Perceptions and Economic Losses of Foot and Mouth Disease to Beef Cattle Farmers in Bantul Regency, Yogyakarta

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ABSTRACT

The objectives of this study were to measure the level of farmers' perceptions on psychological, socio-cultural and economic aspects, and to analyze the economic losses during foot and mouth disease (FMD) outbreaks. This study was conducted in Bantul District, Yogyakarta, during the period of July-September 2023. A total of 148 farmers affected by FMD were surveyed by a purposive sampling method using a questionnaire and the data were analyzed using the ordinal logistic regression method. The result showed that farmers' perceptions of FMD outbreaks of psychological, socio-cultural and economic attributes were in the high category. The majority of farmers experienced low economic losses (47.30%). Age and livestock ownership (p<0.01), formal education, and informal education (p<0.1) had a positive effect on the level of farmers' economic losses, while only farming experience (p<0.01) had a negative effect. Pseudo R-Square value of 33.9% or the level of economic losses, is influenced by farmers' age, farming experience, livestock ownership, as well as formal and informal education. Reaction in the field of opportunity: the highest level of economic losses in the low category is 0.997%. This study shows that FMD handling carried out by farmers is good enough to prevent the impact of large economic losses on cattle farmers in Bantul Regency.

Keywords: economic losses; foot and mouth disease; perceptions; socio-economic

INTRODUCTION

Foot and mouth disease (FMD) outbreaks are likely to have serious consequences for the livestock sector and national economy in Indonesia. FMD, a highly contagious disease of mammals, has the potential to cause severe economic losses and social impacts for farmers. FMD is a type of disease caused by type A virus from the Picornaviridae family, genus Aphthovirus, namely Aphtae epizooticae (Mutoyib *et al.*, 2023). There are seven serotypes of Foot and Mouth Disease Virus (FMDV): O, A, C, SAT 1, SAT 2, SAT 3, and Asia 1 (World Organization for Animal Health, 2018). FMD is known to be very aggressive towards beef cattle, and in Bantul District, beef cattle dominate the FMD infection rate with 92.3% of the total infected livestock (Ministry of Agriculture Indonesia, 2023).

Previous research on FMD in Bantul District highlighted the risk of Anthrax and FMD prevention practices in Yogyakarta Province (Guntoro *et al.*, 2023). The results showed that cattle farmers in Yogyakarta are vulnerable to the risks of FMD prevention practices. Several previous studies have also examined the impact of FMD on cattle farmers. Limon *et al.* (2020) estimated the socio-economic impact of FMD and control measures on farmers in Mongolia. A study by Kusumastuti *et al.* (2024) found that in terms of finances, Indonesia budgeted 0.234% of GDP, while Japan budgeted 0.018% of GDP for FMD's handling. Meanwhile, Govindaraj *et al.* (2021) evaluated the epidemiological parameters and economic costs of FMD in cattle and buffalo in India. Furthermore, Nampanya *et al.* (2015) examined the high financial impact on smallholder farmers in northern Laos, with losses focused on medical costs and losses due to mortality. Smallholder farms are very vulnerable to economic losses when disease outbreaks such as FMD occur. Research by Hussain *et al.* (2017) confirms that FMD causes financial losses on rural cattle farms, including the decreased milk production, pressure in livestock sales, weight loss, and improved feeding. While there are many studies on the socio-economic impacts of FMD, few have addressed farmers' perceptions when FMD outbreaks occur. Therefore, this study will also explore farmers' perceptions of FMD outbreaks. An investigation by Jemberu *et al.* (2014) showed that FMD outbreaks affect the perceptions of cattle farmers. Therefore, an understanding of farmers' perceptions

when FMD outbreaks occur is important as a basis for outbreak management.

The strength of this study lies in the exploration of two crucial aspects, namely, social and economic aspects. Social aspects are explored by measuring the level of perception of farmers during FMD outbreaks, while economic aspects are studied by measuring the impact of farmers' economic losses due to FMD outbreaks. The location chosen in this study was the most FMD-red or FMD-affected area in Bantul Regency. This area has the highest beef cattle slaughter rate in the Yogyakarta Special Region (DIY), which is also the centre of beef supply for Yogyakarta and surrounding provinces. The number of cattle slaughtered in Bantul Regency reached 18.111 head in a year, surpassing the other regions (Central Bureau of Statistic Yogyakarta, 2021). This area has many slaughterhouses and cattle markets, which gives farmers easy access to sell their cattle at a loss during FMD outbreaks. Therefore, FMD outbreaks must be dealt with immediately because Bantul Regency has livestock potential that greatly affects the supply of meat needs in DIY Province.

