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THE FOOT-AND-MOUTH DISEASE IMPACT ON BEEF FARMING: ANALYZING RISKS AT VARYING OWNERSHIP SCALES

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Abstract:

This study, conducted in three sub-districts of Pasuruan District, East Java, Indonesia, investigated the impact of Foot and Mouth Disease (FMD) outbreaks on beef cattle farms from July to September 2023. Using interviews, questionnaires, and Failure Mode Effect Analysis (FMEA), the research categorized respondents by ownership scales—Small, Medium, and Large. For Small-scale farms, the most significant risks were associated with infected/sick cattle and deceased cattle, while Medium-scale farms faced predominant risks related to infected/diseased cattle, deceased cattle, and trade restrictions. Large-scale farms primarily dealt with risks related to deceased and infected/sick cattle. Farmer behavior analysis indicated a consistent trend, with Medium-scale farmers showing the highest understanding of FMD impact, followed by Small and Large scales. Traders reported substantial decreases in sales volume and turnover (>50%), coupled with increased price volatility. In conclusion, this study affirms that FMD profoundly impacts Small and Medium scales, with primary risks centered around cattle health and disease control expenditures, influencing farmer and trader conduct and contributing to economic uncertainty in the beef cattle sector.

Keywords —income risk, behaviour, business, beef cattle, outbreak

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I. INTRODUCTION

Foot-and-mouth disease (FMD) is one of the major challenges faced by the livestock industry worldwide. This condition, caused by the FMD virus, can damage livestock production, affect farm economics and potentially jeopardise food supply (Singh et al, 2013: Kumar et al 2020). FMD is caused by a virus that is acute and very rapidly transmitted in cattle, buffalo, pigs, goats, sheep and other even-hoofed animals, although the mortality rate is low. The high mobility of livestock, products and people can lead to the rapid spread of the disease. In response to this challenge, local governments have been actively implementing preventive measures against FMD. These include vaccination in endemic areas and efforts to limit livestock mobility through closure of animal markets, as outlined by Zainuddin et al. (2022). Firman et al (2022) reported that the FMD virus transmission rate was R0 = 2.85, i.e. one animal exposed to FMD virus can transmit to 3 animals for two weeks. The economic impact of FMD outbreak was estimated at IDR 38.67 trillion.

The Ministry of Agriculture declared an FMD Emergency Status for livestock. As of July 1, 2022, there were 233,370 active cases in 246 districts/cities across 22 provinces, according to Isikhnas data. The top five provinces with the highest cases were East Java (133,460), West Nusa Tenggara (48,246), Central Java (33,178), Aceh (32,330), and West Java (32,178) (BNPB, 2022). Data from the FMD Handling Task Force showed a total of 312,053 sick animals, 73,119 recovered animals, 3,839conditionally slaughtered animals, and 1,726 dead animals due to FMD (Muhari, 2022). Livestock movement restrictions and trade limitations,

implemented for outbreak control, can hinder market access and livestock product distribution. This situation poses a risk to both large and small beef cattle enterprises, leading to potential financial losses, including reduced income and farm asset values. The associated risk may also have adverse effects on economic stability and food security in areas affected by foot-and-mouth disease outbreaks (Tadase et al., 2017).

Beef cattle business can be considered as an enterprise with three main business processes, namely input management, production process, and output/marketing process. The success of these enterprises is measured by income contributions that include increased livestock ownership, livestock weight growth, and additional farmer household income. Income risk involves understanding and assessing factors such as economic fluctuations, market changes, regulations, health and employment situations. Income risk analysis aims to identify and quantify potential losses, while planning effective risk management strategies. Risk identification is a part of risk management that provides a structured process that identifies how individual and organisational objectives can be affected by risk. The risk identification process should identify undesirable events, undesirable outcomes, emerging threats, and existing and emerging opportunities (Almeida, et.al., 2021; Buel and James, 2019; Chapelle, 2019; Wardhana, 2021).

II. MATERIALS AND METHODS

A. Location and Time

Purposive sampling was used to determine which of the 24 sub-districts in Pasuruan district were still in the red zone (based on the zoning criteria of the affected areas and the number of animal infected or death (Pemerintah Kabupaten Pasuruan, 2022). Site selection with considerations such as: (1) largest beef cattle population per subdistrict, (2) FMD endemic status, and (3) level of disease control implementation.

