Research Article

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Strategies for overcoming farmers' lives in volcano-prone areas: A case study in Mount Semeru, Indonesia

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Abstract: Mount Semeru is one of the most active volcanoes in Indonesia and the highest mountain in Java Island. Although the island is prone to volcanic eruptions, it is densely populated and also home to several farmers. The aim of this study is to analyze the strategies for overcoming farmers' lives in Mount Semeru. This study involves 150 farmers who were randomly selected from terrains located at altitudes between 6 and 10 km in Mount Semeru. This study shows that farmers benefit significantly from the fertile lands resulting from volcanic eruptions. And they are highly motivated to engage in mitigation activities to reduce the impacts of eruption; therefore, they tend to participate in mitigation education or programs organized by government or private institutions. Support with the information and financial access regarding any mitigation strategies can help farmers a lot. Coordination among stakeholders to support mitigation strategies is necessary because all the parties are equally responsible for alleviating the impacts of volcanic eruptions. Any strategies for overcoming farmers' lives in volcano areas also can be supported by community resilience.

Keywords: volcano, Mount Semeru, farmers' lives, adaptation, mitigation

1 Introduction

The agricultural sector plays an integral role in developing countries, including Indonesia. Some of its functions in such countries involve supporting local and national incomes, providing livelihood, and providing the raw materials for manufacturing industrial products [1,2]. In fact, these significant contributions are not commensurate with the rewards earned by farmers; consequently, several farmers are below the poverty line [3]. The agricultural sector is still faced with several challenges at individual, local, and national levels. These challenges include small land holding, lack of education, skyrocketing input prices, modernization, and regulation issues [4]. Thus, on the whole, farmers lead extremely difficult lives. Because relying on agriculture to support household needs seems to be an unwise option [5], many farmers often rely on secondary sources of income to fulfill their daily needs. Farmers often project their dreams on to their children, hoping for them to receive better job opportunities.

The difficulties that already existed are aggravated by the natural disasters that have recently occurred in Indonesia [6]. Java Island, Indonesia's most densely populated island with a substantial farming population, is facing the same trend resulting from the occurrence of natural disaster [7]. Rozaki et al. [8] mentioned Java Island to be severely prone to natural disasters, including volcanoes, floods, earthquakes, and landslides. Each of these disasters has its own characteristics and affects the agricultural sector to varying degrees. Mount Merapi is categorized as the most active volcano in Java Island [9].

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However, there are other active volcanoes – including Mount Semeru – that also threaten human life [10]. Mount Semeru poses risks and hazards for the inhabitants – including farmers – residing in the surrounding areas [11,12]. As evident in Figure 1, volcanic eruptions have occurred in almost each of the years from 2000 to 2020. Situated in the East Java Province, Mount Semeru is the highest mountain in this island. Throughout history, the mountain has witnessed several volcanic eruptions from the earliest one dating back to 1818, although the frequency of eruptions increased from 1967 [13].

Despite the frequent volcanic eruptions and significant hazards associated with the same (particularly for inhabitants at higher altitudes), this mountainous region continues to be densely populated. This is because the volcano is the inhabitants' homeland and native place; moreover, the hazards of occupying this region are accompanied by benefits in the form of a fertile land [15]. Regions situated in volcanoes are typically rural areas, with farming being the most prevalent source of livelihood for most inhabitants. Other common primary occupations in these regions include livestock, sand mining, and tourism activities, because these terrains are frequented by mountain climbers [16,17]. Potatoes and vegetables are commonly cultivated in this volcanic region [18]. Each of these economic activities significantly contributes to the development of Mount Semeru [19].

Because of the prevalence of several volcanic mountains in Indonesia, Volcano disaster mitigation is one of the priorities in this country. Consequently, the participation of its inhabitants, including farmers, is crucial to make the efforts a success [20]. Farmers are an important party in agriculture; therefore, farmers' lives should be considered in developing or protecting agriculture, especially in volcano-prone area. The first step toward mitigation awareness is to gauge the general perceptions about the risks and hazards associated with volcanic eruptions; with an understanding of these perceptions, suitable regulations can be made to ensure a better future [21]. To date, there are very few studies about farmers' lives in volcano disaster area; the literature study shows that more research was conducted about farmers' lives in other disaster-prone areas such as forest fire areas [4]. Understanding the strategies to overcome farmers' lives in volcano-prone areas is important and can contribute to suitable policy and actions regarding the efforts to support farmers' lives in vulnerable areas such as Mount Semeru. Therefore, this study aims to analyze farmers' lives in Mount Semeru, East Java, Indonesia and studies their coping strategies in the face of volcano disasters. The structure of this article is introduction, research method, results and discussion, and conclusion.

2 Literature review

Indonesia is a country that has many active volcanoes; it makes this country become more vulnerable because of various disasters not only volcano disaster [22]. Mitigation strategies reduce the impacts of disasters on human lives. In addition to the hazards that occur suddenly, volcano also provides benefits for those who live in surrounding area, including farmers [17]. In disaster-prone area, mitigation efforts are important. The participation of involved parties is also important [20].

The common behavior among people living in volcano-prone area is staying there due to the heritage and the benefits from the volcano soil (i.e., agriculture). It is a complex relation between human, volcano mountain, and environment, which gives people not only economic, but also spiritual and sociocultural benefits [23]. The blessing that farmers get from volcano is fertile land that can give economic benefits through successful agriculture [17].

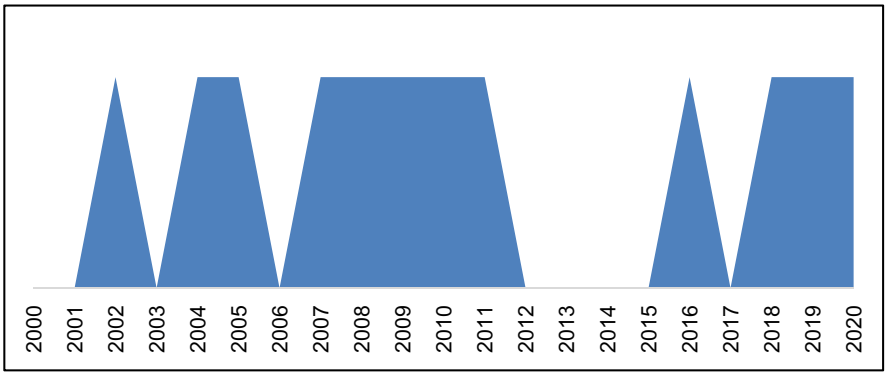

Figure 1: Year eruption occurrence of Mount Semeru [14].

Mount Semeru is the highest mountain in Java Island and categorized as active volcano, and it is located in East Java [11]. This volcano also often erupts with various scales starting from 1818 and became more intense from 1967 [13]. Hot ash is common type of hazard from volcanic eruption in Mount Semeru [12].