The problems encountered are how the impact of FMD on farmers' perceptions, the level of farmers' economic losses due to FMD outbreaks, and the factors of socio-economic characteristics that affect the level of economic losses due to FMD outbreaks in Bantul Regency, Yogyakarta. This study provides recommendations to the government regarding FMD management to reduce economic losses experienced by farmers.

MATERIALS AND METHODS

Study Area

Bantul Regency is one of the five regions in the Special Region of Yogyakarta (DIY) with a high level of livestock mobilization and the second-highest FMD case rate (Ministry of Agriculture Indonesia, 2023). This study was conducted in 10 villages in the Pleret sub-district, namely Demangan, Gunungan, Segoroyoso, Jembangan, Dahromo, Bawuran, Wonokromo, Pandes, Wonolelo and Jambon. Primary data were collected using a structured questionnaire based on the research objectives. Pleret sub-district was chosen because it has the highest number of FMD's in the case of the Bantul regency (Ministry of Agriculture Indonesia, 2023).

Data Collection

This survey started from July 20, 2023, to September 12, 2023, to obtain data from cattle farmers during the FMD outbreak period in Bantul District. Data collection in this study used a purposive sampling technique, according to Campbell *et al.* (2020). Cattle farmers selected as respondents were farmers whose cattle had been infected with the FMD virus.

Farmers' perceptions of FMD outbreaks were evaluated with statements using a Likert scale. The Likert scale is applied as one of the most basic and frequently used psychometric tools in social science research (Joshi *et al.*, 2015). Respondents were interviewed in depth using a structured questionnaire to collect primary data. Due to the unknown population of FMD-affected cattle farmers in Bantul Regency, the minimum number of respondents was chosen following the theory of Hair *et al.* (2021), where the sample size is 100 to 200 respondents to obtain more reliable results. Sections of the questionnaire included statements of perceptions variables, profile data of farmers' socio-economic characteristics (age, farming experience, livestock ownership, formal and non-formal education), and data on economic losses of farmers affected by FMD outbreaks.

In this study, the variables of age, farming experience, and livestock ownership used ratio data levels, so there was no data categorization for these variables. Data categorization is only used for formal education variables, where formal education 1= not educated, 2= primary school, 3= secondary school, 4= high school, 5= bachelor, and what is meant by non-formal education is 0= never received training, 1= received training.

Data Analysis

Data were analyzed using SPSS 25.0 and Excel 2019. Perception variables were measured with 29 statement items using 5 Likert scales: Strongly Disagree= 1, Disagree= 2, Undecided= 3, Agree= 4, and Strongly Agree= 5. In the research aiming to predict farmers' perceptions of FMD outbreaks using theories from previous studies, Linden (2015) combined psychological and socio-cultural aspects to predict risk perceptions of climate change. Additionally, the study by Bukuluki *et al.* (2020) used socio-cultural and economic aspects to predict the impacts of COVID-19 on global society. There are three aspects employed to estimate farmers' perceptions of FMD outbreaks: psychological, socio-cultural, and economic. Descriptive analysis was used for these data to determine the level of farmers' economic losses. The questionnaire was previously tested using a validity test with Pearson's Product Moment and a reliability test with Cronbach's Alpha. Furthermore, it was categorized into two parts, namely low (1-30) and high (31-50) categories, according to the average value score of all respondents' answers. Determination of low and high categories is based on the category interval limits obtained through the following formula:

Category interval= (maximum score - minimum score)/ Number of categories

Category interval of psychological and economic attributes: $[\{(5 \times 10) - (1 \times 10)\} / 2] = 20$

Category interval of socio-cultural attributes: $[\{(5 \times 9) - (1 \times 9)\} / 2] = 18$

Determination of low category (psychological and economic attributes)
= minimum score - (minimum score + category interval)
= 10 – (10 + 20)
= 10 – 30

Determination of low category (socio-cultural attributes)
= (minimum score – (minimum score + category interval)
= 9 – (9 + 18)
= 9 – 27

