Mapping the Impact of Foot and Mouth Disease (FMD) on Socio-Economy situation of on of Cattle Farmers in Wonokerto Village, Malang Regency

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ABSTRACT
This research was conducted in Wonokerto Village, Bantur Subdistrict, Malang Regency, from September to November 2022. This study aimed to provide an overview of the social and economic impacts of the spread of Foot-and-Mouth Disease (FMD) using digital mapping on beef and dairy cattle farmers in Wonokerto Village. Sample selection for this study used a multi-stage sampling approach. The first stage employed purposive sampling techniques, with the criteria being farmers in Wonokerto Village affected by FMD. The second stage utilized random sampling. Data was collected through field surveys involving visits to the research location, observations, and interviews with farmers using questionnaires. The research respondents were beef cattle farmers who owned cattle affected by FMD. Results of the study indicated that the spread of FMD has social and economic impacts. The Foot-and-Mouth Disease (FMD) outbreak prompted farmers to prioritize biosecurity, cleanliness, and housing management. However, the outbreak had detrimental social impacts, instilling public fear of consuming beef, resulting in the closure of livestock markets and a decline in beef sales. Some farmers experienced trauma, leading to a loss of motivation for their cattle farming businesses. In response to the outbreak, farmers invested over Rp16,000 per cow per day for treatment, but this expenditure did not prevent a significant weight reduction of 100 to 150 kg per cow. Despite efforts, treatments failed to restore the animals' body weight to normal levels, resulting in the death of up to 7 cows and economic losses amounting to Rp 133 million rupiah.

Keywords*: Mapping, Foot-and-Mouth Disease, Social Impact, Economic Impact.*

1. INTRODUCTION

This research was conducted in Wonokerto Village, Bantur Subdistrict, Malang Regency, from September to November 2022. This study aims to provide an overview of the social and economic impacts of the spread of Foot-and-Mouth Disease (FMD) using digital mapping on beef and dairy cattle farmers in Wonokerto Village. Sample selection for this study used a multi-stage sampling approach. The first stage employed purposive sampling techniques, with the criteria being farmers in Wonokerto Village affected by FMD. The second stage utilized random sampling, which involves random sample selection. Data was collected through field surveys involving visits to the research location, observations, and interviews with farmers using questionnaires. The research respondents were beef cattle farmers who owned cattle affected by FMD.

Wonokerto is a village in Bantur Sub District of Malang Regency, East Java Province. Geographically, this village has a land-based topography with an elevation of 156 meters above sea level, supported by BPS Wonokerto [1], a temperature of 25°C, and an area of 889.97 hectares. There are four hamlets within Wonokerto Village: Wonogiri Hamlet, Gampingan Hamlet, Gumuk Mojo Hamlet, and Krajan Hamlet. The majority of the livelihoods in Wonokerto Village are dairy and beef cattle farmers. Cattle farming in this village is a small-scale enterprise with ownership ranging from 1 to 10 head of cattle, although some farmers operate larger-scale cattle farming businesses. Farmers in Wonokerto Village typically breed and fatten cattle, leading to an increase in the cattle population and development each year.

Y. A. Yusran et al. (eds.), *Proceedings of the 2023 Brawijaya International Conference (BIC 2023)*, Advances in Economics, Business and Management Research 294,
https://doi.org/10.2991/978-94-6463-525-6_75

In early May 2022, the Indonesian Ministry of Agriculture (PUSVETMA) declared that the beef cattle farming industry in East Java was facing a very challenging period due to the entry of Foot-and-Mouth Disease (FMD) into Indonesia. The Ministry of Agriculture confirmed the FMD outbreak starting from May 7, 2022. Foot-and-mouth disease (FMD), also known as PMK (Penyakit Mulut dan Kuku), is a disease transmitted by the infection of the Picornaviridae family virus. It is acute and highly contagious among cloven-hoofed animals, supported by Sutirna et al [2]. The disease is characterized by symptoms such as loss of appetite, excessive salivation (hypersalivation), blisters on the tongue gums, and infections on the hooves of livestock, rendering them unable to stand or walk (limping). The virus can be transmitted through direct or indirect contact with infected animals, such as through saliva, semen, blood, urine, feces, and organs containing the virus. It can also be transmitted through the air, vehicles, equipment, facilities in the barn, and feed, supported by Nuradji et al [3].

Cattle affected by FMD had infections and blisters on their tongues and hooves, causing weight loss. The recovery process from these infections requires an extended period, which can lead to a considerable decrease in body weight. The weight loss impacts livestock production and makes them susceptible to physical deformities and even death.

