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The Impact of The Eruption of Mount Marapi on Chili (*Capsicum Annuum*) Cultivation in Nagari Bukik Batabuah

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Abstract

Mount Marapi is one of the most active volcanoes in West Sumatra. This study aims to analyze the impact of its eruption on chili cultivation and the adaptation strategies employed by farmers. The method used is descriptive qualitative through observation, interviews, and documentation. The results indicate that volcanic ash caused severe crop damage, reducing production from 8–10 tons/ha to 2–3 tons/ha, and resulting in financial losses exceeding 1 billion rupiah. Farmers implemented adaptation strategies by utilizing organic fertilizers, diversifying crops, and accessing government assistance.

Keywords: volcanic eruption, chili, Mount Marapi, volcanic ash, farmer adaptation

1. Introduction

Mount Marapi is an active volcano located in the Agam and Tanah Datar Regencies, West Sumatra. Since early 2023, the volcano has shown a significant increase in volcanic activity with several explosive eruptions, including a major eruption in December 2023, with activity continuing into 2024. This activity has had a widespread impact on surrounding areas, particularly on the agricultural sector, which serves as the primary source of livelihood for the local community.

Nagari Bukik Batabuah is one of the most severely affected areas due to its location on the slopes of Mount Marapi. Most of the community in this area relies on agriculture, specifically the cultivation of chili peppers (*Capsicum annuum*), which hold high economic value. While the geographic condition of fertile volcanic soil inherently supports chili growth, it simultaneously increases vulnerability to volcanic eruption disasters.

The eruption of Mount Marapi caused high-intensity volcanic ashfall that blanketed agricultural land and chili crops. Volcanic ash contains fine particles that can damage leaf tissues, clog stomata, and inhibit photosynthesis. Furthermore, ash accumulating on the soil surface can disrupt soil structure and reduce fertility, directly impacting crop productivity. Field data indicates that approximately 55 hectares of agricultural land in Nagari Bukik Batabuah suffered severe damage and crop failure, with economic losses estimated at over 1 billion rupiah. In addition to volcanic ash, the eruption also triggered cold lava flows (lahar), further exacerbating damage to agricultural land and supporting infrastructure for production and distribution.

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Vol. 1, No. 1, 31 March 2026, pp. 89-93

The impact of the eruption extends beyond physical damage to social and economic dimensions. The drastic decline in harvest yields has led to reduced farmers' income and heightened economic vulnerability within the community. This situation demands appropriate adaptation strategies so that farmers can survive and restore their agricultural production systems.

2. Methodology

This study was conducted in Nagari Bukik Batabuah, Canduang District, Agam Regency, West Sumatra, one of the areas most affected by the eruption of Mount Marapi. The research was carried out from February to April 2024, a few months following the eruption, ensuring that the condition of the land and crops truly represented the actual post-disaster impact.

The research approach used is descriptive qualitative, aiming to comprehensively depict the impact of the eruption on chili cultivation and identify the adaptation strategies implemented by farmers. This approach was selected for its capacity to capture deep in-field conditions, spanning both biophysical and socioeconomic aspects.

Data collection was executed through several techniques: field observation, interviews, and documentation. Field observations were conducted directly on chili agricultural plots affected by the eruption to observe the physical state of the plants and the environment. Elements observed included plant damage (leaves, stems, fruits, and roots), the severity of land degradation due to volcanic ash, and surrounding environmental conditions such as cold lava residues, changes in soil texture, and damaged agricultural infrastructure.

Furthermore, interviews were conducted with local farmers to gather information regarding shifts in production before and after the eruption, the extent of financial losses incurred, and the adaptation strategies deployed to cope with post-eruption conditions. The interviews were semi-structured to ensure the data collected remained focused while still allowing room to explore broader information. Visual documentation using photos and videos was carried out to record the state of the land, crops, and farmers' activities as supporting data. This documentation serves to substantiate observation findings and provide visual evidence of field conditions.

The acquired data was then analyzed descriptively and qualitatively through several stages: data reduction, data display, and drawing conclusions. The analysis focused on identifying the types and severity of damage to chili plants, comparing production yields before and after the eruption based on reports from farmers and related sources, and evaluating farmers' adaptation strategies in efforts to restore chili cultivation.

3. Results and Discussion

Based on field observations and interviews with farmers in Nagari Bukik Batabuah, the eruption of Mount Marapi exerted a significant impact on chili cultivation across plant physiology, land conditions, and overall productivity. Visually, chili plants sustained severe damage from being covered in volcanic ash ranging from 1 to 3 cm in thickness. Leaves exhibited symptoms of yellowing, wilting, and defoliation, indicating serious disruption to the plants' physiological processes. Moreover, many chili fruits rotted, turned blackish, and became unmarketable. In several cases, plant stems became brittle, snapped, and eventually died.