Determination of high categories for psychological and economic attributes is more than 30 and socio-cultural attributes is more than 27. In this study, beef cattle farmers were interviewed using 29 statements to explore their perceptions of the FMD outbreak: psychological (10 items), socio-cultural (9 items), and economic (10 items) (Table 1). Ordinal Logistic Regression (OLR) was used to analyze the effect of farmers' socio-economic characteristics on the level of economic losses of cattle farmers due to the FMD outbreak. Values of $p<0.05$ and $p<0.1$ were considered statistically significant. OLR is a type of logistic regression model in which the response variable has more than two categories that have levels. OLR may be useful when we analyze a categorical dependent variable as a function of one or more independent variables because the dependent variable has more than two outcomes (Lind *et al.*, 2012). OLR model is as follows:

$$Pb(y)= [\exp (\beta_0 + \beta_1 x)] / [1 + \exp (\beta_0 + \beta_1 x)]$$

The OLR function consists of y (dependent variable with y = 1, 2, 3, …, J) and x (independent variable), β_0 (intercept parameter) and β_1 (regression parameter). Pb is the probability level of economic losses and can be illustrated as follows:

$$\text{Logit } [Pb(Y{\le}j)]= \beta_0 + \beta_1 X1 + \beta_2 X2 + ... + \beta_n Xn, j= 1,2,3,..., J-1$$

Where Pb(Y=j) was the probability of the dependent variable, β is the intercept ($\beta_1 \le \beta_2 \le \beta_3 \le ... \le \beta_{j-1}$), and β_n was the vector of independent variables X1= age, X2= experience, X3= livestock ownership, X4= formal education, and X5= informal education.

OLR showed the effect of several independent variables (age, farming experience, livestock ownership, formal education, and informal education) on the dependent variable of economic loss level. In this study, the economic losses of farmers are determined based on intervals into 3 levels (low, moderate, and high), as presented in Table 2. The relationship between farmers' socio-economic characteristics and the level of economic losses was explored through OLR. Socio-economic characteristics were modeled as a demographic factor that impacts the level of farmers' economic losses during an FMD outbreak. The level of economic losses is believed to change in a certain proportion with a one-unit increase in the independent variables. An increase in farming experience is expected to reduce the level of economic losses of farmers. In addition, during an FMD outbreak, farmers face more constraints when they own more cows.

RESULTS

Description of Characteristics of Cattle Farmers

The socio-economic characteristics of cattle farmers include gender, age, type of work, farming experience,

Table 1. Beef cattle farmers' perceptions of foot and mouth disease outbreaks

Psychological	Socio-culture	Economic
You feel prepared when news emerges about the entry of foot and mouth disease (FMD) into Indonesia	The FMD outbreak has increased the spirit of cooperation among farmers and within livestock groups	The onset of the FMD outbreak caused you economic losses
When a livestock is infected with the FMD virus, you are worried that all livestock could be infected	When livestock mortality from FMD, there is often a gathering of material assistance from fellow farmers	During an FMD outbreak, there are additional costs such as prevention, treatment, and care costs
You realize that FMD is a dangerous and contagious disease	With an FMD outbreak, each livestock group and farmer coordinates intensively in handling this problem	The additional cost of FMD prevention or treatment puts a financial burden on you
The government's vaccination program makes you feel more at ease in dealing with FMD outbreaks	If livestock are suspected of FMD, farmers will usually seek treatment at local veterinary facilities	FMD-affected livestock experience reduced productivity
You feel anxious because there is a possibility that your livestock could contract the FMD virus again at any time	With the emergence of FMD outbreaks, new SOPs for prevention and treatment have emerged that must be followed by all farmers and livestock group members	FMD-affected livestock have decreased selling prices
Although the FMD outbreak is not over yet, you are still motivated to continue raising livestock	Farmers use traditional medicine such as jamu to treat sick livestock	Despite the FMD outbreak, income from the livestock business is still reliable
You believe that with good management, livestock can be protected from FMD	There is regular checking and monitoring by the office or Puskeswan of farmers' pens	You will continue to vaccinate your livestock against FMD if the government provides a paid vaccine
As long as the FMD outbreak is still ongoing, you are still worried about raising livestock	When there are FMD infected livestock, farmers report them to the nearest Puskeswan	FMD effects on increasing calf mortality
When livestock are infected with the FMD virus, your mind becomes stressed	Farmers vaccinate their livestock to prevent FMD transmission	When FMD spreads, feed costs increase
You are satisfied with the FMD management policy implemented by the government		There is a decrease in livestock sales after an FMD outbreak

