importance highlights its role in protecting livestock health, enhancing productivity, and ensuring the sustainability of their farming operations. This awareness is crucial for the successful implementation of vaccination programs and the overall health of the livestock sector.

DISCUSSION

Beef Cattle Farmers’ Satisfaction towards FMD Vaccination Services

The FMD vaccination is a national program in Indonesia designed to strengthen livestock immunity

against Foot and Mouth Disease. This initiative aligns with the Government Regulation of the Republic of Indonesia No. 47 of 2014 on the Control and Management of Animal Diseases. The implementation of the program follows the Minister of Agriculture’s Decree No. 517/KPTS/PK.300/M/7/2022, which revises the earlier Decree No. 510/KPTS/PK.300/M/6/2022 on FMD Vaccination. The primary objective of the program is to immunize cattle to prevent the onset of the disease and effectively reduce the risk of transmission between animals (Directorate General of Livestock and Animal Health, 2022). Historically, the successful implementation of FMD vaccination in Indonesia played a crucial role in controlling the 1986 outbreak (Directorate General of Livestock and Animal Health, 2022). This success underscores the strategic importance of vaccination in safeguarding the health and sustainability of the livestock sector.

This evaluation is guided by the Decree of the Minister of Administrative and Bureaucratic Reform No. 63/KEP/M.PAN/7/2003 (Ministry of Administrative and Bureaucratic Reform, 2003). According to Wijaya (2011), service quality reflects how well a service meets customer expectations. Kotler & Keller (2016) define customer satisfaction as the individual’s feelings after comparing their expectations with the actual service performance. Satisfaction arises from positive disconfirmation, which occurs when the outcomes received exceed expectations, while dissatisfaction results from negative disconfirmation, meaning that the outcomes fall short of expectations (Chen *et al.*, 2018; Nam *et al.*, 2020; Zamani & Pouloudi, 2021; Mazhar *et al.*, 2022; Zhang *et al.*, 2022). This satisfaction or dissatisfaction, as noted by Kotler and Keller (2016), can shape future behaviors and influence continued participation. The high level of satisfaction among beef cattle farmers regarding the FMD vaccination services indicates that the program effectively meets their needs and expectations. However, further analysis using the Importance-Performance Analysis (IPA) reveals several areas for improvement. Addressing these points will be essential for enhancing the overall effectiveness of the vaccination program in the future.

According to Figure 1, indicator 1.1 (the procedures for providing services are designed to be easily understandable) highlights that FMD vaccination registration is managed by farmer group leaders. These leaders are key in building trust and

Table 4. Beef cattle farmers’ perceptions on the benefit of foot and mouth disease vaccination

No	Statement	Mean	Category
1	I believe that this vaccination program can reduce the risk of foot and mouth disease in my beef cattle.	4.29	Very Good
2	This vaccination program assists me in adapting to changes in policies and regulations related to beef cattle farming.	4.14	Very Good
3	I believe that this vaccination program helps me address the financial challenges that may arise from foot and mouth disease in my beef cattle.	4.18	Very Good
4	I feel that this vaccination program aids me in adapting to new innovations and practices in disease management for beef cattle.	4.08	Very Good
5	I believe that this vaccination program supports the long-term sustainability of my livestock farming business.	4.25	Very Good
	Mean	4.19	Very Good

Note: Primary data (2024).

facilitating communication between farmers and vaccination officers, contributing to the program's success. While farmers find the socialization during group meetings clear, they feel less satisfied due to limited direct involvement in the service process. In the attribute of service fairness, there is a specific indicator requiring improvement: indicator 8.2 (Officers do not discriminate based on the locations of farmers' barns), field interviews reveal that some farmers perceive that officers prioritize barns in easily accessible locations or those closer to the Puskesmas (animal health center). The limited number of Animal Health Workers (AHWs) at each Puskesmas—typically only two (a veterinarian and a paramedic)—highlights the need for evaluation. The quantity of staff is as crucial as their quality, especially during emergencies such as an FMD outbreak when numerous complaints that should be addressed promptly are delayed. This aligns with Sa'adah *et al.* (2019), who assert that the distribution of Animal Health Workers (AHWs) within a working area should consider the number of beneficiaries and the area size to ensure equitable service delivery.

In the evaluation of the security attributes of the vaccination service, two key indicators were assessed. The first, Indicator 14.1, pertains to the skill of Animal Health Workers (AHWs) in handling livestock, which farmers have rated as insufficient. This dissatisfaction arises because farmers are often required to handle their own animals during the vaccination process. This situation is further influenced by the limited number of AHWs available, necessitating farmers' assistance in tasks that ideally should be managed by more trained personnel. The second indicator, 14.2, measures the adherence of Animal Health Workers (AHWs) to biosecurity procedures. Biosecurity refers to efforts aimed at protecting livestock and reducing the risk of disease spread that negatively impacts animals (Sari *et al.*, 2023), effective implementation of biosecurity protocols, including proper Personal Protective Equipment (PPE) usage, is critical for maintaining trust in the FMD vaccination program and ensuring the safety of livestock. Although the use of Personal Protective Equipment (PPE) by AHWs has generally been well-implemented, a significant issue is the lack of discipline in changing PPE when moving from one group of livestock to another during vaccination. This oversight has led to complaints from farmers regarding previously healthy animals becoming ill following vaccination visits. Addressing the importance of An adverse event following immunization (AEFI) is crucial for maintaining animal health and fostering farmer trust. AEFI is defined as any untoward medical occurrence following immunization which does not necessarily have a causal relationship to the vaccine (WHO, 2012). Enhancing PPE discipline and improving understanding of AEFI are essential steps toward making veterinary services more effective and secure for all stakeholders involved.