Based on the background description provided above, the author is interested in conducting the mapping of the spread of Foot-and-Mouth Disease (FMD) using ArcGIS to identify how the social and economic impacts on cattle farmers affected by FMD in Wonokerto Village, Bantur Subdistrict, Malang Regency.

2. MATERIALS AND METHODS

2.1. Research Location

The research was conducted in Wonokerto Village, Bantur Subdistrict, Malang Regency. Data collection activities occurred for three months, from September to November 2022.

2.2. Sampling Methodology

Sample determination in this research utilized a multi-stage sampling approach. The first stage involved a purposive sampling technique, with the criteria being cattle farmers in Wonokerto Village affected by FMD. The second stage involved random sampling, randomly selecting the samples, supported by Arieska et al [4].

2.3. Data Collection Techniques

The data collection technique in this research involved direct field surveys, aided by Survey123 as the data input medium, supported by documentation, and interviews as a systematic method to obtain information in the form of oral statements about an object or events in the past, present, and future, supported by Fadhallah et al [5].

2.4. Data Analysis

This research employed a descriptive quantitative approach. The results from Survey123 were transformed into a distribution map using ArcGIS. The created distribution map was then turned into a dashboard to visualize diverse data, providing a general operational overview of the social and economic impacts of FMD on cattle farmers in Wonokerto Village.

3. RESULTS AND DISCUSSION

3.1. Characteristics of Respondents

This study's total number of respondents consists of 84 beef cattle farmers and 17 dairy cattle farmers. Variables such as gender, age, education level, livestock farming experience, and herd size can be used to determine the characteristics of respondents in Wonokerto Village.

Table 1. Characteristics of respondents

Characteristics	Quantity	Percentage (%)
Gender		
Male	90	89,10%
Female	11	10,89%
Age (year)		
25-34	4	3,96%

35-44	11	11%
45-54	37	36,63%
55-64	31	30,69%
≥ 64	18	17,82%
Education		
ES	42	41,58%
JHS	17	16,83%
SHS	41	40,59%
Bachelor	1	0,99%
Farming Experience (year)		
10-15	20	1,98%
15-30	37	3,66%
>30	44	43,56%
Livestock Count		
1-10	88	87,12%
11-20	9	8,91%
>20	4	3,96%

Source: processed primary data

Table 1 shows more male respondents, totalling 90 individuals (89,10%), compared to females 10,89%. The respondents from this village are predominantly in the productive age range (83 respondents), with education levels being mainly elementary school and high school. The respondents engaged in farming and livestock activities in Wonokerto Village mostly have considerable experience in livestock farming (>30 years), amounting to 44 individuals. The respondents' beef cattle are predominantly managed using traditional methods, with varying herd sizes. Some respondents in this village are small-scale livestock keepers, owning 1-5 heads of livestock.

3.2. The Spread Mapping of PMK Virus

The occupations of the residents of Wonokerto Village are diverse, although the majority are farmers. Most of the community in this village is engaged in livestock farming. Various types of animals are being raised, such as ducks, rabbits, pigeons, laying hens, broiler chickens, goats, sheep, dairy cows, beef cattle, and dairy cattle. The PMK virus entered Wonokerto Village in the Gampingan hamlet among dairy cattle, then started to spread to the neighboring hamlets, namely Krajan and Wonogiri, affecting both dairy and beef cattle. Meanwhile, the Gumuk Mojo hamlet remains safe but is indirectly impacted. Figures 1 and 2 depict the distribution map of the PMK virus created using ArcGIS.

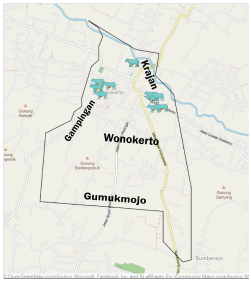

Figure 1 Mapping of Foot-and-Mouth Disease (FMD) Spread in Dairy Cattle among Respondents in Wonokerto Village (ArcGIS.com, 2023)

Figure 1 illustrates the distribution map of FMD in beef cattle across Gampingan Hamlet, Krajan Hamlet, and Wonogiri Hamlet.

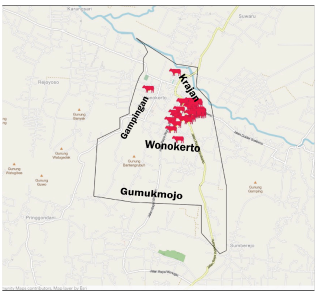

Figure 2 Mapping of the FMD Spread in Beef Cattle among Respondents in Wonokerto Village (ArcGIS.com, 2023).