The study was conducted for three months from July to September 2023, including preliminary survey, data collection, data processing and reporting. Respondent farmers were divided into 3 business groups which were: a) Small Scale (1 - 5 head), b) Medium Scale (6 - 10 head) and c) Large Scale (>11 head).

B. Data

This study gathered two types of data: primary data and secondary data. Primary data came directly from interviews and questionnaires, aiming to understand cattle ownership, maintenance costs, revenue, and farmer income before and during Foot and Mouth Disease (FMD) outbreaks. On the other hand, secondary data were obtained from various agencies like the Central Bureau of Statistics (BPS) and the Livestock and Animal Health Service Office of Pasuruan District. The data were categorized into two groups: (1) Farmers as producers, including: a. Characteristics of respondents, b. Production capacity, c. Quantity of sales, and d. Livestock status (physiological, number of sick/healed/dead). (2) Business actors, such as middleman/belantik traders, feed entrepreneurs, and fresh meat traders.

C. Methods

The census method is a sampling technique where all individuals in the population are enumerated (investigated or interviewed) as samples or respondents (Haris, 2021). Based on the results of the pre-survey conducted and obtaining information from Field Agricultural Extension Officers (PPL) / Inseminator / Health Officers in several Districts of Pasuruan Regency.

D. Analysis Model

Risk analysis of beef cattle business income is carried out using Failure Mode and Effect Analysis (FMEA) in the form of a risk matrix, namely Risk Priority Number (RPN) by calculating the value of S (Severity), O (Occurrence) and D (Detection) (Prasetya et.al, 2021; Aprianto et. al, 2022). S is a quantification of how serious the resulting condition is in the event of a failure, O indicates the level of probability of failure and D indicates the level ofescape of the cause of failure from the installed controls. RPN assessment was the product of severity (S), occurrence (O), and detection (D) ratings.

To measure farmers' perceptions and opinions on FMD outbreaks and social and economic impacts, a Likert scale was used. With this Likert scale,

respondents are asked to complete a questionnaire that requires them to indicate their level of agreement with a series of questions. The level of agreement referred to in this Likert scale consists of 4 scale options that have gradations from Strongly Agree (SS) to Strongly Disagree (STS). The four choices can be seen in the following table:

TABLE I
Score of Likert Scale

No.	Answer options	Code	Score
1.	Strongly agree	SS	4
2.	Agree	S	3
3.	Disagree	TS	2
4.	Strongly disagree	STS	1
5.	Did not know	TT	0

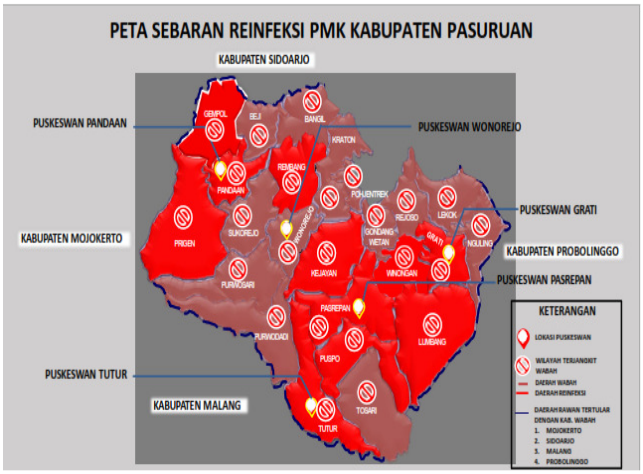

Fig. 1 Distribution of FMD in Pasuruan District

III. RESULTS AND DISCUSSIONS

A. Characteristics of Regions and Respondents

Regions with a high concentration of livestock, particularly cattle, may be more susceptible to FMD outbreaks due to the contagious nature of the disease. FMD control efforts continue to be implemented quickly and massively, coordinated by all parties from the centre to the regions. Pasuruan District, as one of the cattle breeding and development centres in East Java, is an FMD-affected area. Strategic steps to control FMD in synergy with Forkopimda, Forkopimcam, Village Government, community leaders and related stakeholders.

