Economic Impact of Foot and Mouth Disease (FMD) on Beef Cattle Fattening Businesses in Rembang Regency, Central Java

E. Permatasari, J. Mariyono, and D. W. Harjanti

Agribusiness Masters Department, Faculty of Animal Husbandry and Agriculture,
Diponegoro University
Jl. Prof. H. Soedarto, SH Tembalang Semarang, Indonesia 50275
Corresponding Author: erdyanti.p@gmail.com

ABSTRACT

This research aims to analyze the economic impact of FMD on beef cattle fattening businesses in Rembang Regency. The research was conducted in Rembang Regency on a beef cattle fattening business with 115 respondents. Of these 115 respondents, 46 groups of farmers whose livestock were not affected by FMD and 69 groups whose livestock were affected by FMD. Based on the R/C ratio value for both the group not affected by FMD and the group affected by FMD, the R/C value is < 1; it is considered that fattening cattle during an FMD outbreak is not profitable. The research results showed that the average income difference before FMD (2021) and during the FMD outbreak (2022) in the group of cattle not affected by FMD was IDR. - 6,659,570.68, while in the group of cattle affected by FMD, the average income difference was Rp. -7,900,693,088. Thus, the income difference between the group not affected by FMD and those affected by FMD decreased by -15.07%. This research concluded that the outbreak of FMD in Rembang Regency had a significant impact on the beef cattle fattening business; therefore, it is necessary to take preventive measures to prevent the occurrence of FMD in the following year by monitoring livestock movements, increasing immunity through FMD vaccination, increasing the number of Animal Health Centre as the spearhead of animal health in the field, and cross-sectoral coordination and collaboration (One Health) to eradicate the FMD outbreaks.

Keywords: economic impact, R/C ratio value, FMD, beef cattle fattening

INTRODUCTION

Foot and Mouth Disease is endemic in most Southeast Asian countries except the Philippines, Singapore and Brunei. In Indonesia, the first case of FMD occurred in East Java in 1887. The government program consisted of implementing strict animal movements, strict quarantine measures, and a mass vaccination program. There have been no reports of FMD since December 1983, and Indonesia was declared a disease-free country in 1986. However, after 35 years of being free from FMD, in early May 2022, several disease outbreaks with symptoms similar to FMD were reported in the provinces of Aceh and East Java, followed by several cases of FMD in other regions in Java, Sumatra, Kalimantan and NTB (Susila BE, 2022).

Foot and Mouth Disease (FMD) is caused by an acute and highly contagious virus in cloven-hoofed animals such as cattle, buffalo, goats, and sheep. Typical symptoms include ulcer/erosion in the mouth, gums, nose, nipples, and hypersalivation. Blisters or wounds on the feet are also found, so the livestock becomes lame. The morbidity rate is 100%, and the mortality rate is 5% in adult animals and>20% in young animals (Ministry of Agriculture, 2022). This FMD economically creates *externalities* where the outbreak negatively impacts other livestock due to FMD spreading rapidly. The direct impact of FMD is a loss of appetite in livestock due to the development of ulcers, leading to weight loss and death. The indirect impact is the costs that farmers must incur to carry out treatment, a decrease and loss of income due to the sale of livestock being delayed or even dying, a decrease in market activity because the market is closed, and this also affects the selling price of livestock (Tawaf, 2017).

PMK impacts several aspects of animal husbandry, such as material (economic) and non-material losses. The material losses incurred include economic losses to the community due to falling purchasing prices for animals and meat, decreased livestock productivity, low animal body weight gain, and even deaths with low mortality rates. (Mohamad A, 2022). According to (Wulandari, 2022), the highest prevalence of FMD cases is in areas that have high livestock density, with a morbidity rate of 100% and a low mortality rate of around 1.53% of the number of cases.