This perspective is reinforced by Athambawa *et al.* (2021), who emphasize the critical need for educating the public about the identification, transmission, and management of Foot and Mouth Disease (FMD), as

well as the benefits of vaccination. Some farmers hold misconceptions that FMD vaccines cause abortions at any stage of pregnancy, reduce milk production, or even harm the animals. They also believe that FMD does not lead to death and can be treated with antibiotics rather than vaccines. In some rural areas, traditional methods are used for treating FMD-infected animals, and the use of antibiotics during FMD outbreaks has also been documented in other developing nations (Nampanya *et al.*, 2016; Young *et al.*, 2017). To overcome these misconceptions and increase vaccine acceptance, it is crucial to implement regular training programs that address these issues and raise awareness among rural farmers (Rezvanfar, 2007).

Beef Cattle Farmers' Perceptions of the Benefits of the Vaccination Program

Beef cattle farmers generally perceive the FMD vaccination program positively, recognizing its benefits for livestock health and demonstrating strong knowledge and confidence in its effectiveness. This positive perception underscores the program's significant role in supporting livestock health, improving productivity, and ensuring farming sustainability. Animal Health Workers (AHWs), including veterinarians and paramedics, have established strong relationships with farmers through regular monitoring and service delivery, enabling a smoother adaptation to new information during the FMD outbreak. Effective communication between farmers and AHWs is critical for optimizing vaccination strategies, as it provides farmers with essential knowledge on disease prevention and treatment (Hall & Wapenaar, 2012; Qui *et al.*, 2021; Athambawa *et al.*, 2021; Guntoro *et al.*, 2023).

This study's findings align with prior research indicating that participation in livestock management training significantly enhances farmers' knowledge about FMD (Athambawa *et al.*, 2021). Access to extension services is also pivotal in technology adoption and informed decision-making. Additionally, informal education and extension services provided valuable information (Guntoro *et al.*, 2016). Extension services deliver timely and pertinent information that helps farmers address agricultural challenges and make more informed decisions about their farming practices (Qui *et al.*, 2021; Kassem *et al.*, 2021).

However, it is important to note that farmers' understanding and acceptance of FMD vaccination can be undermined by the spread of misinformation or disinformation. Broader outbreaks or pandemics often exacerbate the dissemination of disinformation, which negatively affects public trust in scientific knowledge and policy implementation (De Figueiredo *et al.*, 2020). Therefore, in addition to promoting the efficacy of vaccines, governments and stakeholders must actively counter misinformation. In this context, farmer groups can play a critical role in disseminating accurate information and providing farmers with a clear understanding of vaccination benefits. A strategic communication approach through these groups can enhance vaccine

acceptance and significantly contribute to the success of vaccination programs (Sok & Fischer, 2020).

Research has consistently shown that group activities and membership are key factors influencing farmers' engagement and commitment to their social networks (Haryadi *et al.*, 2019). Membership in such groups fosters social capital by building trust, facilitating idea exchange, and enhancing information sharing (Ganguly *et al.*, 2019). Social networks play a crucial role in agricultural innovation, as farmers share knowledge and learn from one another (Ouya *et al.*, 2022). Guntoro *et al.* (2016) also highlighted the importance of peer networks, where fellow farmers and friends are key sources of reliable information. This is consistent with the theory of goal attainment, which suggests that actions taken by individuals or groups aim to achieve objectives across interconnected systems (Kiresuk *et al.*, 2014). Consequently, the role of farmer groups is essential not only for fostering trust in the vaccination program but also for countering disinformation that could be detrimental.

CONCLUSION

This study found that beef cattle farmers' overall satisfaction with the program stands at 82.25%, reflecting a positive evaluation. Beef cattle farmers generally perceive the foot and mouth disease (FMD) vaccination program as highly beneficial, with five key indicators—confidence in vaccination effectiveness, policy and regulatory support, financial aid, adaptation to disease management innovations, and sustainability of livestock farming—being well-understood and accepted, with an overall perception rating of 83.8%. To enhance the program's effectiveness, urgent improvements in service performance are needed. Priority areas include simplifying service procedures, ensuring equitable treatment regardless of farm location, strengthening officer handling skills, and correctly applying biosecurity measures. Additionally, increasing the number of animal health workers (AHWs) is crucial for delivering timely and comprehensive services, especially during outbreaks. Further research should address access, logistical challenges, and ways to improve farmer engagement, which are essential to advancing vaccination programs and promoting sustainable agricultural practices.

CONFLICT OF INTEREST

We declare that there is no conflict of interest with financial, personal, or other relationships with other people or organizations related to the material discussed in the manuscript.

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