Pre – post FMD (foot and mouth disease) outbreak income analysis of beef cattle farmers in Ngargoyoso district Karanganyar regency

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Abstract. This study aimed to analyze the income of beef cattle farmers before, during, and after the FMD (Foot and Mouth Disease) outbreak. The research was conducted in Ngargoyoso District, Karanganyar Regency, which experienced a decline in cattle population from 5,651 heads in 2023 to 1,399 heads in 2024. Respondents of the study were 30 farmers who owned at least two beef cattle. The research employed a descriptive quantitative method using survey techniques. Data were collected through interviews with cattle farmers, then tabulated, calculated, and analyzed descriptively. The analysis results showed that the 2022 FMD outbreak significantly impacted beef cattle farming in Ngargoyoso District, reducing the cattle population by 39.8% and causing farmers to experience an average loss of IDR 2,088,811 per ST per year with an R/C ratio of 0.93, indicating economically inefficient operations. Despite improved profitability post-outbreak, both PBBH and IOFC remained substantially lower than pre-epidemic levels, demonstrating incomplete recovery in productivity and economic performance.

1 Introduction

One of the important pillars supporting the global food system in providing animal protein for the world community is the development of the livestock sector. The beef cattle sub-sector is a major source of income for millions of farming households in Indonesia, contributing significantly to meeting national animal protein requirements. Small and medium-scale beef cattle farmers generally rely on livestock farming as their primary source of income, with a dependency rate of 75-90% of total household income [1].

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The characteristics of smallholder livestock farming, which is dominant in Indonesia, make it highly vulnerable to external disturbances, particularly outbreaks of infectious animal diseases that can threaten business continuity and welfare [2]. Foot and Mouth Disease (FMD) is an acute viral disease that attacks cloven-hoofed animals, caused by Aphthovirus from the Picornaviridae family. This disease has an incubation period of 2-14 days with clinical manifestations of high fever, blisters on the mouth, tongue, gums, and areas around the hooves, as well as a drastic decrease in appetite and milk production [3]. FMD has a very high transmission rate with the ability to spread through direct, indirect, and aerosol contact over a wide radius, making it a serious threat to the sustainability of livestock businesses [4]. FMD outbreaks have complex economic impacts on livestock businesses. Direct impacts include livestock mortality, weight loss, reproductive disorders, and treatment costs, while indirect impacts include trade restrictions, lower selling prices, vaccination costs, and supply chain disruptions [5]. International studies show that the ratio of indirect losses to direct losses due to FMD outbreaks can reach 4:1 to 10:1, with total economic losses per outbreak reaching millions to billions of rupiah [6].

The spread of FMD in Indonesia, which was confirmed in July 2022 after more than 30 years of FMD-free status, has spread to 15 provinces, including Central Java. Karanganyar Regency, as one of the beef cattle farming centers in Central Java with a population of around 66.779 heads, has been significantly affected, particularly Gondangrejo District, which has recorded 120 confirmed cases and experienced a population decline from 6.581 heads in 2023 to 4.594 heads in 2024 [7]. Research on the economic impact of FMD outbreaks at the global level has been extensively conducted, focusing on macro and microeconomic losses. However, studies analyzing the impact of FMD outbreaks on the individual income of beef cattle farmers, particularly using a before-and-after comparison approach, remain very limited in Indonesia. Most existing studies use secondary data or simulation approaches, while analyses based on primary data from farmers who have directly experienced the impact of the outbreak are still rare. Analysis of farmer income before and after the FMD outbreak is important because livestock business income is influenced by various interacting factors. Internal factors such as business scale, capital structure, and farming experience, as well as external factors such as market prices, access to feed, and institutional support can undergo drastic changes due to disease outbreaks [8]. The FMD outbreak as an external disturbance can change the dynamics of farmer income growth through direct and indirect mechanisms [9]. The economic impact of animal disease outbreaks varies between regions and farmer characteristics, but specific information for conditions in Indonesia, especially at the individual farmer level, is still very limited [10].