People who live in the surrounding of volcano-prone area are vary, but commonly work as farmers because the land is suitable for agriculture. The same is true for people who live in the surrounding of Mount Semeru, where they are working in agriculture, tourism, and other related economic activities. Each economic sector plays an important role for the development of this volcano [19]. Agriculture practice in Mount Semeru is dominated by potato and vegetable cultivation [18]. Farmers' lives in volcano-prone area are unique because of their will to still stay and do farming activities, even though the hazards are close to them. People in the area are trying to face and adapt to the hazards of volcano disaster [24].

Farmers who live in volcano-prone areas become more vulnerable, because without living in disaster prone-area they are already vulnerable because of the fluctuations in agricultural product, input price, human resources, and environment [25]. Therefore, farmers in volcano-prone area do have high willingness to survive and overcome any challenges and threat that they face. The strategies to overcome the farmers' lives in volcano-prone areas are important for supporting their lives and future generation [26]. Considering the implementation of circular economy for agriculture practice in volcano-prone areas may increase the agriculture sustainability and employment opportunity [27].

3 Research method

3.1 Study area

This study was conducted in Mount Semeru, an active volcano region in East Java. Many farmers inhabiting this region face risks and hazards resulting from this volcano, warranting an analysis of farmers' lives in such terrains. This study, conducted in areas located at a distance of 6–10 km from the center of the volcano, covers: (i) Supiturang Village, Pronojiwo Subdistrict, Lumajang Regency; and (ii) Oro-oro Village, Batu Subdistrict, Batu City.

3.2 Sampling procedure and data collection

This study comprised a total of 150 farmers, i.e., 75 farmers each from Supiturang Village and Oro-oro Village, respectively. Those farmers were chosen randomly, and the data were collected using a semi-structured interview with a designated questionnaire developed through observation and a literature review. The interview used a data collection technique that can cover a broad range of topics [28]. This study used four main variables, each consisting of sub-variables and indicators (Tables 1–4). Each indicator was measured using specific questions contained in a questionnaire. Observations were also drawn to supplement the findings obtained from semi-structured interviews [6]. The research methodology flowchart is shown in Figure 2. Three main parameters for assessing farmers' lives and coping strategies are as follows: first, volcanic hazard variable that shows the impact of volcano on farmers' lives [20]. Second, mitigation that shows the level of mitigation condition in farmers' lives [21]. And third, external variable that shows some aspects external to farmers that may affect the farmers' lives in volcano-prone area [20]. Those variables can contribute to analyze the farmers' vulnerability, although they are already vulnerable because of poverty [3]. The findings of this study can show how farmers prepare, deal and adapt toward the volcano hazard and risk impacts [8].

Informed consent: Informed consent has been obtained from all individuals included in this study.

Table 1: Demographics of respondent variables

Variable	Measurement
Gender	Male or female
Age	How old the farmers were (year of birth)
Education	Elementary school to university/diploma
Number of family members	Persons in the family
Farm size	m^2
Farming experience	For how long the participants were involved in farming (years)

Table 2: Volcanic hazard variable

Variable	Measurement
Hazard type and frequency	Type of hazard (hot ash, bomb, lava, or other). Hazard frequency measured using a Likert scale: 1 (very rare) to 5 (very often)
Risk and hazard degree	Likert scale: 1 (very small) to 5 (critical)
Eruption impact	Impact on agriculture, nonagriculture, and human life (family members). Measured using a Likert scale from 1 (no loss) to 5 (colossal losses)
Volcano benefit	Likert scale from 1 (strongly disagree) to 5 (strongly agree)

Table 3: Mitigation variable

Variable	Measurement
Risk and response knowledge	Understanding of the risk factors (Yes/No). The response action when the eruption occurs is measured based on whether they evacuate or not
Mitigation motivation	Likert scale from 1 (very low) to 5 (very high)
Mitigation education	The availability, provider, and how the mitigation education is beneficial prior, during, and post eruption

3.3 Analytical technique

A descriptive method is used to present and elaborate on the findings. Mean, frequency, and percentage were calculated to determine the trends in and differences between variables and indicators. A multiple logistic regression analysis has been used to analyze the relation between independent variables (demographics of respondents) and dependent variables (volcanic hazards, mitigation, and external variables).

4 Results

4.1 Demographics of respondents

The demographics of respondents are important variables in every research as they reveal their basic conditions [29]. In general, respondents' (in this context, the farmers) demographics influence their decision-making and necessary reforms with regard to their lives and faming activities [30]. These demographics also act as

Table 4: External variable

Variable	Measurement
Government support	How the government support provides benefits during the pre-, during, and post-eruption phases
Financial access	Financial support and ease of obtaining capital are determined using a Likert scale from 1 (strongly disagree) to 5 (strongly agree)
Environment and infrastructure support	Likert scale from 1 (strongly disagree) to 5 (strongly agree)
Social access	Ease of social interactions and people's unity are the primary indicators. These variables are measured through a Likert scale from 1 (strongly disagree) to 5 (strongly agree)
Information access	Ease of obtaining information is measured using a Likert scale from 1 (strongly disagree) to 5 (strongly agree). Additionally, the source of information pertains to the sources that farmers access to obtain information regarding a disaster and its mitigation

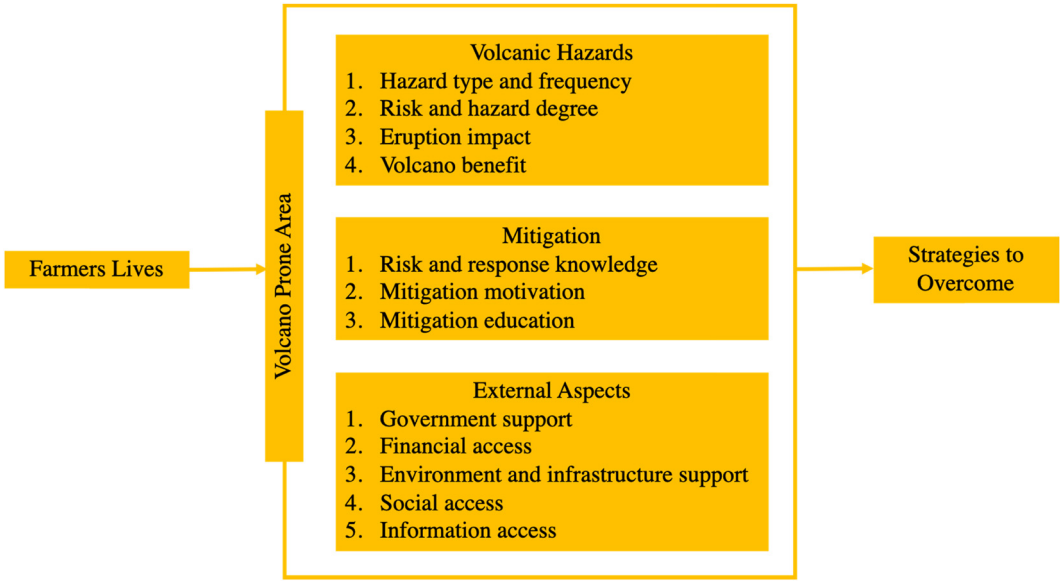

Figure 2: Research flowchart.

baselines indicating farmers' conducts on their agriculture practices.