Figure 2 displays the map illustrating the distribution of FMD in beef cattle in Gampingan Hamlet, Krajan Hamlet, and Wonogiri Hamlet.

3.3. Social and Economic Impacts

The social impacts of the spread of the FMD virus include reduced social interactions, trauma affecting the return to cattle farming, decreased interest in consuming beef, changes in management practices, and biosecurity measures within the barn.

3.3.1. Social Impact

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3.3.1.1. Social Interaction

Humans are fundamentally social beings. Individuals cannot lead an everyday life without the presence of others. As a result, social interactions are divided into three categories, including relationships between individuals, groups and groups, as well as between individuals and groups, supported by Muslim A [6].

3.3.1.2. Individual and Individual

Interaction between individuals can occur because of the relationships between each individual, as demonstrated through verbal communication and body gestures, supported by Awi et al [7]. Some respondents who still had healthy cattle tried to anticipate the spread of FMD by limiting interactions among farmers. During the FMD outbreak, not just interactions among farmers were restricted; guests and neighbors were also prohibited from entering the barn area to prevent direct contact with the livestock. Even during the FMD outbreak, respondents refrained from artificial insemination (AI) due to the fear of FMD transmission from the inseminator.

3.3.1.3. Group and Group

Lestari [8] states that group-to-group interactions can occur as a unit, not just as individual members of the respective groups. During the spread of the FMD virus, cattle groups and the Department of Livestock collaborated in handling FMD. Additionally, the Department of Livestock provided vaccinations by visiting each farmer's barn, assisted by veterinarians.

3.3.1.4. Trauma in Returning to Farming

Trauma is the body's emotional response to traumatic events that result in physical or emotional injury. Trauma can occur immediately after an event or in the long term. One beef cattle farmer in Wonokerto Village experienced trauma due to the FMD virus outbreak. Five of his beef cattle were infected with FMD and could not be saved because the farmer's knowledge about FMD was still low, along with all the associated risks.

A similar situation occurred with a dairy cattle farmer in Gampingan, Hamlet, who experienced trauma when hundreds of his cattle died. However, this trauma could be overcome with motivation and a high level of curiosity, allowing his cattle farming business to continue.

3.3.1.5. Decreased Interest in Beef Consumption

A decline in interest in beef consumption occurred in Wonokerto Village due to rumors in the community claiming that beef from cattle infected with FMD could be zoonotic (transmissible to humans). As a result of these unverified claims and fuelled by public fear, some beef sellers and cattle farmers were affected. This impact included decreased beef sales income and temporary closures of livestock market activities.

Rohma et al. [9] stated that businesses involving food and beverages made from beef and milk have started losing consumer interest. However, the FMD virus is not zoonotic, as suggested by Hussain et al. [10], who stated that Foot-and-Mouth Disease is not a zoonotic disease, and products from animals infected with FMD are safe for human consumption. However, livestock products from animals suspected of having FMD can potentially lead to changes in the quality or composition of the resulting products.

3.3.2. Management Changes in Livestock Care

There were changes in beef and dairy cattle management during the FMD outbreak. The management aspects discussed include feed, housing, and milking management in dairy cattle.

3.3.2.1. Feeding and Drinking

In normal conditions, cattle farmers in Wonokerto Village provide feed twice a day, in the morning and the evening, with a ratio of approximately ±10% of the animal's body weight for green fodder, 1 - 2% of the body weight for concentrated feed, and ad-libitum access to drinking water. However, cattle affected by FMD experience weight loss due to lesions on the tongue and gums in the mouth area. Sumadwita et al. [11] stated that health symptoms in cattle affected by FMD include fever, loss of appetite, and lesions in the mucous membranes of the mouth, such as the tongue, gums, and inner cheek. Cattle affected by FMD consistently refuse to eat, resulting in a decline in health and even death. Therefore, farmers provide finely chopped green fodder and then offer it to the affected cattle. If cattle still cannot eat, the farmers will hand-feed them.

3.3.2.2. Housing Management

On average, the respondents used a two-row colony barn model with opposite rows, where the front part had feeding troughs and the back part had a ditch. This design aimed to make it easier for farmers to clean the barn. Most of the cattle barns in Wonokerto Village were simple and located behind the farmers' houses. Respondents also housed adult cattle with heifers, but calves were separated from their mothers. All respondents also used floor mats to minimize injuries to the cattle's hooves.