Therefore, detailed information on the level and pattern of income changes due to FMD outbreaks is urgently needed as a basis for formulating effective compensation programs and livestock economic recovery strategies [11]. Based on these conditions, this study aims to analyze the income levels of beef cattle farmers before and after being affected by the FMD outbreak in Ngargoyoso District, Karanganyar Regency.

2 Materials and Methods

This study was conducted on beef cattle farms in Ngargoyoso District, Karanganyar Regency. Data were collected in July 2025. Ngargoyoso District was chosen as the research location because it experienced the largest population decline in Karanganyar Regency.

Data were collected by recording data related to cost components, including fixed and variable costs in IDR/AU/year. Fixed costs included property tax, depreciation costs for cage, equipment, and vehicles. Variable costs included the cost of purchasing feeder cattle, feed costs, medication and electricity costs, transportation, labor costs, and veterinary services.

The respondents used in this study were 30 beef cattle farmers with a minimum of 3 cows who had raised beef cattle using the fattening system before the FMD outbreak, during the FMD outbreak, and after the FMD outbreak. A purposive sampling method was employed, selecting farmers based on specific criteria: ownership of at least 3 beef cattle and continuous operation of fattening systems throughout all three outbreak periods. Revenue or income obtained in the three periods or three years, namely one year before the FMD outbreak, one year during the FMD outbreak, and one year after the FMD outbreak. In calculating the income of beef cattle farmers, the following formula is used:

$$Income/Revenue = Price \times Quantity\ of\ production \quad (1)$$

$$Total\ Costs = Fixed\ Costs + Variable\ Costs \quad (2)$$

The efficiency of beef cattle farming uses the R/C (Revenue Cost Ratio) formula, which is the ratio between the revenue received and the costs incurred [10]. The performance parameters for beef cattle use the formula for daily average gain (ADG) and income over feed cost (IOFC), or the difference between feed costs and income [15]. Systematically, this can be written as follows:

$$R/C = Revenue/Total\ Costs \quad (3)$$

(criteria: if the R/C Ratio is < 1, the business is not efficient; if the R/C Ratio = 1, it is break-even; if the R/C Ratio is > 1, the business is efficient) [10].

$$PPBH = (initial\ body\ weight - final\ body\ weight)/length\ of\ maintenance \quad (4)$$

$$IOFC = livestock\ sales\ revenue - feed\ costs \quad (5)$$

3 Result and Discussion

3.1 General Conditions of the Research Location

Ngargoyoso Subdistrict is one of the subdistricts in Karanganyar Regency, Central Java Province, with an area of approximately 47.16 km². This subdistrict is located in the eastern part of Karanganyar Regency at an altitude of between 900 and 1,500 meters above sea level, making it a highland area with a cool climate [12]. The research location in Ngargoyoso Subdistrict consists of 12 villages, namely Ngargoyoso Village, Segorogunung, Puntukrejo, Berjo, Kemuning, Girimulyo, Jatirejo, Dukuh, Ngargoyoso, Berjo, Segorogunung, and Puntukrejo, whose main livelihood is in the livestock sector in addition to the agriculture and plantation sectors [13].

The beef cattle population in Ngargoyoso Subdistrict experienced the highest population decline in Karanganyar Regency in 2024, as shown in Table 1. The highest population decline in the five subdistricts with the highest populations in Karanganyar Regency, based on Table 1, was in Ngargoyoso Subdistrict. This can be seen from the population of 5.651 animals in 2023 to 3.399 animals in 2024. One of the causes of the population decline of 2.252 animals, or 39.8%, is indicated to be the impact of the FMD outbreak that occurred in 2022. The FMD outbreak, which is one of the causes of the decline in livestock population, is likely to have an impact on the decline in farmers'

income in the livestock sector. Although the mortality rate in adult cattle is relatively low at around 1-3 percent, the economic impact is significant due to the decline in body weight, milk production, and livestock sales value [14].

Table 1. Beef cattle population in Karanganyar District from 2023 to 2024.