scale of livestock ownership, formal and informal education, showing that male farmers reach 97.97% dominated by productive age farmers with an average age of 54 years, and the majority have elementary school education. There are 43.92% of farmers in this study who have high farming experience in raising beef cattle, which is above 30 years. The scale of livestock ownership of cattle farmers shows that 55.40% have a small-scale farming business of less than 4 heads, with the dominance of the Simpo cattle breed. The majority of 34.46% of farmers have jobs as off-farm laborers. Formal education attained by farmers 47.97% had completed elementary school, and 6.08% of farmers had completed undergraduate education. Most farmers (66.89%) stated that they had not participated in any training related to beef cattle farming.

Impact of FMD Outbreak on Beef Cattle Farmers in Bantul District

The occurrence of FMD outbreaks has a major impact on the social and economic aspects of beef cattle farmers. Most farmers stated that FMD outbreaks are a serious obstacle on their farms that can cause a decrease in the productivity of beef cattle, decreased milk production, increased calf mortality, and the risk of livestock mortality. These problems certainly affect the psychological, socio-cultural, and economic conditions of beef cattle farmers (Table 2). There are several variables of beef cattle farmer characteristics that affect the handling of FMD outbreaks. The dominance of old farmers, the low experience of farmers in dealing with outbreak status, the level of livestock ownership, and the level of formal and non-formal education are factors that concern farmers in dealing with FMD outbreak status and determine the economic losses caused by FMD outbreaks.

Perception Level of Cattle Farmers Towards FMD Outbreak

This research covers the psychological aspect, which focuses on the mental and emotional state of farmers, as well as how they respond to certain events. The statement items of psychological aspects that stood out were "as long as the FMD outbreak has not ended, farmers keep livestock with a sense of worry" and "when there is livestock infected with the FMD virus, farmers feel worried that all livestock are infected with the FMD virus" with a mean value of 4.29 and 4.24 respectively. Table 3 shows that psychological aspects fall into the high category, indicating that the FMD outbreak affected the psychology of cattle farmers in Bantul District, causing them to feel worried, anxious, stressed, and emotional during the FMD outbreak. Socio-cultural aspects include a group of people's ideas, habits and skills over a while. Farmers' responses related to socio-cultural aspects such as "The existence of FMD outbreaks increases the sense of cooperation in the farmer environment and livestock group environment" showed a mean value of 4.3. The measurement results of socio-cultural aspects are also included in the high category. This indicates that the FMD outbreak created new behavioral changes in the farmer's environment in dealing with the situation. Economic aspects include the costs farmers incur and the losses they experience during an outbreak. The distribution of farmers' answers regarding economic aspects showed that the item "FMD infected livestock have decreased productivity and selling price" had a mean value of 4.34. The economic aspect also falls into the high category, indicating that FMD outbreaks cause economic losses for cattle farmers in Bantul District.

Level of Losses of Cattle Farmers When FMD Outbreak Occurs

Table 4 shows that the majority of farmers experienced low economic losses. The treatment costs were in-

Table 3. Distribution of farmers' perceptions of foot and mouth disease outbreak (n=148)

Indicator aspect	Index value	Category
Psychological	41.22	High
Sosio-cultural	34.72	High
Economic	41.77	High

Table 2. Operational definition of research

Variables	Definition
Perceptions variable	Farmer response to foot and mouth disease (FMD) outbreaks
Psychological	Related to the feelings, mental, and psychological conditions of farmers, also related to a person's reaction to something.
Socio-culture	Ideas, habits, and skills that characterize a particular group of people at a particular time.
Economic	Expenses and economic losses experienced by farmers.
Dependent variable	
Farmer's economic losses level	Low: farmers who did not sell their livestock, did not experience cattle mortality, and therefore only incurred FMD treatment costs. Moderate: farmers who sold their livestock at a loss when they contracted FMD.
	High: farmers who experienced cattle mortality due to FMD.
Independent variable	
Age	Farmer's age from date of birth to last birthday (years)
Farming experience	Number of years the farmer started keeping cattle (years)
Livestock ownership	Number of livestock owned by the farmer (head)
Formal education	Level of formal education the farmer has completed (score)
Dummy (nonformal education)	Training or similar related to livestock farming.

curred to treat FMD-infected livestock. In addition, costs were used to disinfect cages and livestock equipment. Handling costs during an FMD outbreak are presented in Table 5.