This research was conducted in Rembang Regency with a beef cattle population as of the end of 2022 of 151,890 heads, with the beef cattle population ranking number 4 (four) in Central Java (Dintanpan Rembang, 2022). Rain-fed agricultural land only takes 4-6 months, so that time is used to cultivate livestock. AI technology has also been well received, with beef cattle cultivation becoming familiar and widespread as a producer of post-weaning cattle brought to other districts. Rembang Regency is located north of Java Island, directly bordering East Java Province, and is the first district in Central Java to be affected by FMD. The first case of FMD in Rembang Regency was discovered on May 7 2022, in Dukuh Gingsir, Sidomulyo Village, Kaliori District, Rembang Regency; this was caused by a beef cattle fattening farmer who bought feeder cattle from Jatirogo Market, East Java. The FMD incident in Kaliori District significantly impacted beef cattle fattening farmers because Kaliori District is a centre for fattening in Rembang Regency. The people there fatten beef cattle with maintenance for 3 to 6 months. The fattening aims to stock up for the Eid al-Adha holiday. According to (Fathurrohman, 2022), the government has made many efforts to tackle cases of FMD, including administering vaccines evenly, carrying out biosecurity, treating animals exposed to FMD, carrying out testing and tests, as well as slaughtering livestock that have been exposed to the disease. It was done to rebuild the Indonesian economy, devastated by the FMD, especially for livestock farmers.

Research aimed to analyze the economic impact of FMD on the beef cattle fattening business in Rembang Regency. The benefit of this research was that it estimated the financial losses of cattle-fattening farmers due to FMD in the Rembang Regency.

RESEARCH METHODS

The research used a survey methodology in which samples were drawn from one population, and questionnaires were used as data collection tools (Singarimbun, 1995). The research on the economic impact of beef cattle fattening businesses in Rembang Regency was carried out by data collection by providing questionnaires to farmers who carried out Beef Cattle Fattening Business in Rembang Regency. Data collection was taken from the period of the beef cattle fattening business before the FMD outbreak (2021), the beef cattle fattening business during the FMD outbreak (2022), and the cattle fattening business after the FMD outbreak (2023).

Location and Time of Research

This research was conducted in Rembang Regency on all farmers who carry out beef cattle fattening business in Rembang Regency. Rembang Regency was chosen as the research location because it is one of the districts in Central Java, a centre for fattening beef cattle that are economically affected by foot and mouth disease (FMD). This study was conducted from May to June 2023.

Sampling Technique

According to (Sugiyono, 2019), sampling techniques are grouped into probability sampling and non-probability sampling. In this research, the sampling technique uses a non-probability sampling technique, namely a sampling technique that does not provide equal opportunities for each element or member of the population to be selected as a sample. The sampling technique used is purposive sampling, which is a technique for determining samples with specific considerations. The samples taken in this study were 115 respondents from beef cattle fattening farmers.

Data analysis

Quantitative descriptive statistics analyzed the collected data to determine the income and feasibility of the beef cattle fattening business as follows:

1. The Income Formula is as follows (Ekowati, 2012)

$$\pi = TR - TC$$

Information:
π = Beef Cattle Fattening Income
TR = Total Revenue
TC = Total Cost

2. The Business Feasibility formula uses R/C Ratio Analysis as follows:

R/C ratio (Revenue Cost Ratio), namely the comparison between revenue and costs (Soekartawi, 1995)

$$R/C = TR/TC$$

Information:
TR = Total Revenue
TC = Total Cost
Decision criteria:
R/C > 1 = Profitable cattle fattening business
R/C < 1 = Unprofitable cattle fattening business
R/C = 1 = Cattle fattening effort is considered break-even

The data obtained were also processed using the *Statistical Package for Social Science* (SPSS) program version 26. The *Kolmogorov-Smirnov Test* was used for analysis if the sign value is less than 0.005, the data are not normally distributed, and *the Homogeneity Test of Variance* between data groups was performed using the Levene statistic at a 5% significance level. The results of the *Levene* Test showed a significance value of 0.171, which is greater than 0.05. The homogeneous data was then continued with the *Mann-Whitney Test*.

RESULTS AND DISCUSSION

Feasibility of Beef Cattle Fattening Business

Based on calculations from interviews with respondents, the feasibility of beef cattle fattening businesses is shown in Table 1.