No	District	2023	2024
1	Jatiyoso	6.780	6.018
2	Ngargoyoso	5.651	3.399
3	Karanganyar	6.086	4.056
4	Gondangrejo	6.581	4.594
5	Mojogedang	6.828	6.394

Source: Karanganyar Regency Central Statistics Agency (2024).

3.2 Respondent Characteristics

The characteristics of the respondents analyzed in this study include age, education level, farming experience, and number of livestock owned. Everything such as attitude, mindset, and personality can be considered characteristics. The characteristic of respondents in this research are shown in Table 2.

Table 2. Characteristic of beef farmers in Ngargoyoso District.

Farmer's age	Number of farmers (people)	Persentage (%)
<15 years	0	0.00
15-64 years	29	96.70
>64 years	1	3.30
Farmer's education		
Not pass elementary	6	20.00
Elementary school	5	16.70
Junior high school	9	30.00
Senior high school	3	10.00
Bachelor degree	6	20.00
Farming experiences		
5-10 years	5	16.70
10-15 years	23	76.70
>15 years	2	6.70
Number of cattle		
6-10	13	43.30
11-20	11	36.60
>20	6	20.00

Each farmer generally has different indicators such as mindset, knowledge, and experience. This can be seen from the age factor of farmers, which can influence these indicators. The majority of respondents' ages fall into the productive working age category, with only a small number of elderly farmers. Productive farmers tend to have high abilities and creativity due to the support of cognitive knowledge and a strong work ethic, enabling them to develop a strong work mindset and sense of responsibility for the work they are engaged in [7]. In terms of education, the farmers have diverse educational backgrounds,

ranging from those who did not complete elementary school to those with bachelor degrees, with junior high school education being the most common level. Regarding farming experience, most farmers have moderate experience ranging from ten to fifteen years, while those with less experience or extensive experience of more than fifteen years represent smaller proportions. The number of cattle owned also varies among farmers, with the majority owning small to medium-sized herds, particularly those with six to ten head of cattle, followed by those with larger herds.

3.3 Income Analysis

The cost components obtained from 30 beef cattle farmers in Ngargoyoso District consist of fixed costs, variable costs, and sales over the last 3 years, namely the periods before, during, and after the FMD outbreak. Fixed cost components consist of depreciation of barns, equipment, and vehicles, while variable components consist of feeder cattle, feed, labor, medicines, and transportation. Revenue is derived from cattle sales. All cost and revenue components are calculated in rupiah per animal unit (AU) per year. Further details of the calculations can be found in Table 3.

Table 3. Average costs and revenues of smallholder beef cattle farmers in Ngargoyoso Subdistrict (IDR/AU/year).

Description	Before FMD	During FMD	After FMD
Fixed Costs			
Depreciation of the cage	379.862	461.610	685.172
Equipment depreciation	210.840	256.309	345.513
Vehicle depreciation	762.114	1.022.420	1.242.730
Property tax	6.546	7.054	9.735
Total cost	1.359.361	1.747.392	2.283.150
Variable costs			
Feeder cattle	20.223.319	20.234.320	18.238.768
Feed	5.105.397	4.366.859	7.205.608
Vitamins and medications	588.827	990.995	1.125.657
Transportation	130.919	130.655	203.849
Electricity	320.306	385.261	360.357
Labor	159.568	82.911	84.898
Total variable costs	26.528.335	26.321.074	27.567.526
Total costs	27.887.696	28.068.466	29.850.676
Revenue	33.023.685	25.979.655	34.073.401
Income	5.135.989	- 2.088.811	4.222.725

Source: Processed Primary Data (2025).

3.3.1 Fixed and variable costs

Based on Table 3, fixed costs contribute 6.3% of total production costs, consisting of depreciation costs and Land and Building Tax (Property Tax). Depreciation costs originating from the depreciation of barns, equipment, and vehicles have a constant value each month during the maintenance period. The difference in depreciation values in the

periods before, during, and after the FMD outbreak was due to variations in the number of livestock in each period, so that the divisor used to calculate the average per Anmal Unit (AU) differed in each period. The variable cost components with the highest percentages were the purchase of feeder cattle at 73.0% and feed at 20.7%. These results are consistent with research on Bali cattle fattening businesses post-pandemic, which shows that variable costs account for 60-70% of total production costs [15].