The issue of gender is inextricably linked to agriculture as the degree of imbalance in agricultural workload between the genders is significantly influenced by the area being considered [31]. In the modern world, males and females have equal rights in some occupations, but for physical occupation such as agriculture, the equality is not explained as equal in workload, but more in giving female opportunity to work. And as a result of their physical prowess, men are typically employed in larger numbers in occupations requiring manual labor [32]. In this study, the male and female respondents are 56% and 44%, respectively (Table 5). Farmers in this study stated that occupations such as planting, watering, and harvesting, which require considerable physical labor, are dominated by men. On the other hand, occupations relating to management and sale of products typically involve more women than men [33]. Although not formally documented, this gendered division of labor has become the norm in the agriculture activities practiced at Mount Semeru.

As a result of the manual labor involved in agriculture, farmers' performance is affected by age [34]. The younger the farmers, the more is their strength; thus, they can contribute more in the physical activities involved in agriculture. The agricultural sector consists of aging farmers, not only in Indonesia but also worldwide. This trend relegates agriculture to a more vulnerable position, particularly in the future [4]. The average age of respondents in this study is 47.17 years; although this age is still classified within the productive age group, it is close to the age of 50, which implies that their productive years are limited. Also, most respondents (43.33%) fall into the age range of 41–53 years. The age range with the least number of respondents (i.e., with 4.67%) is 15–27 years. Additionally, farmers spend most of their lives in Mount Semeru: this is demonstrated by the length of stay that averages 43.5 years. Moreover, the majority, i.e., 70%, of respondents have already lived in this volcano for more than 40 years.

Education is another internal factor that affects farmer's decision-making [28]. Evidently, the lesser the education, the lower are the levels of awareness and acceptance of change or innovation in their lives. In developing countries like Indonesia, farmers typically have lesser education levels [35]. With 63.34% of the respondents having only completed elementary school education, this study unearths that a majority of farmers are poorly educated. Although 3.33% farmers can reach diploma/university, the majority have a low level of education. This can lead to a lack of acceptance of change or innovations [36].

The primary demographical issue in Indonesia is the prevalence of large families [37]. The popular belief here is that the more the number of children, the more are the prosperity and sustenance levels. Therefore, many people have more than two children. To control this population explosion, the government initiated a family planning program that encourages people to have only two children [38]. In this study, a majority of the respondents have four or more family members; this is further demonstrated by the mean, which is more than four. Consequently, farmers typically have more mouths to feed [39].

Table 5: Demographics of respondents

	Freq.	Percent		Freq.	Percent
Gender			Education		
Male	84	56.00	None	1	0.67
Female	66	44.00	Elementary	95	63.34
Total	150	100.00	Junior	32	21.33
Age (Year, Mean: 47.17)			High	17	11.33
15–27	7	4.67	Diploma/Univ.	5	3.33
28–40	34	22.67	Total	150	100.00
41–53	65	43.33	Family member (Mean: 4.12)		
54–64	33	22.00	1	0	0
≥ 65	11	7.33	2	10	6.67
Total	150	100.00	3	32	21.33
Farm size (m^2, mean: 4897.67)			4	59	39.33
0–999	0	0.00	≥ 5	49	32.67
1,000–1,9999	13	8.67	Total	150	100.00
2,000–2,999	77	51.33	Farming Experience (year, mean: 21.74)		
3,000–3,999	0	0.00	0–9	18	12.00
≥ 4,000	60	40.00	10–19	35	23.33
Total	150	100.00	20–29	51	34.00
Length of stay (year, mean: 43.5)			30–39	31	20.67
0–9	3	2.00	≥ 40	15	10.00
10–19	5	3.33	Total	150	100.00
20–29	16	10.67			
30–39	21	14.00			
≥40	105	70.00			
Total	150	100.00			

The primary issue with regard to agricultural development in Indonesia is that a majority of farmers are small landholders [40]. Efforts to increase the production through intensification and modernization are limited as a result of the small-sized farm lands they own [41]. In this study, the average farm size is less than half a hectare, which is 4897.67 m^2. Moreover, a majority of the farms are in the size range of 2,000–2,999 m^2. The farm lands in mountainous areas are typically sloping, making it difficult for one to optimize the land, unlike in a regular farmland. Based on the interview, respondents stated that most of their farms were inherited from their parents; they are less likely to purchase new land as land prices are high [42].

As they gain more experience through the years, farmers tend to hone their agricultural skills [43]. As the average age of respondents in this study is more than 40 years, the study hypothesized that most of them are likely to have had a farming experience of more than 20 years. This assumption was proved by the finding that the average farming experience is 21.74 years. Furthermore, a majority of the farmers have experience of more than 20 years. In general, the farming experience is commensurate with the farmers' ability to engage in agricultural activities. Additionally, such tremendous experience sometimes leads to increased acceptance of new innovation; however, conversely, highly experienced farmers also tend to become rigid with regard to their farming practices [44].

4.2 Volcanic hazard variables

4.2.1 Hazard type and frequency

Volcanic eruption has emerged as one of the most serious disasters affecting farmers' lives [45], phenomena such as hot ash, bomb, lava, and landslide that commonly accompany the eruption [9]. A majority (51.33%) of respondents perceive hot ash as the primary hazard accompanying volcanic eruptions; 40 and 8.67% of respondents have cited the primary hazards as lava and bomb, respectively (Figure 3). Although eruption also typically triggers landslide [46], none of the respondents in this study experienced landslide as a hazard accompanying eruption.

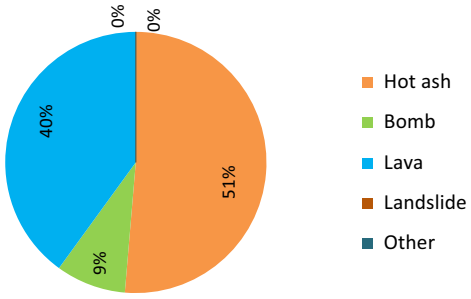

Figure 3: Hazard types in percent.