Table 1. Feasibility of Beef Cattle Fattening Business

Description	R/C value		Results		Information
	Not Subject to PMK	Got PMK	Not Subject to PMK	Got PMK	
Before PMK (Year 2021)	1.03	1.07	R/C > 1	R/C > 1	Profitable
During PMK (Year 2022)	0.769	0.768	R/C < 1	R/C < 1	Unprofitable
After PMK (Year 2023)	1.42	1.32	R/C > 1	R/C > 1	Profitable

Based on the calculation results, it was found that the R/C value of the beef cattle fattening business in Rembang Regency in 2021 (before the PMK occurred) was still more than one, so it was considered that the beef cattle fattening business was still feasible. In 2022 (when there is PMK) in Rembang Regency, from the R/C ratio analysis, it can be seen that when PMK occurs, both groups affected by PMK and groups not affected by PMK have an R/C ratio value of less than 1 (R/C <1). It is considered that the business of fattening beef cattle when FMD occurs is not profitable. Based on calculations, it was found that the difference in the R/C ratio value of the group not affected by FMD versus the group affected by FMD had decreased by 0.13%, where the group affected by FMD had an R/C ratio value of 0.13% lower than the group unaffected FMD.

Based on the results of interviews with beef cattle fattening farmers, when PMK is not profitable for groups unaffected by FMD due to 1) The fattening period for cattle is over six months due to unsold livestock, 2) the price of feed is not comparable to the selling price of the livestock, where the selling price of livestock during PMK is lower, 3) some breeders are afraid so they sell their cows before they get fat, 4) there are fewer cows to maintain than usual because breeders are selling some of their livestock, 5) Livestock that should be sold during the year are not entirely sold because there are few buyers, and 6) there are additional costs for disease prevention. Meanwhile, the group affected by FMD was caused by 1) additional costs in treating the disease, 2) Death of some livestock, and 3) an extended maintenance period because it requires recovery time for fattening. 4) there are sick cattle that are slaughtered and sold to butchers at meagre prices (forced slaughter).

(Oaks, 2021) said that the impact of FMD is divided into 2 (two) categories, namely direct losses and indirect losses. Direct losses can be classified as either visible losses or invisible losses. Visible losses include reduced weight gain and mortality in affected animals. Invisible losses include changes in livestock composition or numbers, the burden of delayed sales of production animals, and additional maintenance costs. Indirect losses result from post-outbreak vaccine and surveillance costs, market access barriers, and costs of maintaining successful FMD control programs. A short duration of immunity is induced due to the FMD vaccine, which requires cattle to be vaccinated for 1-3 years per year for continued control.

The R/C values after FMD in 2023, unaffected and affected by FMD, had a higher R/C value than before FMD in 2021. This is because some farmers did not sell their livestock during the FMD outbreak in 2022 but waited until 2023. As a result, the average R/C value

after FMD in 2023 is higher than the R/C before the FMD outbreak in 2021 and during the FMD outbreak in 2022.

Results of Descriptive Analysis of PMK Cases in Rembang Regency

The impact of the foot and mouth disease (FMD) outbreak on the difference in income per cow in two groups, namely the group of cows affected by FMD and those not affected by FMD, can be seen in Table 2. From the descriptive analysis results, the average income difference in the group of cows unaffected by FMD was IDR -6,659,570.68. The minimum or most significant loss is IDR -36,180,500.00, and the maximum value or most significant profit is IDR 10,581,666.67. The maximum income difference obtained by the group of cattle not affected by PMK is IDR 46,762,166.67. In the group of cattle affected by PMK, the average difference in income was IDR -7,900,693.088261. The minimum value or highest loss is IDR -55,065,000.00, while the maximum value or highest profit is IDR 21,573,250.00. The maximum income difference obtained by this group is IDR 76,638,250.00.

Table 2. Descriptive of PMK cases in Rembang Regency

Description	Difference in Breeders' Income for 2021-2022	
	Not affected by PMK	Affected by FMD
Mean (average)	- 6,659,570.68	- 7,900,693.09
Median	- 2,942,875.00	- 6,665,000.00
Minimum	- 36,180,500.00	- 55,065,000.00
Maximum	10,581,667.00	21,573,250.00
Range	46,762,167.00	76,638,250.00

From the results of this analysis, it can be seen that the impact of the FMD outbreak resulted in a more significant decrease in income for the group of cattle affected by FMD compared to the group of cattle not affected by FMD, where the difference in income between the group not affected by FMD and the group affected by FMD decreased by 15.07%. The group affected by FMD had an income 15.07% lower than the group not affected by FMD.