Regional Characteristics

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Characteristic of Respondent

The age of respondents in the three selected sub-districts (Kejayan, Wonorejo, and Prigen) are all at the productive age of 15-65 years (BPS, 2021), productive age is measured from the age range of 15-64 years and non-productive is classified based on a certain age range or more than 64 years. 57.37% of respondents were aged >50 years, followed by <40 years (23.07%) and 40-50 years (19.55%). This findings was different to reports on Bali Cattle Farm in Timor Island (Habaora et al, 2019), the average of farmers age was mostly range from 31-45 years and they were spread out in four agroecosystem, namely Pasture, Forestry, Agriculture, and Plantation. Farmer productivity is influenced by physical strength and ability to think so that the productive age determines the taking of actions and efforts to increase knowledge skills of information and new technologies in diversifying their businesses. Engaging in food crop farming asthe primary source of livelihood, many individuals in operating beef cattle fattening as a secondary business, as highlighted in the findings of Isyanto and Sudrajat (2019). Their research reveals that this secondary venture boasts a productivity range of 0.23 to 1.0, averaging at 0.53, while technical efficiency spans from 0.54 to 0.99, averaging at 0.77. Noteworthy influencers of technical inefficiency include

education, experience, the quantity of owned beef cattle, and accessibility to credit.

TABLE II
CHARACTERISTICS OF RESPONDENT IN THREE SUB-DISTRICTS OF PASURUAN

No.	Items	Sub-districts			Total number
		Kejayan	Wonorejo	Prigen	
1	Number of respondent	102	109	101	312
2	Livestock ownership scale :				
	a. Small (1-5 head)	56	90	31	117
	b. Medium (6-10 head)	42	9	29	80
	c. Large (>11 head)	4	10	41	55
3	Age :				
	a. < 40 years	31	20	21	72
	b. 40 - 50 years	20	22	19	61
	c. > 50years	51	67	61	179
4	Education				
	a. Not completed Elementary School	-	5	6	11
	b. Elementary School	84	39	32	155
	c. Junior School	13	37	27	77
	d. Senior High School	35	27	33	95
	e. Bachelor Science	-	-	1	1
5	Length of beef farming				
	a. < 1 years	-	-	-	-
	b. 1-5 years	4	1	1	6
	c. > 5 years	98	108	100	306
6	Number of family member				
	a. < 3 person	61	31	65	157
	b. 3-5 person	34	42	20	96
	c. > 6 person	7	36	16	59
7	Livestock business as a:				
	a. Part-time	102	109	101	312
	b. Main, i.e:				
	- Farmer	68	49	53	170
	- Farm labourer	9	14	12	35
	- Trader	5	4	13	22
	- Tradesmen/craftsmen	1	4	8	13
	- Civil servant			1	1
	- Entrepreneur	18	10	-	28
	- Others (Private Employee, Driver,	1	29	14	44

8	Family income (IDR/month)				
	a. < 1 million	-	-	-	-
	b. 1.1-3 million	42	59	5	106
	c. > 3.1 million	59	50	96	205
9	Own livestock other than cattle				
	a. yes	97	42	5	144
	b. no	5	67	96	168

B. Income Risk Factors at Three Scales of Livestock Ownership

Any business in the livestock sector will always face various risk factors, which if not anticipated and handled properly, can have a negative impact on the results of the business. Although risks in the production process cannot be completely eliminated, they can be better managed through risk identification activities. In the context of beef cattle farming income risk, there are two aspects measured, namely risk factors and risk indicators.

Based on risk identification, there are five risk factors for beef cattle business due to FMD faced by farmers in Pasuruan District, namely the risk of the number of cattle kept, the physiological status of livestock, cultivation techniques, the cost of treatment and disease control, and marketing risk. Survey data on risk factors and risk indicators that reflect SOD and RPN values are summarised in Table III.

Small Scale

Severity (S) analysis results with the highest score of 9 (range 1-10) were found in all risk factors. Risk factor Marketing (5) was found in the indicator of low selling price of sick cattle; risk factor Disease treatment/control (4) was found in the indicator of infected cattle, while risk factor (1) physiological status of cattle was found in the indicator of mature cattle. The other two risk factors that scored 9 were Number of Cattle Kept (2) and Technical Farming (3); respectively in the Dead Cattle and Cage and Environmental Sanitation risk indicators. The severity level is in line with the opinion of Aprianto et al (2020) that the Severity Level is an assessment of the seriousness of the effects caused in the sense that each failure that arises will be assessed how serious it is.