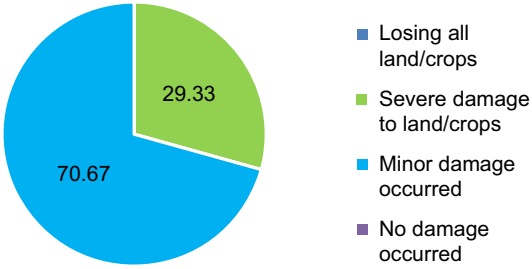

Figure 5: Eruption impact on agriculture in percentage.

4.2.2 Risk and hazard degree

The degree of disaster depends on its type [7]. The degree to which an eruption affects agriculture or human life varies depending on the type of hazard – such as hot ash, bomb, lava, or landslide – that accompanies it [47]. Farmers believe that the most predominant hazard is hot ash as it can destroy crops in a second when it flies and sweeps across the agricultural land [45]. Respondents stated that the degree of eruption disaster is at a high level (82.67%), followed by very big with 17.33% (Figure 4). This finding reveals that respondents understand and realize that the hazard that they face is real and hazardous.

4.2.3 Eruption impact

The impact of eruption is studied based on three categories: agriculture, nonagriculture, and human life [47]. Although none of the respondents have lost their entire land or all of their crops because of the eruption, 29.33 and 70.67% have experienced severe damage and minor damage, respectively, to land and crops (Figure 5). Some of their practices – such as using an agroforestry system – to protect their crops before the eruption can reduce its impact [48]. Also, commonly, when the respondents are asked to evacuate, they always head to the refugee shelter for the nights but return to their homes during the day to protect their livestock, properties, and crops; this finding is similar to that of Muir et al. [9], where people tend to protect their property even in the face of hazards. Mixed farming is practiced in the study area where farmers are planting crops and trees and some are having livestock too.

In this study, respondents did not report a significant impact of volcanic eruptions on nonagriculture, including properties such as houses and vehicles. All respondents reported only a minor damage to their properties as a result of eruptions (Figure 6). The impact of volcanic eruptions on human life (family members) also reveals the same trend; all respondents reported only minor injuries to their family members during the eruption (Figure 7). These two trends might result from the preparedness of respondents for the eruption, typically in the form of mitigation strategies. Suharini and Kurniawan [49] found that such disaster preparedness helps reduce its impact.

4.2.4 Volcano benefits

Farmers voluntarily inhabit the areas surrounding Mount Semeru, despite the mountain being an active volcano [50]. Studies on people who live in volcano areas demonstrate that the ramifications of occupying these regions are also accompanied by benefits or blessings [16]. The

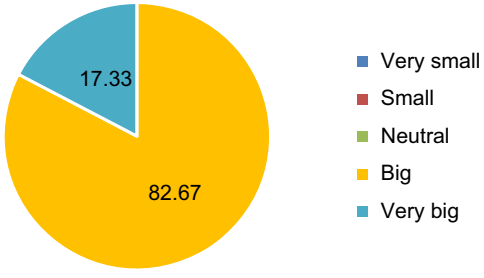

Figure 4: Hazard degree in percent.

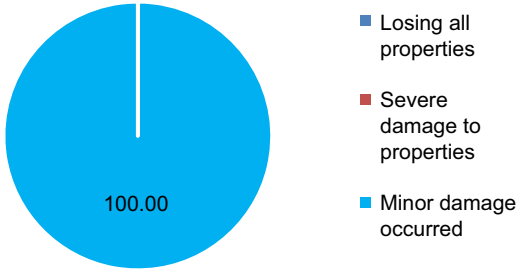

Figure 6: Eruption impact on nonagriculture in percentage.

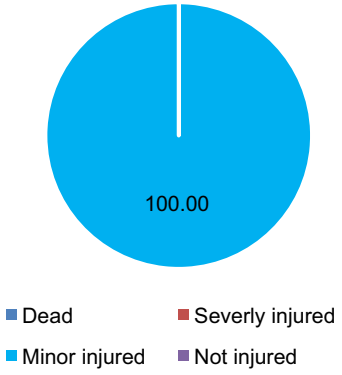

Figure 7: Eruption impact on human life/family members in percentage.

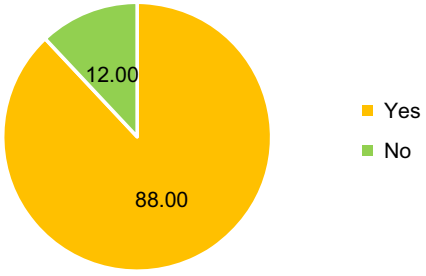

Figure 9: Understanding the hazard level in percentage.

present study corresponds to such findings; a majority (78%) of the respondents agreed that there were several benefits of living around Mount Semeru (Figure 8). The primary benefit of the same in terms of agriculture is the fertile land; the volcanic ash falling on the land during the eruption can increase the fertility of the land, even if the land fertility needs process not directly when the eruption occurs [47].

4.3 Mitigation variables

4.3.1 Risk and response knowledge

In general, the Indonesian Government, through its National Disaster Management Authority (in Indonesian language, it is abbreviated to BNPB), has classified eruption disasters into four levels: *Normal* (Normal, Level 1), *Waspada* (Alert, Level 2), *Siaga* (Standby, Level 3), and *Awas* (Beware, Level 4) [51]. The higher the level of the disaster, the more are the hazards likely to affect the area. Eighty-eight percent of respondents were aware of this classification (Figure 9). This sign is developed to provide an early warning system for all people who are related to the volcano area. Understanding this early warning sign can help people reduce the impact of the eruption. Generally, people will be ordered to evacuate when the situation comes to *Siaga*. Cooperation from all parties is required to reduce the negative impact of the eruption [31].

In the face of such hazards, especially when preceded by the early warning system, a majority (98.65%) of the respondents evacuate the site without taking along their belongings (Figure 10). People cannot move faster if they have many belongings; hence, they typically prioritize their family members and important documents [52]. Respondents also typically monitor their properties and farming when possible during the day and return to their refugee shelters at night.

4.3.2 Mitigation motivation/interest

Farmers in Mount Semeru realize the importance of mitigation efforts to reduce the impact of eruption [53]. The simple mitigation practices followed by farmers involve understanding the hazard signs and preparing for evacuation if required [21]. Commonly, the mitigation is conducted during the pre-disaster period to prepare for and reduce the impacts of disaster [45]. The participation and

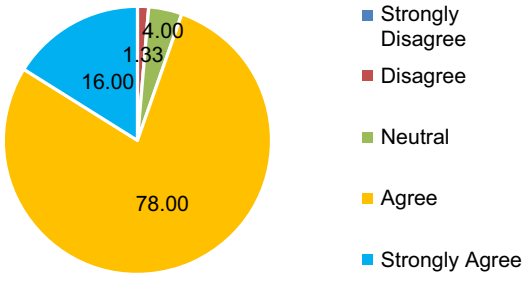

Figure 8: Benefits of the volcano in percentage.