The feeder cattle purchased by farmers were Simmental and Ongole (Simpo) crossbreds of various ages and with an average weight of 393 kg. Feed costs, which include forage and concentrate, increased significantly after the FMD outbreak, namely by 41.14% compared to the period before the outbreak and 65.00% compared to the period during the outbreak. This increase in costs was due to farmers' increased awareness of the importance of livestock health, which was manifested in the provision of larger amounts of feed compared to the period before the outbreak.

The cost components of vitamins and medicines include vitamin C, deworming medicine, wound medicine, vitamin B complex, traditional herbal medicine, vaccination costs, and veterinary services. The average cost of a veterinary consultation is IDR 50.000 per visit and IDR 30.000 per animal for each vaccinated animal. The cost of vitamins and medicines incurred during the outbreak period increased by 68.30% compared to the period before the outbreak. The majority of farmers used traditional herbs as an effort to accelerate the healing process and restore the appetite of livestock infected with FMD. The herbal medicine consisted of empon-empon (curcuma and turmeric) and duck eggs. In the post-outbreak period, farmers increased the frequency of administering herbal medicine and consulting veterinarians as a preventive measure, resulting in a 91.17% increase in the cost of vitamins and medicines compared to the pre-outbreak period. The use of herbal plants such as turmeric has been proven effective because it contains curcumin, which has been shown to contribute to livestock growth and disease resistance, as well as having anti-inflammatory and antioxidant properties that can increase the concentration of IgA, IgM, and IgG in plasma, thereby supporting the livestock immune system [15].

Labor costs decreased during the outbreak period as some farmers laid off workers due to a reduction in livestock ownership. The labor system consisted of monthly and daily workers. Monthly workers were employed on large-scale farms (population ≥200 animals) and medium-scale farms (population >10 animals) with an average wage of IDR 2.500.000 per month. Meanwhile, daily labor is applied to small-scale farms (population <10 animals) with a wage of IDR 100.000 per day. Studies on this impact are in line with global findings that livestock disease outbreaks not only cause direct production losses but also have an impact on employment and additional costs for veterinary care, with economic consequences that include labor losses for both farmers and support workers [15].

3.3.2 Income and R/C

During the outbreak period, revenue fell by 21.33% due to the selling price of livestock falling from an average of IDR 50.000 per kg to IDR 25.000 per kg of livestock sold and experiencing a loss or decline in income of 59.33% with an average income of IDR (-2,088,811). This was because total expenses exceeded revenue. Total expenses and revenue for each period can be seen in Table 3.

Revenue increased by 31.15% in the post-epidemic period compared to the epidemic period and by 3.18% compared to the pre-epidemic period. However, income in the post-epidemic period was still lower than before the epidemic, with a difference of IDR 913.264 or 17.78% lower. This condition was caused by an increase in feed and medicine costs

incurred by farmers as part of their post-epidemic recovery efforts. This situation is caused by increased feed and medication costs incurred by farmers in their post-outbreak recovery efforts. The causes of livestock business losses are largely due to weight loss, livestock mortality, and disease control costs [14].

A comparison between the income and expenses incurred by farmers for beef cattle farming can be seen in Table 4.

Table 4. R/C Analysis.

FMD	Value	Description	Conclusion
Pre	1.18	> 1	Efficient/profitable
During	0.93	<1	Inefficient
Post	1.14	> 1	Efficient/profitable

Source: Processed primary data (2025).

Table 4 shows that the period when the outbreak occurred had a ratio value of less than 1, meaning that during that period, the beef cattle business suffered losses. The highest income value can be seen from the highest ratio value, which was during the period before the outbreak. The income for each period can be seen in Table 3.