The quantity of occurrence (Occurrence, O) with the highest score =9 is found in all risk factors, namely in the risk indicators Adult Cattle (1.1), Healthy Cattle (2.1), Cage Sanitation and Environment (3.4.), Sick/Infected Cattle (4.1), Healthy Cattle (4.3), and Selling Price of Sick Cattle (5.2). These scores reflect the frequency of FMD outbreaks affecting adult and healthy cattle. The incidence of outbreaks on this small scale is found in poor housing sanitation and in a polluted environment, both internal and in contact with humans, feed, or other housing infrastructure.

Detection (D) with the highest score =1 is found in the risk factors Number of Cattle Raised (2) and Technical Farming (3), respectively in the risk indicators Healthy Cattle (2.1), Livestock Care (3.2), and Cage and Environmental Sanitation (3.4). These Detection rate values are negatively correlated with Occurrence and Severity rates. Assesses how effective the detection system is at detecting or preventing a failure mode specifically in terms of revenue generation failure. The scale is generally from 1 to 10, where value=1 indicates a high detection rate, and value=10 indicates a low detection rate.

The highest risk score (Risk Priority Number) is found in the risk factor number of cattle kept (2), namely in the risk indicator number of sick/infected cattle (2.2) (RPN=448), followed by the risk indicator number of dead

cattle (2.3) (RPN=441), and the risk factor cost of treatment/control (4) with the risk indicator cost of controlling sick/infected cattle (RPN=324). The highest RPN value in this risk indicator is related to the ranking obtained, namely ranking 1, 2, and 3 as a priority that must be followed up. Thus, a mitigation strategy is needed to maintain the income of small-scale farmers by maintaining the number of cattle population (healthy cattle) raised by immediately taking control measures against FMD through tightening the biosecurity system (implementation of vaccination and total sanitation).

Medium Scale

The data in Table III shows that the highest score = 9 in Severity (S) occurred for the risk indicator of physiological status of adult cattle (1.1). The same score for the risk factor of cost of treatment/control of infected cattle (4.1) and the risk factor of low selling price of sick cattle (5.2). This situation appears to be similar to that experienced by small-scale farmers. The same pattern is also shown for the highest frequency of occurrence (Occurrence, O) as a source of production at risk at the income level of Medium-scale farmers is found in the risk factors of (1) Physiological Status of Livestock, (2) Number of cattle kept, (3) Technical Cultivation, (4) Cost of treatment and disease control, and (5) Marketing. While the highest detection value (score=1) occurs in the risk indicators Healthy Cattle (2.2), Livestock Care (3.2), and Cage and Environmental Sanitation (3.3). On the other hand, Hanum et.al (2020) reported that in the beef cattle breeding business 3 out of 11 risks that have the highest RPN value for group farmers are the quality of feed used, AI failure, and breeder errors in identifying the time of calving.

The highest RPN value in the Medium Scale group was generated in the risk factor of the number of cattle kept (2), namely in the risk indicators of infected/sick cattle (=392) and dead cattle (392), each in the rank-1 position, followed by the risk factor of treatment/control costs of infected cattle (324) and the marketing risk factor of low selling price of sick cattle (324); thus each in the rank-2 position. Meanwhile, the marketing risk factor on trade restriction indicator ranked 3rd (RPN= 216).

When compared between Small Scale and Medium Scale groups, it turns out that the risk factors of number of cattle kept, cost of controlling/treating livestock have the same ranking, which is rank-1 in the sense that they are the main risks faced by Small Scale and Medium Scale groups. However, the RPN value of Small Scale is higher than Medium Scale (448 vs 392). The difference in RPN values is strongly related to the severity (S), occurrence (O), and detection (D); where the Small Scale shows a greater score than the Medium Scale. Therefore, in the context of FMD research in beef cattle enterprises, a high Severity score for factors related to cattle health and economic impacts will increase the RPN value, which may indicate that corrective or mitigating actions need to be taken to reduce risks and impacts related to farmers' production and income.