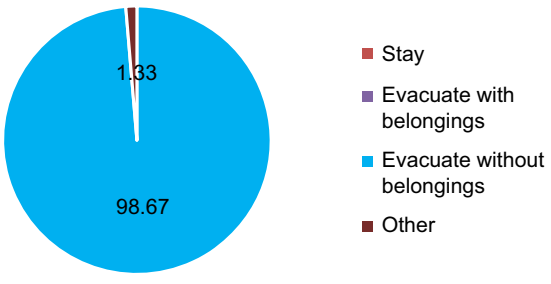

Figure 10: Response when hazards come in percentage.

motivation of people in the surrounding areas of this volcano play important roles in the success of the mitigation. Without adequate motivation, individuals are typically not inclined to participate in mitigation strategies. Such negligence would affect their lives in the long run [54]. A total of 69.33% of the respondents are highly motivated to participate in all mitigation strategies; moreover, 25.33 of the respondents exhibit very high motivation (Figure 11). Although 5.33% display low motivation, the mitigation strategies must be continued to support the efforts to reduce the impact of the volcano disaster. More than 90% of the respondents are motivated (high and very high motivation levels) to participate in mitigation strategies; therefore, any mitigation effort is likely to be adapted by farmers in this volcano. Research by Siegrist and Gutscher [55] demonstrated that mitigation motivation is important to propel the efforts to prepare for and face the disasters.

4.4 Mitigation education

For the mitigation strategies to succeed, mitigation education and awareness must increase. Such education and awareness would increase motivation to create mitigation strategies and cause a reduction in disaster impact [56]. More than half of the respondents stated that mitigation education is available in their area; however, 43.33% of the respondents stated the contrary (Figure 12). Such availability means that mitigation education is provided in their area through various methods such as training, extension, social media, and posters. The education may include lessons on the essential hazard signs, preparedness for an imminent disaster, community resilience, evacuation route and transport, and agriculture system practices such as agroforestry that can protect the crops and prevent landslide, etc. [57].

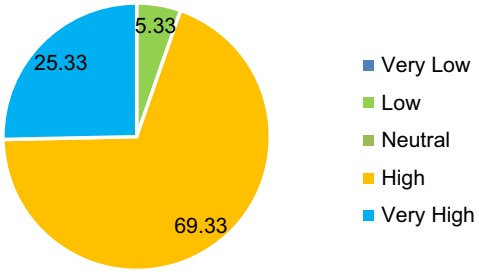

Figure 11: Mitigation motivation in percentage.

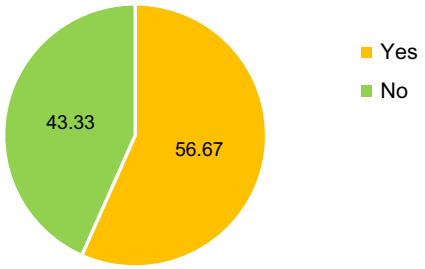

Figure 12: Mitigation education availability in percentage.

Respondents who have stated that there is no mitigation education in their area might either hail from areas with limited mitigation education or may not be active in their communities and hence unaware of such educational practices because mitigation education is typically delivered in a community. Such individuals may learn about mitigation strategies by themselves or through neighbors or other public information sources.

Ninety-two percentage and eight percentage of respondents claimed that their mitigation education is provided by the government and the private sector, respectively (Figure 13). The government provides mitigation education through schemes such as BNPB, local government, extension, and school education [7]. Private organization or non government organization are also providing mitigation education; many parties have realized that alleviating disasters' impacts is an equal responsibility of all parties and a joint effort to prevent destruction caused by disasters striking in Indonesia in general as well as the Mount Semeru area in particular [58].

It is hoped that the impact of eruption can be reduced through various kinds of mitigation education [8]. The benefits of mitigation education may be classified as pre-, during, and post-disaster benefits and may vary for each individual. As delineated in Figure 14, 54% of the respondents agree that pre-eruption disaster mitigation education has benefits such as ensuring greater

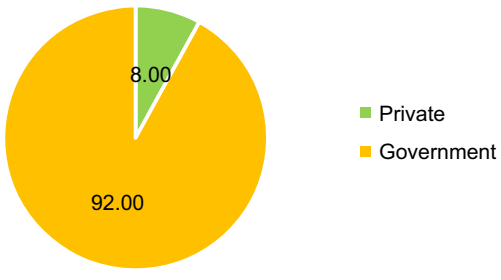

Figure 13: Mitigation education provider in percentage.

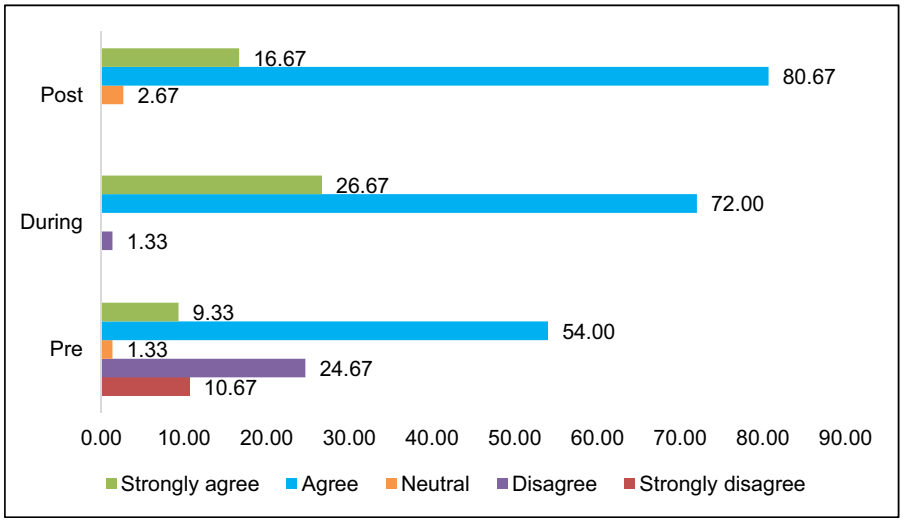

Figure 14: Benefits of mitigation education in percentage.

preparedness regarding eruption hazards. However, the percentages of individuals disagreeing and strongly disagreeing with this notion are 24.67 and 10.67%, respectively. Over 70% respondents agree that mitigation education has its benefits during the disaster. Some of these benefits include increased understanding among people about ways to evacuate the area and help one another. For example, some individuals may let their mini-trucks be used for evacuation. Over 90% respondents agree and strongly agree that mitigation education is beneficial post the disaster. These post-eruption benefits include better handling of the affected properties through the processes of rebuilding, cleaning, etc. Such benefits that respondents receive through these three stages of mitigation education may propel increased awareness among stakeholders to provide adequate education and among people to participate in such activities. Pawitan and Haryani [59] stated that the availability and accessibility of mitigation education can benefit all parties.