In terms of production, a highly significant drop in harvest yields occurred. Before the eruption, chili production averaged 8–10 tons per hectare; however, after the eruption, it plummeted to approximately 2–3 tons per hectare. This indicates that roughly 70% of the crops faced failure. This drop in production directly impacted farmers' income, with economic losses estimated to exceed 1 billion rupiah. Beyond affecting the crops, volcanic ash altered soil conditions. The soil surface became blanketed with ash, causing it to become denser and harder to cultivate. Drainage

Vol. 1, No. 1, 31 March 2026, pp. 89-93

systems were disrupted, leading to waterlogging in several areas. Furthermore, the remaining cold lava material altered the chemical properties of the soil, specifically increasing acidity and lowering nutrient availability.

Although chili prices briefly rose due to a supply shortage, this condition failed to benefit farmers because their harvest yields were extremely limited, and most did not meet market quality standards. In response to these conditions, farmers implemented various adaptation strategies. Efforts included using organic fertilizers, such as manure and compost, to restore soil structure and fertility; diversifying crops by shifting parts of their chili plots to more resilient crops like corn and cassava; and utilizing government aid in the form of seeds, fertilizers, and post-disaster cultivation training.

3.1 Impact of Volcanic Ash on Plants and Land

The results demonstrate that volcanic ash has a direct impact on the physiology of chili plants. The layer of ash covering the leaf surfaces hinders photosynthesis by reducing the intensity of light received and clogging the stomata. This condition also disrupts plant respiration and transpiration, triggering physiological stress characterized by wilting, chlorosis, and eventual plant death. Damage to the chili fruits indicates that volcanic ash affects not only the vegetative growth but also the generative phase of the plants. Fruits blanketed in ash become more susceptible to rotting due to increased micro-humidity and the activity of pathogenic microorganisms. This carries implications for both the quality and quantity of harvest yields.

From the soil aspect, the accumulation of volcanic ash causes changes in the physical and chemical properties of the soil. The soil becomes denser, hindering root penetration and water absorption. Additionally, disrupted drainage systems cause anaerobic soil conditions that can worsen plant growth. In the short term, volcanic ash tends to decrease soil fertility, although it has the potential to increase mineral content over the long term if managed properly. These findings align with previous studies stating that volcanic eruptions cause declines in crop productivity due to physiological disruptions and agricultural land degradation.

3.2 Effectiveness of Farmers' Adaptation Strategies

The adaptation strategies implemented by farmers indicate efforts to sustain the viability of their farming operations amid post-eruption conditions. The use of organic fertilizers has proven helpful in restoring soil structure damaged by volcanic ash. Organic matter enhances soil porosity, improves water-holding capacity, and increases nutrient availability. Nevertheless, the soil recovery process requires a relatively long time and does not yield instant results.

Crop diversification serves as a fairly effective strategy to mitigate the risk of total loss. Crops like corn and cassava exhibit higher tolerance to less fertile soil conditions and disturbed environments. However, shifting to these commodities has not been able to fully substitute the economic value of chili as the primary commodity. Government assistance through the distribution of seeds, fertilizers, and post-disaster cultivation training has also contributed positively to the recovery process. However, limitations in distribution and the volume of aid remain obstacles to reaching all farmers equitably.

3.3 Implications and Recommendations

The impact of the Mount Marapi eruption on chili cultivation in Nagari Bukik Batabuah highlights that the agricultural sector in disaster-prone areas is highly vulnerable to external disruptions. Consequently, more systematic efforts are required to enhance the resilience of the agricultural system. One such effort is the development of disaster-responsive cultivation technologies, including the use of crop varieties more tolerant to volcanic ash.

Vol. 1, No. 1, 31 March 2026, pp. 89-93

Furthermore, capacity building for farmers through education and extension services regarding post-eruption land management is critical. Improving agricultural infrastructure, particularly drainage systems and land management, must also be prioritized to minimize the compounding impacts of disasters. On the other hand, agricultural diversification should continue to be promoted as a long-term adaptation strategy to reduce dependency on a single commodity.

4. Conclusion and Suggestions

The eruption of Mount Marapi caused severe damage to chili cultivation in Nagari Bukik Batabuah. Volcanic ash with a thickness of 1–3 cm covered chili leaves and fruits, resulting in yellowing, wilting, defoliation, as well as rotting and blackening of the fruits, while plant stems became brittle and died.

Farmers executed various adaptation efforts:

- Utilizing organic fertilizers (manure and compost) to restore soil structures.
- Diversifying crops into more resilient post-eruption alternatives like corn and cassava.

While the adaptation strategies implemented by farmers were helpful, they have not yet successfully restored income and production to pre-eruption levels. Government assistance has been meaningful, but its distribution and overall volume remain limited.

5. Declarations

5.1 Author Contributions

Conceptualization: A.P.F.; Methodology: A.P.F.; Investigation: A.P.F.; Data Curation: A.P.F.; Writing – Original Draft Preparation: A.P.F.; Writing – Review and Editing: A.P.F.

5.2 Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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5.4 Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this manuscript.

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Vol. 1, No. 1, 31 March 2026, pp. 89-93

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