Large Scale

The highest Severity Level (S) analysis results (score=9) in the Large Scale group were found in three risk factors, namely: Animal Physiological Status (1), Costs of Treatment and Disease Control (4), and Marketing (5); respectively on the risk indicators for Mature Cattle (1.1), infected/sick cattle (4.1), and Low Selling Price for Sick Cattle (5.2).

TABLE III
THE SCORE OF SEVERITY, OCCURRENCE, DETECTION, AND RISK PRIORITY NUMBER AT THREE SCALES OF BEEF CATTLE OWNERSHIP

Factor of Risk	No.	Risk Indicator	Small scale					Medium scale					Large Scale				
			S	O	D	RPN	Rank	S	O	D	RPN	Rank	S	O	D	RPN	Rank
(1) Physiological states of animal	1.1	Mature cattle	9	9	2	162	5	9	9	2	162	4	9	9	1	81	11
	1.2	Heifers/Young male	8	4	3	96	7	7	4	3	84	8	7	5	3	105	8
	1.3	Calf	7	6	2	84	9	8	6	2	96	7	8	6	3	144	7
(2) Number of cattle raised	2.1	Healthy cattle	6	9	1	54	11	8	9	1	72	9	8	9	3	216	4
	2.2	Infected/diseased cattle	8	7	8	448	1	7	7	8	392	1	7	6	8	336	2
	2.3	Dead cow	9	7	7	441	2	8	7	7	392	1	8	7	7	392	1
(3) Management	3.1	Feed management	7	3	2	42	12	7	3	2	42	10	7	4	2	56	13
	3.2	Raising cattle	8	5	1	40	13	8	5	1	40	11	8	6	2	96	9
	3.3	Mating	6	5	3	90	8	7	5	3	105	6	8	6	3	144	7
	3.4	Sanitation	9	9	1	81	10	8	9	1	72	9	8	9	1	72	12
(4) Costs of treatment and disease control	4.1	Sick/infected cattle	9	9	4	324	3	9	9	4	324	2	9	9	4	324	3
	4.2	Dead cattle	4	3	7	84	9	4	3	7	84	8	4	3	7	84	10
	4.3	Healthy cattle	8	9	2	144	6	7	9	2	126	5	7	9	3	189	5
(5) Marketing	5.1	High selling price of healthy cattle	5	6	3	90	8	5	6	3	90	8	7	7	3	147	6
	5.2	Low selling price of sick cattle	9	9	4	324	3	9	9	4	324	2	9	9	4	324	3
	5.3	Trade Restrictions	8	9	3	216	4	8	9	3	216	3	8	9	3	216	4

The sameresults were obtained in the Medium scale and Small scale groups, namely in the risk indicators (1.1), (4.1), and (5.2), but the highest level of severity in the Small Scale group was also found in the cultivation technical factor (3) in the sanitation risk indicator. environmental pen (3.4) and risk factors for treatment/disease control costs (4) on indicators of infected/sick cattle (4.1). The data in Table III shows that the highest incidence rate (Occurrence, O) (score = 9) is found in six risk indicators, namely (1.1), (2.1), (3.4), (4.1), (4.3), and (5.3). Meanwhile, the Small Scale and Medium Scale groups each have seven risk indicators.

The highest detection (D) value (=1) in the Large scale group was found in the risk indicators for the number of Adult cows (1.1) and Sanitation of Enclosure and Environment (3.4). This is not linear with the RPN getting bigger which has the potential to make the indicator rank the highest. The highest RPN (396) was actually found in the risk indicator for the number of dead cows (2.3), followed by the risk indicator for infected/sick cows (2.2) RPN score = 336, so that respectively they got rankings 1 and 2 as risk factors that can affect income. beef cattle breeder. Rank 3 was obtained in the risk factors for medical costs and disease control (4) and marketing (5); each is found in the indicators of infected cows/sick cows. Akbar et.al (2021) reported that the number of livestock owned ($p<0.05$) was a factor that had a negative effect on farmers' opportunities to carry out risk mitigation strategies. Apart from the income aspect, Hanum et al (2021) added that the Feed factor (an indicator of the risk of the quality of the feed provided) and Artificial Insemination (an indicator of the failure of artificial insemination) are the highest risks in the beef cattle breeding business.