Effect of Socio-economic Characteristics on the Level of Farmers' Economic Losses

The results of the OLR analysis show a positive influence of age, livestock ownership, formal and informal education on the level of farmers' economic losses (Table 6). Conversely, farming experience has a negative influence on the level of farmers' economic losses. The odds ratio values of farmer's age (year) and livestock ownership (head) show that a one-unit increase tends to increase the probability of economic losses by 2.34 times and 1.062 times, respectively, assuming other variables are constant (ceteris paribus). Farming experience, an increase of one year tends to reduce the level of economic losses by 1.119 times, assuming other variables are constant (ceteris paribus). Then, farmers with formal elementary and high school education tended to experience the opportunity of economic losses 4.745 and 4.726 times greater, respectively, than farmers with formal education categories college, assuming other variables

were constant (ceteris paribus). In addition, farmers who never received informal education (training) experienced economic losses of 2.138 times greater than farmers who had received training.

Based on Table 6 of the OLR model estimation results, the dependent variable can be seen in the estimate column and in the threshold row with a value of 3.606 and 5.402, respectively. The value of the independent variable can be seen in the estimate column and in the location row with a value of 0.085, -0.112, 0.06, 1.577, and 0.769 so that 3 intervals can be formed to determine the category of economic losses of beef cattle farmers in Bantul District, Yogyakarta as follows: low economic losses (Y=1) if $y \leq 3.606$, moderate economic losses (Y=2) if $3.606 < y \leq 5.402$, high economic losses (Y=3) if $y > 5.402$.

Where $y = 0.085X_1 - 0.112X_2 + 0.06X_3 + 1.577X_4 + 0.769X_5$, resulting in the logit form equation of the cumulative logistic model as follows:

$$\text{Logit } P(Y \leq 1|Yi) = 3.606 + 0.085X_1 - 0.112X_2 + 0.06X_3 + 1.577X_4 + 0.769X_5$$
$$\text{Logit } P(Y \leq 2|Yi) = 5.402 + 0.085X_1 - 0.112X_2 + 0.06X_3 + 1.577X_4 + 0.769X_5$$

From the cumulative logistic model equation, the logistic regression equation is obtained as follows:

$$\pi(1) = [\exp (3.606 + 0.085X_1 - 0.112X_2 + 0.06X_3 + 1.577X_4 + 0.769X_5)] / (1 + \exp (3.606 + 0.085X_1 - 0.112X_2 + 0.06X_3 + 1.577X_4 + 0.769X_5)]$$

Table 4. Distribution of farmers' economic losses

Category	Frequence (n=148)	(%)	Economic losses (IDR)[a]
Low	70	47.3	Treatment cost
			Min= 360,000
			Max= 3,950,000
Moderate	45	30.4	Distress sale
			Min= 5,450,000
			Max= 35,980,000
High	33	22.3	Cattle mortality
			Min= 12,950,000
			Max= 163,000,000

Note: Source: processed primary data (2023); [a]IDR is Indonesian rupiahs, Indonesian currency, 1 US$= IDR 15,978 (per May 17, 2024)

Table 5. Expenditures for foot and mouth disease outbreak management

Management of FMD	Value (IDR)[a]
Purchase of gusanex solution	350,000
Purchase of super tetra medicine	100,000
Purchase of *akar daun* herbal medicine	30,000
Purchase of disinfectant solution	60,000
Vitamins injection	50,000–100,000/cattle
Purchase of *Citrun*	135,000
Purchase of molasses	15,000

Note: [a]IDR is Indonesian rupiahs, Indonesian currency, 1 US$= IDR 15,978 (per May 17, 2024)

Table 6. Results of ordinal logistic regression analysis of socio-economic characteristics on the level of farmers' economic loss

	Estimate	Std.Error	Wald	Sig.	*Odds ratio*
Threshold Loss= 1	3.606	1.416	6.487	.011	
Loss= 2	5.402	1.460	13.685	.000	
Location (X_1) Age	.085	.023	13.536	.000***	2,340
(X_2) Farming experience	-.112	.021	27.814	.000***	-1,119
(X_3) Livestock ownership	.060	.020	8.911	.003***	1,062
(X_4) Formal education					
[Formal=1.00]	.634	1.051	.364	.546	
[Formal=2.00]	1.577	.896	3.098	.078*	4,745
[Formal=3.00]	.807	.944	.731	.392	
[Formal=4.00]	1.553	.943	2.715	.099*	4,726
[Formal=5.00]	0[a]	.	.	.	.
Dummy (X_5) Non formal education					
[Non formal=.00]	.769	.401	3.669	.055*	2,138
[Non formal=1.00]	0[a]	.	.	.	.