Data Normality Test

The results of the data normality test using the *Kolmogorov-Smirnov* and *Shapiro-Wilk Statistics* for the group of cows not affected by FMD showed significance values of 0.02 and 0.000, respectively. Both values are smaller than 0.05, so the null hypothesis is rejected. Thus, it can be concluded that the data on the difference in income per cow in this group is not normally distributed. Similar results were obtained for the group of cows affected by FMD, where the Kolmogorov-Smirnov and Shapiro-Wilk significance values were 0.000 each. This value is smaller than 0.05, so the null hypothesis is rejected. Therefore, the data on the difference in income per cow in this group is not normally distributed.

Homogeneity Test

One of the main assumptions in using parametric tests is a homogeneity of variance between data groups. According to (Sianturi, 2022), the homogeneity test determines whether several population variants are the same.

Table 3. Data normality test

	Disease	Kolmogorov-Smirnov [a]			Shapiro-Wilk		
		Statistics	df	Sig	Statistics	df	Sig
Income Difference	Not affected by FMD	0.170	46	0.002	0.839	46	0.000
	Affected by FMD	0.204	69	0.000	0.750	69	0.000

This test was carried out as a requirement in the independent sample t-test and ANOVA analysis. Test homogeneity of variance in the two sample groups, namely the cows affected by FMD and those not affected by FMD. In this homogeneity test, the Levene statistic is used with a significance level of 5%. Suppose the result value is sig. Levene > 0.05, the variance of the two groups is considered to be the same or homogeneous.

Table 4. Homogeneity of variance test between data groups

		Levene Statistics	df1	df2	Sig.
Income difference	Based on Mean	1.901	1	113	0.171
	Based on Median	0.955	1	113	0.331
	Based on the Median and with adjusted df	0.955	1	112.112	0.331
	Based on trimmed mean	1.694	1	113	0.196

Based on Table 4, the Levene Test results show a significance value of 0.171. This value is more significant than 0.05, so it can be concluded that the variance between groups of cows affected by FMD and those not affected by FMD is the same or homogeneous. However, based on the results of the previous normality test, it was concluded that the data was not normally distributed. Because the normality assumption is not met, the parametric regression model cannot be used. For this reason, the next follow-up test uses a non-parametric test, namely the Mann-Whitney Test. Although the homogeneity assumption has been fulfilled, the normality assumption has not; therefore, parametric tests are not applicable.

Mann Whitney test

Based on the results of the previous normality and homogeneity of variance tests, it is known that the data on differences in cattle income are generally not distributed but have the same variance (homogeneous). According to (Singgih, 2015), the Whitney U Test is a non-parametric test used to determine the difference in medians of 2 independent groups if the dependent variable data scale is ordinal or interval/ratio but not normally distributed. In this study, a non-parametric test, namely the Mann Whitney Test, was carried out to determine whether there were differences between groups of cows affected by FMD and those not affected by FMD.

The Mann-Whitney Test results show a significance value of 0.045. This value is smaller than the significance level set at 0.05. Based on decision-making rules, if the p-value is less than 0.05, then H1 is accepted. In other words, there is a significant difference between the groups of cows affected by FMD and those not affected by FMD.

Table 5. Mann Whitney Test

	Income Difference
Mann-Whitney U	1236,000
Wilcoxon W	3651,000
Z	-2,004
Asymp Sig (2-failed)	0.045

a. Grouping Variable: disease

The Mann-Whitney Test results showed a statistically significant income difference between the cows affected by FMD and those not affected by FMD. The resulting significance value of 0.045 is smaller than the significance level of 0.05. The absolute Z value -2.004 is more significant than the critical value (± 1.96). Thus, hypothesis 0 (H0), which states there is no difference in income between the group of cows affected by FMD and those not affected by FMD, is rejected. Evidence supports the alternative hypothesis (H1) that there is income between the cows affected by FMD and those not affected by FMD.