C. PERCEPTIONS AND ATTITUDES OF BUSINESS ACTORS TOWARDS FMD OUTBREAK

Farmer Response

Farmers take foot and mouth disease in livestock seriously, because this condition can affect animal health and productivity, and ultimately impact the level of business sustainability. Foot and mouth disease in livestock is usually caused by microorganisms in the form of viruses. Some common breeder responses to this disease involve preventive measures, early diagnosis, and appropriate treatment.

The data in Figure 2 illustrates livestock farmers in the three sub-districts show the same response to the understanding that the FMD disease attack has threatened business sustainability (p1) with an average score of Agree (3.39±0.08). This has implications for the number of livestock kept which is affected by the FMD outbreak (p2). The highest score was found in Medium scale farmers (3.52) followed by Small scale (3.35) and Large scale (3.17). Small scale farmers gave the highest response (3.85) to (p11) that sanitation/biosecurity programs are very useful for efforts to control FMD outbreaks. This high score was followed by the Medium scale (3.51) and Large scale (3.40) breeder groups, so the average score obtained also appeared to be the highest (3.59±0.14). This appears to be in line with the results of the analysis of factors and risk indicators on breeder income (as listed in Table III), that the Severity and Occurrence levels of the risk indicators for Cage Sanitation and Environment have the highest score (score=9). This indicates that farmers are aware that with this FMD outbreak, disease control actions in the form of sanitation of cages including efforts to disinfect livestock, cages, workers and cage equipment are something that must be done. Likewise, farmers must limit the movement of incoming people, especially those from areas endemic to FMD outbreaks.

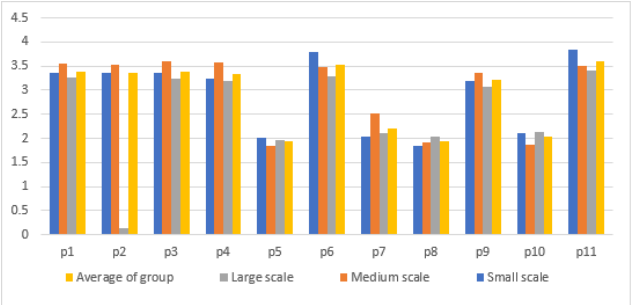

Fig. 2 Farmers Behavioral Response to the FMD Outbreak on the Three Scales of Livestock Ownership

Regarding the negative-direct question (p7), there is an understanding that the majority of farmers stated that they Disagree (TS) with a score of 2.21±0.15, that cows affected by FMD should be slaughtered with the aim of avoiding secondary transmission and are still valuable. This condition reflects that breeders do not yet know and choose the risks of treatment/control. In line with question (p8), the farmer stated that he Disagrees (TS) with the understanding that meat affected by FMD can still be consumed by humans. The highest score was found in Large scale breeders (2.03), followed by Medium scale (1.92) and Small scale (1.84). This fact reflects that farmers need to understand and socialize that meat from cattle affected by FMD is still suitable for consumption, so that farmers have the courage to make the decision to sell their livestock and losses caused by the FMD outbreak can be reduced.

Response of the Traders

The FMD outbreak has had a serious impact on the livestock industry and trade in cattle, fresh meat and feed. Business actors' responses to this outbreak may vary depending on a number of factors, including the level of disease spread, preventive measures taken, government policies, and the level of industry preparedness. Both small-scale (belantik) and large-scale cattle traders expressed almost the same response to question (ps1) that the FMD outbreak had an effect on livestock buying and selling activities, 78% said Agree (S) and 22% Strongly Agree (SS). As many as 94% of cattle traders stated that the number of cattle they bought from breeders or from other traders had decreased due to the FMD (PS2) outbreak, however, the activity of selling cattle was not all down, this was proven by 46% of traders stating Disagree (TS) when responding question (ps3) even though the trader admitted that due to the Animal Market being closed, it was difficult for traders to get livestock which are healthy for sale (ps4) and this is a logical consequence of the policy implemented by the Regency Government through the UPT Animal Market Service to limit direct transactions of buying and selling cattle with the aim of preventing the further spread of the outbreak caused by the FMD virus. The research results show that at the marketing level, the price of live cattle is relatively constant/the same (before and after the outbreak). This refers to the answer to question (ps6), that 50% of Cattle Traders stated that they Agree (S) that the purchase price of livestock before the outbreak was higher, but 50% of other traders answered Disagree (TS). More traders confirmed that the price of healthy cattle before the outbreak was higher than after the outbreak (ps7 and ps10) with mean scores of (2.61±0.15) and (2.72±0.32) respectively. Although in the end more than half of cattle traders (67%) stated that they Disagree (TS) to question (ps12), that is, in general, livestock traders' profits have suffered a loss of >50% due to the outbreak.