Note: number of observations=148; *** = significant (p<0.01); * = significant (p<0.1); Pseudo R_2= 0.339; Chi2= 0.000; Prob Y_1= x ≤ 3.606, Y_2= 3.606 < x ≤ 5.402, Y_3= x > 5.402. Source: processed primary data (2023).

$\pi(2)= [(\exp (5.402 + 0.085X_1 - 0.112X_2 + 0.06X_3 + 1.577X_4 + 0.769X_5)] / (1 + \exp (5.402 + 0.085X_1 - 0.112X_2 + 0.06X_3 + 1.577X_4 + 0.769X_5)]$

The chance of economic losses for beef cattle farmers as a result of the FMD outbreak is categorized into 3 categories as follows: low category with $Y_i= 1$, moderate category with $Y_i= 2$, and high category with $Y_i= 3$. The opportunity model according to the equation obtained from the OLR equation on the effect of the farmers' socio-economic characteristics on the level of economic losses due to FMD outbreaks is as follows:

$\alpha_1(X_i) = P (Y= 1|X_i) = P (Y \le 1|X_i)$
$=[\exp (3.606 + 0.085 - 0.112 + 0.06 + 1.577 + 0.769)] / (1 + \exp (3.606 + 0.085 - 0.112 + 0.06 + 1.577 + 0.769)]$
$= 0.997$

Based on the calculation, the chance of farmers experiencing economic losses in the low category due to the FMD outbreak is 0.997%.

$\alpha_2(X_i) = P (Y=2 |X_i) = P (Y \le 2|X_i) – P (Y \le 1|X_i)$
$= \{[\exp (5.402 + 0.085 - 0.112 + 0.06 + 1.577 + 0.769)] / (1 + (5.402 + 0.085 - 0.112 + 0.06 + 1.577 + 0.769)]\} - \{[\exp (3.606 + 0.085 - 0.112 + 0.06 + 1.577 + 0.769)] / (1 + \exp (3.606 + 0.085 - 0.112 + 0.06 + 1.577 + 0.769)]\}$
$= 0.0026$

The chance of farmers experiencing moderate economic losses due to FMD outbreaks is 0.0026%.

$\alpha_3(X_i) = P(Y= 3|X_i) = P(Y \le 3|X_i) – P(Y \le 2|X_i)$
$=[1 - \exp (5.402 + 0.085 - 0.112 + 0.06 + 1.577 + 0.769)] / (1 + \exp (5.402 + 0.085 - 0.112 + 0.06 + 1.577 + 0.769)]$
$= 0.0004$

The probability of farmers experiencing high economic losses due to FMD outbreaks is 0.0004%.

DISCUSSION

The Level of Farmers' Perceptions Towards FMD Outbreaks

The majority of farmers interviewed revealed that they feel worried and anxious while the FMD outbreak is still ongoing, believing that if any cattle contract the FMD virus, it is likely that all cattle will be infected. These feelings of worry and anxiety arose in response to the negative experiences caused by FMD. Symptoms of depression, anxiety, and distress associated with trauma before and after FMD outbreaks can occur in farmers. Farmers are vulnerable to anxiety and the presence of FMD in their environment increases the risk of anxiety and depression. Several studies have shown that farmers have higher levels of anxiety and depression compared to other occupations (Stallones et al., 2013; Torske et al., 2016).