3.3.2.3. Milking

Milking activities conducted by the respondents occurred twice a day, once in the morning and once in the evening. Before milking, the respondents would clean the barn and the cows first to minimize milk contamination. This activity included cleaning and brushing the cow's waste with flowing water, washing the cows to be milked, and washing the udder with a warm cloth. Additionally, the attending farmer had to ensure they were clean, with trimmed fingernails. Milking equipment also had to be clean. Blowey and Edmondson [12] stated that milking requirements include:

- health checks on the cattle,
- the health of the operator (washing hands, drying hands, and trimming nails),
- cleaning the cows and the barn beforehand,
- cleaning equipment,
- milking in the morning and evening,
- dipping the udder in a disinfectant solution and
- recording the milking results.

3.3.2.3. Biosecurity

According to Pinardi et al. [13], the essential components of barn biosecurity include isolation, cleaning and disinfection, and traffic control within the barn area.

3.3.2.4. Quarantine and Isolation

Susanti and Sukoco [14] suggest that whenever new cattle are purchased, they should ideally be placed in a quarantine barn and not mixed with existing cattle. However, most small-scale cattle farmers do not implement quarantine for new cattle due to limited space, resulting in new cattle being kept with existing cattle in the same barn. Furthermore, if there are sick cattle, they should ideally be separated from healthy ones. Pinardi et al. [13] also state that sick cattle should be isolated in separate barns, and waste collection facilities should be established to prevent disease contamination. Cattle suspected of having FMD should be separated from healthy cattle to prevent spreading

the virus/disease. Farmers in Wonokerto Village often lack extensive barn space, so most place FMD-affected cattle outside the barn but still near healthy cattle. According to farmers with cattle affected by FMD, they ensure that it is separated if one of the cattle is affected by FMD.

3.3.2.5. Barn Traffic Control

Khasanah et al. (2020) [14] state that traffic control involves preventing the spread of diseases through facilities and infrastructure such as transportation tools, carriers, other non-livestock animals, pests, insects, and visitors in the livestock area. The respondents know barn traffic control, but most dairy cattle farmers have not effectively and correctly implemented biosecurity measures. During FMD cases, respondents also restrict visitors, except for cooperatives, partners, and officials from the department. Small-scale farmers do not hold meetings with each other to reduce the spread of the FMD virus.

3.3.2.6. Sanitation

Sanitation is one of the measures to prevent fecal contamination of livestock and humans because many diseases can be transmitted through the fecal-oral route, thus necessitating sanitation measures, supported by Khasanah et al. [15]. Sanitation has been implemented by dairy cattle farmers in Wonokerto Village, including regularly cleaning cattle waste (twice a day), bathing the cattle, spraying disinfectants in every corner of the barn, and having a ditch for livestock waste. Some farmers in Wonokerto Village have already utilized livestock waste to produce organic fertilizer that can be sold for themselves, and some have even used it for biogas production. However, some farmers still maintain their barns in unclean conditions. During FMD outbreaks, farmers in Wonokerto Village take extra precautions to maintain barn cleanliness and tighten barn biosecurity.

3.3.3. Economic Impact

The economic impact of the spread of FMD includes cattle refusing to eat due to lesions in specific areas, leading to a decline in livestock production, increased maintenance costs, and decreased fertility and population levels, supported by Tawaf R [16].

3.3.3.1. Decreased Livestock Production

A decrease in cattle production will undoubtedly impact and disrupt the performance of other industries. Therefore, the phenomenon of FMD outbreaks can affect the economy of a region or even a country. FMD has a detrimental impact on livestock production and productivity, reducing milk production and body weight.

Table 2. Decrease in Body Weight (Beef Cattle)

Livestock Body Weight		
Before FMD	**During FMD**	**After FMD**
986 kg	824 kg	916 kg
948 kg	798 kg	868 kg

Source: Processed primary data, 2022.

Table 2 illustrates the decrease in body weight due to cattle losing their appetite, caused by lesions on the tongue, lips, and gums, which make it painful for the cattle to chew and swallow their feed and ultimately result in weight loss for the cattle.

Respondents mentioned that a decreased income was also experienced in dairy cattle due to reduced milk production. The decrease in milk production resulted in significant financial losses, accompanied by the cattle's illness and continuously increasing daily maintenance costs. There was a change in the selling price of milk, driven by the higher demand for cow's milk during the FMD outbreak due to limited milk availability. As a result, partners adjusted the milk prices.