4.5 External variables

4.5.1 Government support

The government, through BNPB and other related institutions, plays a crucial role in disaster management in Indonesia. As an entity with the power to create and implement regulation, the government can considerably help with the pre-, during, and post-eruption strategies in the Mount Semeru region. In terms of the pre-eruption mitigation strategies, the government executes the provision of a build bunker, an evacuation road, a monitoring station, and mitigation education for people [17]. The percentages of respondents who agree and strongly agree that government support during pre-eruption has its benefits are 70.67 and 25.53%, respectively (Figure 15).

During the eruption, the government provides support in the form of evacuation, shelter, and logistics. A majority of respondents (70 and 28%, respectively) agree and strongly agree that this period is critical because the eruption can become more intense at any time; therefore, quick decision-making is required. In terms of post-eruption, government support primarily involves efforts to rebuild the destroyed public properties, as well as trauma healing, relocation, and livelihood support. With such support, livelihood can steadily recover from any shock, including eruption disaster [60]. The percentages of respondents agreeing and strongly agreeing that government support during post-eruption has its benefits are 85.33 and 12.67%, respectively.

4.5.2 Financial access

Farmers' financial condition is an important determinant of the quality of their farming activities, as farmers incur expenses through these activities [61]. The financial conditions of a majority of smallholder farmers are dire; typically, they do not have enough reserve to begin their next planting season as their money is spent on daily expenses. It is common in Indonesia for farmers to borrow capital from financial institutions such as bank; such financial access helps farmers continue their farming [62], especially in regions like Mount Semeru, where the challenge of agriculture is greater than that of regular agriculture,

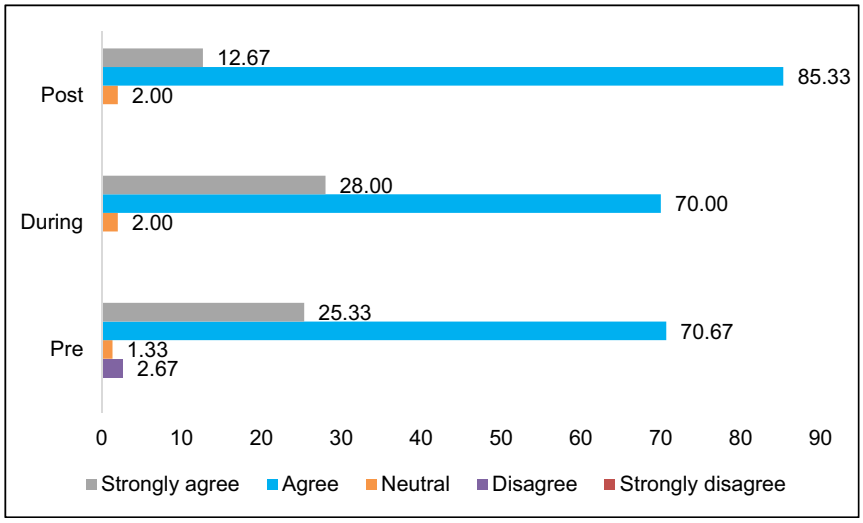

Figure 15: Benefits of Government support in percentage.

and crops are often destroyed by eruptions. Sixty percent respondents agree and 28.67% strongly agree that financial support from credit/financial institutions can help them obtain capital for farming. Although Mount Semeru is quite a remote area, there are sufficient credit institutions available to help farmers access capital. A total of 74.67% respondents agreed that obtaining capital was not a difficult feat (Figure 16).

4.5.3 Environmental and infrastructural support

Environmental factors entail topography, soil fertility, and other natural conditions in the study area [23]. A majority of farmers agree (74.67%) and strongly agree (18.67%) that the favorable environmental conditions support their efforts to sustain as well as prepare for and reduce the disasters' impacts. Infrastructure is also crucial for supporting the farmers' lives and reducing the impacts of disaster and eruption, as this study demonstrates. The evacuation road, bunker, shelter, and monitoring station are some forms of infrastructure support found in Mount Semeru [11]. The percentages of respondents who agree and strongly agree that such infrastructural support is useful are 75.67 and 14.67%, respectively (Figure 17). However, an improvement in infrastructure pertaining to farmers' livelihood and efforts for reducing the impacts of eruption is required [63].

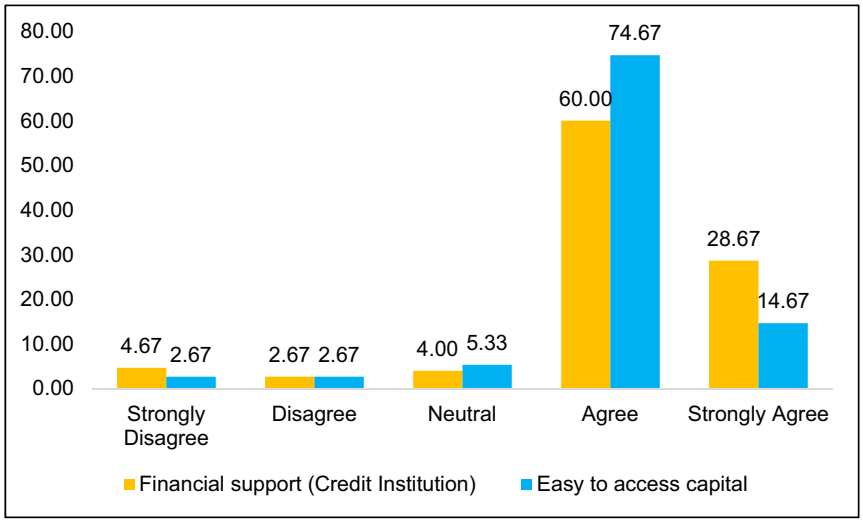

Figure 16: Financial access in percentage.

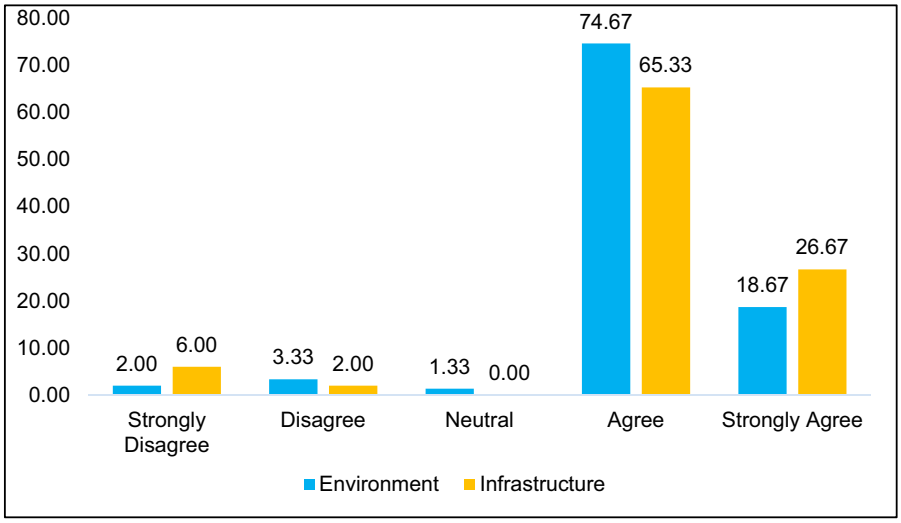

Figure 17: Environment and infrastructure support in percentage.