The FMD outbreak has affected the socio-cultural aspects of the farmers' environment, especially the increased sense of mutual cooperation among them. This cooperation is reflected in the form of non-material assistance given to each other when there are FMD-infected livestock. In this context, mutual cooperation

is a non-material social capital based on a sense of volunteerism, solidarity, and togetherness among farmers. Social capital refers to the resources associated with long-lasting social relationships, and the sense of community that exists within the relationship will bridge the dimension of social capital (Menardo et al., 2022). It seems that having supportive friends leads to greater Social Capital ties, while a strong sense of belonging in the community leads to bridging Social Capital. The occurrence of FMD has also triggered changes in operational procedures in the pen environment, especially related to the mobility of livestock in and out, as a measure to prevent the spread of FMD in the pen. Livestock movement is one of the main factors in the spread of FMD, as supported by the studies of Moreno et al. (2023) and Menezes et al. (2020). FMD outbreaks cause complex economic losses for cattle farmers, affecting their overall socio-economic conditions. Therefore, handling these outbreaks becomes very important. The findings of this study are in line with the results of previous research (Jibat et al., 2013; Jemberu et al., 2014; Alhaji et al., 2020; Govindaraj et al., 2021), which confirmed that FMD causes losses due to the reduced productivity, milk production, as well as forced sale and mortality of livestock. All of these have an impact on the social and economic welfare of farmers in FMD-affected areas.

Losses Rates of Cattle Farmers during FMD Outbreaks

The results of this study proved that the majority of farmers experienced low losses. Indirect losses are related to additional expenditure in disease control, as well as treatment of sick livestock (Molla et al., 2017). The study by Govindaraj et al. (2021) confirms that the cost of treatment is the cost per head of cattle spent on cattle affected by FMD. Another source of farmer losses is the sale of livestock when infected with FMD, where the selling price decreases due to decreased livestock productivity. To reduce the financial burden of FMD outbreaks on farms, some farmers conduct distress sales, resulting in considerable losses (Govindaraj et al., 2021). Pleret sub-district is a beef supply area for Yogyakarta Province, so there are many slaughterhouses that are not registered and slaughterhouses that are ready to accommodate FMD-infected cattle. They are forced to sell cattle at low prices due to the lack of alternative sources of income to pay for medicines and vaccinations and because farmers are afraid of losing the remaining cattle in the herd. The selling price of FMD-infected adult cattle usually depreciates by a minimum of IDR 5 million per head, depending on the severity of the cattle's condition. In India, average livestock sales losses ranged from IDR 1.86 million to IDR 8 million per cow (Govindaraj et al., 2021). The largest losses occurred for farmers who experienced cattle mortality due to FMD. The mortality of cattle due to FMD, although rare, causes huge losses to farmers. The body weight of mortality livestock is a determining factor in the number of losses farmers suffer due to FMD outbreaks. Livestock that cannot survive the FMD virus attack cause significant economic losses to farmers (Young et al., 2013). The amount of loss depends on the body

weight of the mortality livestock; the greater the body weight, the greater the losses.

Effect of Socio-economic Factors on Farmers' Economic Losses Rate

The farmers' age and livestock ownership positively affect the level of farmers' economic losses due to FMD. This finding is in line with the results obtained by Ashfaq *et al.* (2015), which prove that older farmers tend to bear more economic losses due to cattle diseases. This is because older farmers have become somewhat careless and reluctant to use technological disease control. Field observations show that in some areas, disease control has been done traditionally, including using spices to treat FMD-infected cattle. On the other hand, research by Usman *et al.* (2015) showed that as farmers get older, the greater the tendency to use local FMD control methods. In addition, older farmers keep cattle as savings rather than as a business cycle, so they tend to keep cattle for a period until they need cash. Experience has inevitably taught farmers that keeping cattle for long periods will result in losses due to drought, disease and old age (Dlamini & Huang, 2019).

Another result, large livestock holdings also result in significant economic losses. Ashfaq *et al.* (2015) showed that the number of livestock owned was positively and significantly correlated with economic losses due to disease in cattle, implying that economic losses are proportional to the scale of the farm. Research by Qui *et al.* (2020) confirms that farmers will tend to control the size of their herds when disease outbreaks occur. To reduce the cost of treatment and mortality risk, they will sell their livestock at a lower-than-normal selling price. Farmers often sell livestock at lower prices to reduce treatment costs and avoid the risk of mortality, especially when alternative sources of income are limited (Baluka *et al.*, 2014). Supported by Dewi *et al.* (2020), total economic losses due to livestock diseases, indirect costs accounted for the largest proportion of the impact (46%), and among these, preventive treatment costs were the highest (40% of total costs). Further research by Chanchaidechachai *et al.* (2022) proved that each additional cattle on the farm contributed to a 4.5% increase in total economic losses due to FMD. The study by Nguyen-Thi *et al.* (2021) highlighted significant economic losses among farmers, especially moderate and large farmers, who depend on livestock production as their main source of income.