The response from meat traders in traditional markets showed that 94% of respondents stated that they agreed (S) that the FMD outbreak had an impact on the activities of fresh meat entrepreneurs (pd1). This result is closely related to the reduced supply of meat from slaughterhouses (RPH) due to the large number of cows that died or became sick due to FMD attacks. Thus, meat traders stated that the turnover of fresh meat in the market had decreased; in line with the answers to questions (pd2), (pd3), and (pd4), as illustrated in Figure 2.b. The decrease in turnover has no effect on the increase in the price of meat sold on the market; 60% of meat traders stated that they Agree (S) with question (pd5) that Market Entrepreneurs (retailers) reduce the selling price of meat, with an average score of 2.93±0.76. This is thought to be related to the decreasing level of

market demand due to consumers being wary of local meat products in the context of the FMD outbreak. The principle of caution and being alert to the meat products being sold, the majority of traders (80%) ask about the origin of the livestock they bought (region/village/district) (pd7); The average score obtained was 2.87±0.51.

The same response was shown by meat traders and feed traders to the endemic situation of the outbreak. The majority (94%) of feed traders (agricultural residue, raw materials and concentrates) stated that the FMD outbreak had an impact on animal feed buying and selling activities (pk1) with an average score of 3.06 - 0.06. This is supported by the statement of a decrease in feed sales turnover during the outbreak, which is in line with the answers to questions (pk3) and (pk4). During the outbreak, feed traders admitted that they did not increase the selling price of feed. This is proven by TS's feed with an average score of 2.13±0.09. Thus feed traders confirmed that they stated losses due to the decline in feed sales turnover and stated Disagree (TS) (75% of respondents) to question (pk8), that profits remained or were the same as conditions before the outbreak, the average score obtained was 2.25± 0.1.

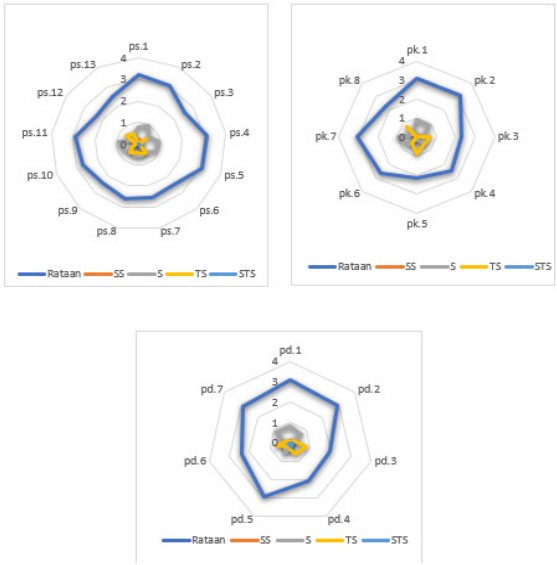

Fig. 3 (3.a): Response of Catle Traders, (3b) Response of Feed Traders, (3.c) Response of Fresh Meat Traders.SS:

IV. CONCLUSIONS

The risk factors for the number of cattle kept, costs of controlling/treating livestock, and marketing are the main risks that influence the income of farmers at three scales of livestock ownership during a FMD outbreak.

The Small Scale RPN value (448) appears higher than the Medium Scale (392) and Large Scale (392). The difference in RPN values is closely related to the level of Severity (S), Occurrence (O), and Detection (Detection, D). A high severity score on factors related to cattle health and economic impact increases the RPN value, which can be a clue that corrective or mitigation actions need to be taken to reduce the risks and impacts associated with production and farmer income.

There has been a decrease in turnover and activity by business actors (cattle traders, fresh meat traders and feed traders), but there is no certainty of an increase or decrease in the prices of traded goods.

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