3.3.3.2. Increase in Maintenance Costs

Farmers are deeply concerned about the risk of losing their cattle due to FMD. The high cost of treatment and the lack of vaccination are examples of how both the community and the government were unprepared to respond to the widespread occurrence of FMD. The movement of animals, products, vehicles, and objects contaminated with FMD virus has led to the rapid and extensive spread of FMD in vulnerable livestock in several areas. This indicates that for the government and the community to successfully stop the spread of FMD, they need to have a thorough understanding of the disease and the correct methods of handling it. The increase in maintenance costs for cattle affected by FMD.

Table 3. Treatment Costs

Types of Treatment	Frequency	Dosage/head/day	Price/head/day (Rupiah)
Jamu	2 times a day	250ml	5.000
Vaksin	Every 6 months	2ml	0
Limoxin spray	2 times a day	7,5ml	11.250
Mineral	1 time a day	35gram	735
Total			16.985

Source: Processed primary data, 2022.

Table 3 shows that the type of treatment given to infected livestock should follow the symptoms, frequency, and the appropriate dosage.

3.3.3.3. Decrease in Fertility & Population Level

Another negative impact of FMD is the decrease in livestock population. Some farmers in Gampingan and Krajan Hamlets have experienced a decline in population growth due to the death of beef cattle infected with FMD, resulting in economic losses (Table 4).

Table 4. Livestock Deaths (Beef Cattle)

Hamlet	Number of Livestock Deaths (Head)	Price (Million Rp/head)	Total Price (Million Rp)
Krajan	1 cow 4 heifers	15 20	95
Gampingan	1 calves 1 pregnant	8 30	38
Total	7		133

Source: Processed primary data, 2022.

Another case observed in one of the farmers in Gampingan Hamlet is sudden abortion in productive livestock. According to Septiani and Triwulandari [17], this condition can be referred to as opportunity loss, meaning the loss of opportunities to generate future profits due to a specific moment when livestock is highly vulnerable to death because they are not receiving milk from their mothers and experience heart disturbances in calves, thus requiring the provision of substitute milk, supported by Wulandari [18]. Based on the explanation from the farmer, deceased livestock are buried in an area far from water flow to prevent the virus from spreading through water. Bagenda et al. [19] state that dead livestock should be buried at least two meters from the surface to prevent disease transmission to live animals. The death of livestock leads to significant financial losses for farmers, so cattle that are weakened and likely unable to be saved are forcibly slaughtered by farmers, and their meat is either sold or distributed to those in need. In addition, livestock infected with FMD are sold at low prices. Forcible slaughter is performed because in cattle infected with FMD, the diseased legs will cause the cattle to be unable to bear weight and collapse, and also due to their weakened physical condition and immunity, making them unable to survive any longer, supported by Wulandari [18].

4. CONCLUSION AND RECOMMENDATION

4.1. Conclusion

The outbreak of Foot-and-Mouth Disease (FMD) heightened farmers' awareness of biosecurity, cleanliness, and housing management practices. Despite these positive outcomes, the FMD outbreak had adverse social effects. It instilled public apprehension regarding beef consumption, leading to the closure of livestock markets and a decline in beef sales. Additionally, some farmers experienced trauma, losing motivation to sustain their cattle farming businesses.

To combat the FMD outbreak, farmers invested over Rp16,000 per cow per day for treatment. Cows witnessed a significant weight reduction ranging from 100 to 150 kg per cow during the outbreak, and the treatments administered by farmers failed to restore the animals' body weight to normal levels. Livestock casualties reached up to 7 cows, equivalent to Rp 133 million rupiah in economic losses.

Foot and Mouth Disease exerts social ramifications, such as limitations on social engagements, trauma impeding the resumption of cattle farming, alterations in maintenance practices, and a waning consumer interest in beef, culminating in a drop in beef prices. Certain individuals faced economic repercussions, encompassing diminished fertility and population rates, decreased livestock output, and elevated maintenance expenses for the afflicted cattle, resulting in substantial economic setbacks.

4.2. Recommendations

It is recommended that farmers tighten biosecurity measures within their respective barns to protect healthy livestock from foot and mouth disease.

AUTHORS' CONTRIBUTIONS

Rizki Prafitri: Planned, executed, analyzed and supervised the research, Kuswati: Developed the initial research idea of the research, Galuh Aditya: Collected data and drafted the manuscript, Salwa Salsabila: Collected data and drafted the manuscript, Zahrah Mufidah: Edited and finalized the manuscript.

ACKNOWLEDGMENTS

We would like to express our sincere gratitude to Universitas Brawijaya for the Financial Support of the research with Dokter Mengabdi Funding 2022 (No: 973.59/UN10.C10/PM/2022).

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