In this study, it was found that farming experience has a negative impact on the level of economic losses of farmers. This finding is consistent with research by Okello *et al.* (2022), which states that farmer experience increases the ability of farmers to deal with pig health problems. These results are supported by Athambawa *et al.* (2021), proving that farming experience contributes to increasing farmer participation in vaccination programs. As farming experience increases, farmers' ability to overcome livestock health problems and their participation in vaccination programs increases. This reduces the risk of contracting FMD disease, thus reducing the risk of farmer losses.

Regarding the conditions in the field, some farmers still have concerns about FMD vaccination. They thought that vaccines could cause abortions, reduce milk production, and weaken livestock. To overcome these misconceptions, educational efforts must be made so that farmers may adopt vaccination as an important factor in the FMD control program. Maintaining regular vaccinations based on standard procedures is also important to maintain herd immunity to FMD, in accordance with the control program recommended by the World Organization for Animal Health (OIE) (FAO, 2018). The farming experience variable is expected to influence farmers' sales decisions positively. A previous study by Dlamini & Huang (2019) stated evidence that farming experience positively influences cattle sales decisions. Therefore, when selling FMD-affected livestock, farmers can choose the best trading partners to reduce the risk of significant losses.

The analysis showed a positive relationship between farmers' formal education and the level of economic losses they experienced. This finding aligns with research by Tirivanhu *et al.* (2023), which confirms that farmer education can reduce economic losses due to cattle disease. This is supported by a study by Athambawa *et al.* (2021), which shows that farmers' knowledge of FMD is closely related to their level of education. Farmers who have higher formal education tend to have a better understanding of livestock health issues. Furthermore, Onogwu *et al.* (2017) also indicated that increasing farmers' formal education can increase their cattle productivity. The analysis results showed that farmers who have never received training tend to experience greater economic losses than those who have received training. This finding is in line with the research of Tirivanhu *et al.* (2023), who found that training for farmers can reduce economic losses due to cattle diseases. Yu *et al.* (2023) also support these findings, confirming that agricultural training is effective in addressing the limitations faced by older farmers, especially in terms of their declining ability to accept new technologies. Thus, agricultural training can mitigate the negative impact of aging on agricultural technology utilization. Farmers who have received training tend to have better knowledge in managing their livestock, recognizing early disease symptoms, and taking the necessary precautions to stop the spread of disease, thereby minimizing losses. This finding is supported by Wolff *et al.* (2019), who found that farmers with access to training experienced fewer losses due to several livestock diseases. Therefore, it is imperative to strengthen training initiatives on livestock management, including livestock diseases. In this context, recommendations were given to the government to enhance training programs on cattle disease prevention and control (Tirivanhu *et al.*, 2023). The study results of Athambawa *et al.* (2021) also emphasized the importance of formal education to farmers in improving knowledge of FMD, while participation in livestock training programs significantly improved knowledge of FMD.

From these results, it can be suggested that young farmers are prioritized in attending informal education to degrade traditional practices in handling livestock

outbreaks that have long been carried out among farmers. Informal education is needed to reduce knowledge gaps among farmers, especially in dealing with outbreaks. This is important because farmers in Bantul Regency are mostly older farmers with low formal education, and it would be better if informal education conducted by extension workers had a curriculum; then, if the curriculum is refined, especially in handling livestock outbreaks, it will have more effective implications in handling outbreak conditions in farmers. The results showed that older farmers who have a large number of livestock and farmers who have minimal farming experience and have never participated in training tend to experience greater economic losses.

CONCLUSION

This study concluded that the perceptions of psychological, socio-cultural, and economic aspects of the effect of FMD outbreak had a high index value. A total of 47.3% of cattle farmers in the Pleret Sub-district of DIY experienced low-category economic losses. The farmers' age, livestock ownership, formal education, and non-formal education positively affect the level of farmers' economic losses. Meanwhile, the farming experience has a negative effect on the level of farmers' economic losses due to the FMD outbreak. The highest probability of farmers experiencing economic losses is in the low category of 0.997%. This study shows that FMD handling carried out by farmers is good enough to prevent the impact of large economic losses on cattle farmers. From these results, it can be suggested that informal education has a positive effect on farmers' economic losses, so it is necessary to improve the curriculum, especially in handling livestock outbreaks, to be more effective in dealing with outbreak conditions for farmers.

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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