The R/C ratio results from this study demonstrate patterns consistent with broader research on livestock disease impacts on farm profitability. The pre-outbreak R/C ratio of 1.18 indicates that farmers in Ngargoyoso District were operating efficiently before the FMD outbreak, with returns exceeding costs by 18%. This baseline profitability represents typical performance for beef cattle fattening operations under normal conditions, where operational efficiency enables sustainable income generation for smallholder farmers. The sharp decline to an R/C ratio of 0.93 during the FMD outbreak represents a critical threshold where operations become economically unviable. This 21.2% reduction in efficiency is notably severe compared to other documented disease outbreaks in Indonesia. Research on the economic impact of FMD in Semarang Regency reported R/C ratios declining to 0.95 during the outbreak period, indicating that the impact in Ngargoyoso District was marginally more severe [14].

The sub-unity R/C ratio observed during the outbreak period indicates that for every IDR 1.00 spent, farmers received only IDR 0.93 in return, resulting in a net loss. This loss mechanism differs fundamentally from typical operational challenges, as disease outbreaks simultaneously reduce revenue (through mortality, weight loss, and price depression) while increasing costs (through treatment, additional veterinary services, and biosecurity measures). The post-outbreak recovery to an R/C ratio of 1.14, while representing a return to profitability, reveals incomplete economic recovery. This ratio remains 3.4% below pre-outbreak levels, despite being 22.6% higher than during the outbreak. The slower recovery in Ngargoyoso District may be attributed to the persistent elevation of input costs, particularly the 41.14% increase in feed costs and 91.17% increase in veterinary and medication costs, which continued into the post-outbreak period as preventive measures. This pattern of incomplete recovery has significant implications for long-term farm viability and household income stability. International comparative analysis provides additional context for interpreting these results. Research on FMD impacts in East African pastoral systems reported R/C ratio declines ranging from 15% to 40% during outbreak periods, with recovery periods extending 2-3 years [9].

3.4 Income Over Feed Cost (IOFC)

The scale and income of beef cattle farming businesses do not necessarily reflect their efficiency. One way to facilitate the evaluation of the economic condition of a cattle farming business is to determine the average daily gain (ADG) and IOFC, which can be seen in Table 5.

Table 5. IOFC calculation results.

Parameter	Pre FMD	During FMD	Post FMD
ADG (kg/head/day)	0.96	0.24	0.6
IOFC (/hari)	36.086	- 47.120	10.341

Source: Processed primary data (2025)

The daily weight gain produced (see Table 5) during the outbreak decreased by 75% or 0.72 kg/head/day lower than before the outbreak. This significant decrease in body weight is in line with studies showing that a 29-day FMD outbreak caused a 35% decrease in cattle productivity, indicating that the impact of FMD on livestock productivity is universal and detrimental [14].

The income value from feed costs during the outbreak decreased by more than 100% or Rp 83.206/day compared to before the outbreak. The negative value (in Table 4) indicates that income from livestock sales was unable to cover feed costs, resulting in net losses for farmers and indicating that livestock farming was economically inefficient. IOFC in small to medium-scale beef cattle fattening businesses in East Java emphasizes that IOFC is an important indicator for evaluating the economic efficiency of a business [15].

In the post-epidemic period, ADG partially recovered to 0.36 kg higher and IOFC increased by Rp57.461.00 higher than during the epidemic. However, this increase was not optimal based on the ADG figure, which was still 37.5% lower, and the IOFC value, which was 71.4% lower than before the epidemic.

4 Conclusion

Based on the results of the study, the 2022 FMD outbreak had a significant economic impact on beef cattle farming in Ngargoyoso District, with a population decline of 39.8% from 5.651 to 3.399. During the outbreak, farmers suffered an average loss of IDR 2.088.811 per AU per year with an R/C value of 0.93 due to a decline in livestock selling prices and a 75% decrease in PBBH to 0.24 kg/head/day, as well as a negative IOFC value of -IDR 47.120/day, indicating that the business was not economically efficient. Although the business became profitable again in the post-outbreak period with an R/C of 1.14 and an income of IDR 4.222.725 per AU per year, recovery was not optimal because income was still 17.78% lower, PBBH 37.5% lower, and IOFC 71.4% lower compared to the pre-epidemic period, due to a 41.14% increase in feed costs and a 91.17% increase in vitamin and medication costs as part of post-epidemic prevention and recovery efforts.

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