4.5.4 Social access/community resilience

In general, people are more likely to interact with one another because they cannot live in this world alone. The same applies to farmers in Mount Semeru; many of them interact with one another to seek help and acquire information that is useful for their lives and farming. They form a community that stands together to preserve their beliefs and develop together [64]. In terms of disaster, the community plays an important role in mitigating disasters. People can access valuable information or training more easily through their communities than alone. Javanese people are known for their strong sense of community; this study reveals that more than 80% of the farmers agree and 16% strongly agree that they can easily interact or have social interaction with other farmers or communities (Figure 18). This indicates that well-developed social behavior develops their preparedness for disasters, farmers can receive timely help and useful information shared in the community [65]. Farmers also state that all inhabitants, including farmers, in Mount Semeru are united; therefore, in case of any eruption or other daily occurrences, they tend to help each other. This strong bond is crucial in disaster mitigation efforts [66]. Meanwhile, the farmers outside of the area, their community tend to focus on finding the economic support the disaster mitigation [8]. Regarding the ethnographic and specific practice of perception and

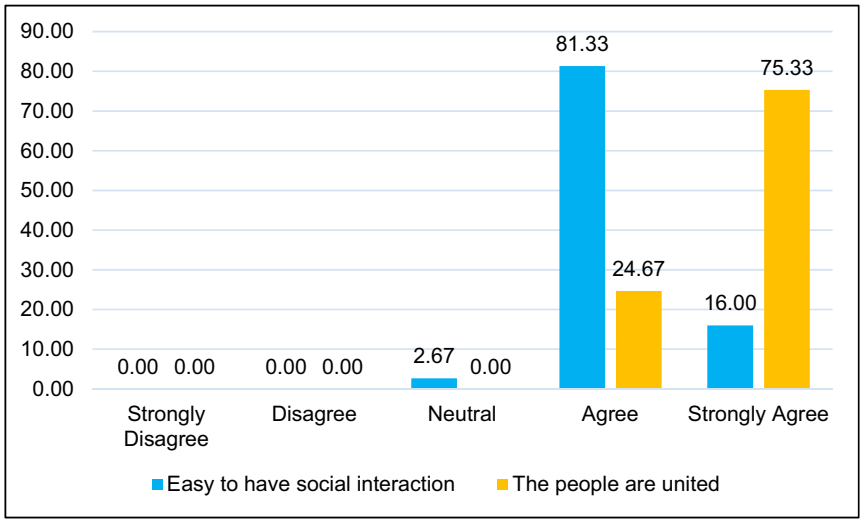

Figure 18: Community access in percentage.

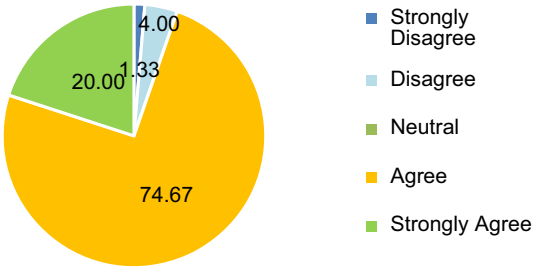

Figure 19: Easy-to-access information.

belief by community, even only practiced by some people, there is Offering Ritual (mainly agricultural products) such as in *Suro* month (Javanese Calendar) as the gratitude expression for nature.

4.5.5 Information access

Nowadays, information is crucial for all human life, including farmers [67]. Everybody accesses information for fulfilling their needs. Information in terms of disaster is important for delivering the news, education materials regarding mitigation, early warning system, regulation, and other related assistance [68]. A majority (74.67%) of the respondents agree that they can easily access information regarding volcano disasters (Figure 19). Conversely, the farmers living in outside of area prefer searching information regarding the agriculture practice that can help their economic situation to information about disaster mitigation strategies [4].

Ninety-eight percent of the respondents commonly access information through their community or neighbors (Figure 20). This sense of community is strong in Indonesia, especially in rural areas. Any information received by the community from the government and pertaining to eruption is shared with community members or the neighborhood shortly. Such information sharing is associated with community resilience during a disaster. In other words, strong communities typically engage in massive information sharing, which can then increase the preparedness of its members during disasters. Zaki et al. [24] and Oktari et al. [69] demonstrated that community resilience had to be increased so that the mitigation efforts can become more successful.

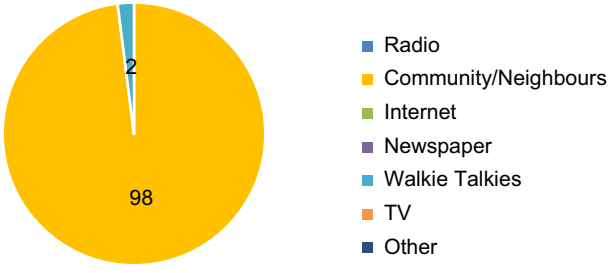

Figure 20: Information source.

4.5.6 Factors affecting the farmers' lives and coping strategies

There are three variables that have no goodness of fit for the multiple logistic regression model because the Pearson point is below 0.5: they are risk and hazard degree, financial support, and social access (Table 6). Risk and hazard degree is beyond farmers' control because it cannot be predicted [70]. Financial access is an important factor that supports farming development; even though the regression model has no goodness of fit, financial access still becomes the important part for farmers' lives. Commonly, the challenge is how farmers prove their eligibility for credit to the credit institution, perhaps through preparing the collateral [71]. Social access also shows no goodness of fit; this might be caused by the fact that farmers are the majority in old age, and young farmers are few. However, social access is still becoming an important part in mitigation efforts, because through social interactions, community resilience on disaster can be increased and strengthened [72].

Volcano benefit is significant with farming experience and family member. The farming experience led farmers to understand more about the benefit of volcano; common benefit that is felt by farmers is the fertile land that they get from the volcano ash. Mitigation motivation is significant with the family member at 0.01 level with significant point 0.007. The family member drives farmers to have more effort for reducing the eruption impacts to protect their farms and family; therefore, it is significant. Meanwhile, for mitigation education, only significant was relationship found with farming experience at 0.01 level with significant point 0.002. Farmers with higher farming experience tend to use more opportunities for mitigation education from various sources such as government or private institution, or from the local communities. But there is a challenge, which is the skeptical regarding the effectivity of mitigation education. Also, some farmers might think that education should be in the form of formal condition; however, in the field, mitigation education can be in many forms such as posters, social media, message broadcast, community discussion, and extension [59,73,74].