In general, it can be concluded that there is a significant difference in average income between the cattle affected by FMD and those not affected by FMD, where the average income of the group of cattle affected by FMD tends to be lower than the group of cattle not affected by FMD based on the results of the Z Test. Because the significance and Z values meet the criteria, it can be concluded that there is a real difference in income between the group of cattle affected by FMD and those not affected by FMD. Previous research also strengthens the opinion that livestock affected by the disease will incur more

costs to return to health care than livestock unaffected by the disease. (Moronte, 2020) said that if an animal tests positive for TB, the farm will lose profits, which is mainly due to the slaughter of the animal, replacement of the slaughtered animal, and sale of the livestock, where the selling price of infected livestock is lower than the market price under normal conditions

CONCLUSION

The occurrence of FMD in Rembang Regency significantly impacted the beef cattle fattening business, so preventive measures need to be taken so that FMD events do not reoccur in the following year. Actions that need to be taken are monitoring livestock traffic, increasing immunity with FMD vaccination, increasing the number of Puskeswan as the spearhead of animal health in the field, and cross-sectoral collaboration and coordination (one Health) to eradicate the FMD outbreak.

REFERENCES

Dintanpan Rembang. 2022. Rembang Regency Agricultural Statistics. Rembang: Rembang Regency Agriculture and Food Service.

Ekowati, T. 2012. Analysis of Beef Cattle Engineering Business and Optimization of Agribusiness System Based Fattening Business in Central Java. Yogyakarta: Faculty of Agriculture, Gajah Mada University, Yogyakarta.

Fathurrohman, R.A.N. and D.S.K. Dewi. 2022. Dynamics of Indonesian Government Policy in Handling the Foot and Mouth Disease (FMD) Endemic. Journal of Social and Political Sciences (JISIP), e-ISSN. 2442-6962. 12 (3): 317-327.

Ministry of Agriculture. 2022. Indonesian Veterinary Emergency Preparedness Foot and Mouth Disease Series (Kiat Vetindo PMK). Jakarta: Directorate of Animal Health, Directorate General of Animal Husbandry and Animal Health, Ministry of Agriculture. Printed and reproduced by the Wates Veterinary Center.

Mohamad A, and N. F. Shaari. MARA University of Technology. 2022. Foot and Mouth Disease on Cattle in Peninsular Malaysia: towards sustainable livestock. Journal of Sustainability Science and Management 17(5): 149-156. DOI: 10.46754/jssm.2022.05.012.

Moronte, R. P., C. P. Rosa., C. G. Schmidt and A. I. M. Cardova. 2020. Quantifying the Economic Impact of Bovine Tuberculosis on Livestock Farms in South-Western Spain. Animals 10: 2433; DOI: 10.3390/ani10122433.

Oak, N. and R. S. Khillare. 2021. Foot and mouth disease: Epidemiology, economic significance, prevention and control strategies in India : A review. The Pharma Innovation Journal, SP. 10 (12): 776-778.

Sianturi, R. 2022. Homogeneity test as a requirement for analysis testing. Journal of Science Education 8 (1) : 386- 397.

Singarimbun and S. Efendi. 1995. Survey Research Methods. Jakarta: PT. Pertja.

Singgih. 2015. Solving Various Status Problems with SPSS. Jakarta: PT. Elex Media Komputindo, Gramedia Group.

Soekartawi. 1995. Farming Analysis. Jakarta: University of Indonesia Press.

Sugiyono. 2019. Quantitative and Qualitative Research Methods and R&D. Bandung: Alpha Beta Publishers. Printed September 1 2019.

Susila, B. E., R. S. D. Daulay, D. N. Hidayati, S. R. B. Prasetyowati, E. Wriningati, S. H. Andesfha, S. H. Irianingsih, I. N. Dibia, A. Faisal, A. Supriyadi, Y. Yupiana, M. M Hidayat, N. Zainuddin and H. Wibawa. 2022. Detection and Identification of Foot and Mouth Disease O/ME-SA/Ind-2001 virus lineage, Indonesia. Journal of Applied Animal Research 51 (1): 487-494. DOI : 10.1080/09712119.2023.2229414.

Tawaf, R. 2017. Socioeconomic Impact of the Foot and Mouth Disease Epidemic on Livestock Development in Indonesia. Proceedings of the National Seminar on Location-Specific Agroinnovation for Food Security in the Era of the ASEAN Economic Community (pp. 1535-1547). Jakarta.

Wulandani, I. 2022. Foot and Mouth Disease (FMD) in Beef Cattle in Central Bangka Regency, Bangka Belitung Islands Province. Vet Bio Clin J. 4 (2): 66-74.