Table 6: Factors affecting farmers' lives and coping strategies

Variable	Risk and hazard degree		Volcano benefit		Mitigation motivation		Mitigation education		Government support		Finance access		Environment infrastructure support		Social acc.		Infor. acc	
	X^2	Sig.	X^2	Sig.	X^2	Sig.	X^2	Sig.	X^2	Sig.	X^2	Sig.	X^2	Sig.	X^2	Sig.	X^2	Sig.
Age	10.478	0.033	24.642	0.076	8.915	0.35	4.962	0.762	11.921	0.155	15.584	0.482	63.701	0	2.962	0.564	19.282	0.082
Education	7.664	0.105	15.83	0.465	1.8	0.987	4.958	0.762	2.26	0.972	.	.	.	.	6.364	0.174	6.879	0.866
Farm size	2.521	0.283	8.292	0.405	5.988	0.2	0.282	0.991	4.405	0.354	2.906	0.94	.	.	0.274	0.872	3.802	0.703
Farming experience	3.742	0.422	26.499	0.047	8.148	0.429	23.781	0.002	6.07	0.639	9.603	0.887	35.389	0.004	1.48	0.83	11.986	0.447
Length of stay	8.584	0.072	10.658	0.83	4.279	0.831	3.334	0.912	6.346	0.609	4.52	0.998	.	.	2.655	0.617	12.686	0.392
Family member	2.362	0.501	30.101	0.003	17.587	0.007	3.243	0.778	6.611	0.358	10.426	0.579	.	.	2.864	0.416	5.173	0.819
Pearson (Goodness of fit)	0.248		1		1		1		1		0		1		0.236		1	
R^2 (Nagelkerke)	0.255		0.646		0.34		0.459		0.391		0.203		0.464		0.121		0.399	

Government support, as explained earlier, is believed to have benefits on farmers' lives and the mitigation strategies toward the eruption. But, as shown in Table 6, this variable has no significant correlation with the independent variable. But still in any regulation from the government, especially with regard to the mitigation efforts, the farmers characteristics need to be considered.

Environment and infrastructure support are shown to be affected by age and farming experience. Farmers' characteristics affect how they accept and wisely use the environment toward their life and mitigation efforts. In addition, the characteristics also affect farmers' feel and perception on the infrastructure that has been built for their life and mitigation efforts. Social access shows no significant relation with dependent variables; it might be affected by the social interaction among farmers are conducted in routine activities, therefore they are considering the social access is not difficult thing.

5 Discussion

Volcanic hazards are real and can harm people, including farmers and those who live near volcanoes. This study proves that various volcanic hazards affect the agricultural conditions of the local farmers, in negative (e.g., destroying the crops) and positive ways (e.g., soil becomes fertile by the effect of the ash). Other studies also confirm these findings [47]. The farmers decision to still stay and farm in volcano area may be found reasonable, as it is based not solely on the ancestors' heritage, but also on the economic and agricultural benefits they receive from the volcano-prone area.

Disaster mitigation strategies are efforts to reduce the impact of disasters. Each disaster has different characteristics; therefore, the mitigation strategies vary depending on the disaster type [49]. Even though there is eruption monitoring station, volcano disaster occurs suddenly that people need to have good reaction to reduce the impacts. Mitigation education is a good method to improve the farmers' disaster preparedness, even though some farmers stated that there is no mitigation education but they expect to get it because they believe the education can help them to increase their preparedness [69]. Farmers are educated to react with correct reaction such as to evacuate in certain level. The eruption disaster level is categorized into four: *Normal* (Normal, Level 1), *Waspada* (Alert, Level 2), *Siaga* (Standby, Level 3), and *Awas* (Beware, Level 4) [51]. Maximum in *Siaga*, farmers must evacuate with or without belongings, but in emergency condition,

they must focus on their lives rather than properties. Government and other stakeholders are needed to collaborate in providing good mitigation education. And the education should cover pre, during, and post-disaster [8]. But to ensure that any mitigation education can run effectively, farmers need to have motivation to do mitigation strategies, because they are the main actors in the efforts [55].

Motivation can help farmers to do work that can be beneficial for them and the community in facing volcano disaster hazards. Government is the main stakeholder that can help and support farmers in various ways, such as policy, infrastructure, and education. So, the role of government should be strengthened [52]. Farmers in volcano-prone area are similar to other farmers who need help for their farming; therefore, such as financial access for supporting their farming might give big support for farmers. The financial access is limited not only for farming but also for any effort for mitigation strategies.

Social access becomes an important part of farmers' efforts to face volcano disasters. This study proves that an united community helps farmers to face and adapt to the disasters and also for their farming activities. Community resilience can support farmers through the united community and fast information regarding any disaster movement. Even though there are advanced technologies for distributing information, community still becomes the fastest method for farmers to get information [56]. The community resilience exists due to the social awareness of mutual help in case of a volcano-related disaster. Farmers face and adapt to the volcano disasters because they still want to live there disregarding the circumstances. Even though the volcano mountain may have different characteristics, the findings from this study still can be used to help farmers in facing and adapting to the volcano disasters.

6 Conclusion

Despite the hazards and threatening risks of eruption, many farmers continue to live in Mount Semeru and practice farming to fulfill their basic needs. Hot ash and lava are common types of eruption hazards, and the frequency of eruption is high; however, its size is typically not large and the hazards are not felt very often by farmers. The benefit of volcano activity, i.e., soil fertility, is enjoyed by farmers in Mount Semeru. High mitigation motivation causes farmers to participate in mitigation strategies such as understanding the early warning system, increasing the community resilience, and participating in any government programs for reducing eruption impacts. Government contribution to provide mitigation education and infrastructure such as an evacuation road and a refugee shelter is benefiting for farmers' lives in Mount Semeru volcano-prone area: these become their opportunity. Farming experience has proven significant effect on the volcano benefit, mitigation education, and environment and infrastructure support. Along with the increase in farming experience, the farmers tend of good perception of mitigation education, which in turn improves their mitigation skills. Compared to the farmers outside of volcano area, farmers in volcano area have more preparedness regarding any disaster that comes without notice. They also have more sense of respecting nature because of the frequent experience of natural disaster: it becomes their strength. Farmers in volcano-prone area should optimize their strength and opportunity to increase the quality of their lives, even though in natural disaster-prone area. In addition, stakeholder coordination to support the mitigation strategies is required, and farmers should also shoulder the responsibility to participate in any programs related to eruption risk reduction.

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