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THE UNPREPAREDNESS OF FARMERS IN FACING FLOOD DISASTER RISKS AS AN IMPACT OF CLIMATE CHANGE: A CASE STUDY IN BALONG, PONOROGO

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ABSTRACT

Climate change-induced floods have significantly impacted agriculture in several villages of Balong Subdistrict, Ponorogo Regency. This study aims to (1) assess flood impacts on agricultural systems, (2) analyze farmers' unpreparedness for climate change, and (3) evaluate government policy responses in supporting flood resilience. Using a qualitative case study approach, data was collected through interviews with 13 farmers, 1 village head, 1 agricultural office staff, and 1 irrigation officer, supplemented by field observations and document analysis. Findings reveal 156 hectares of crops destroyed, with farmers maintaining traditional practices despite climate variability. Most farmers perceived floods as natural events rather than climate change consequences, while government responses emphasized reactive measures over long-term adaptation strategies. The study provides practical recommendations for integrated flood adaptation combining infrastructure improvement, farmer education, and policy reform. These findings offer valuable insights for enhancing climate resilience in flood-prone agricultural areas across Indonesia.

A. INTRODUCTION

Climate change has increased the frequency and intensity of hydrometeorological disasters such as floods (IPCC, 2022), threatening the resilience of the global agricultural sector (Vijai et al., 2023; Nijs, 2014). In developing countries where smallholder farmers heavily rely on rain-fed agriculture, the impacts are particularly severe (Morton, 2007; Mendelsohn & Dinar, 2012). Indonesia, as an agrarian country with high climate vulnerability, has experienced rising agricultural losses due to flooding in recent years (Eswaran et al., 2024; Anjum et al., 2024). Studies in countries with similar characteristics, such as Panezai & Kakar’s (2024) research in Pakistan and Giang & Vy’s (2021) work in Vetnam, demonstrate that floods not only cause short-term crop damage but also lead to soil degradation, declining productivity, and threats to

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farmers' household economic stability (Trinh et al., 2021).

However, many farmers in flood-prone areas remain unprepared for these shifting climate patterns. Research by Budhathoki et al. (2020) in Nepal and Borah et al. (2024) in India reveals that reliance on traditional knowledge, limited access to climate information, and inadequate institutional support are major barriers to adaptation. A similar pattern has been observed in Indonesia, where studies by Nguyen et al. (2021) and Handayani et al. (2025) found that farmers often perceive extreme weather as a natural phenomenon rather than a consequence of climate change, leading to passive rather than proactive responses.

In Ponorogo Regency, East Java, floods have become a recurring disaster, with 89 recorded incidents in 2024 alone, severely affecting rice and corn production (Nofiu & Baharudin, 2024). Unfortunately, research on farmers' perceptions of flood risks, adaptive capacity, and the effectiveness of government interventions in this region remains limited. Existing studies on climate adaptation in Indonesia, such as those by Singh et al. (2011) and Takal & Tahiru (2025), have primarily focused on drought adaptation, leaving a knowledge gap concerning flood resilience strategies for smallholder farmers.

Against this backdrop, this study aims to: (1) examine the impact of floods on the agricultural system in Balong District, (2) analyze farmers' unpreparedness in the face of climate change, and (3) assess government policies and programs in supporting farmers' flood resilience. By achieving these objectives, this research is expected to contribute to the discourse on climate adaptation in agrarian communities while providing targeted policy recommendations for flood-prone regions in Indonesia.

B. METHOD

This study employs a qualitative case study approach to explore farmers' unpreparedness in facing flood risks as an impact of climate change in Ponorogo Regency, East Java, Indonesia. This research design was selected to gain an in-depth and contextual understanding of farmers' perceptions, behaviors, and limitations in confronting flood disasters. The study focuses on several flood-prone villages in Balong District, Ponorogo Regency. The selection of these locations was based on historical flood data and the predominance of agricultural livelihoods among the local population.

Data collection techniques included in-depth interviews, field observations, and documentation. Semi-structured interviews were conducted with 13 farmers, 1 village head, 1 agricultural office staff member, and 1 irrigation officer to gather information about flood experiences, agricultural losses, adaptation strategies, and understanding of climate variability. Field observations were carried out to examine farming practices, infrastructure conditions, and visible flood impacts on agricultural land. Documentation was used to collect supporting data from government reports, flood maps, and agricultural impact assessments published by the Badan Penanggulangan Bencana Daerah (BPBD) Ponorogo and the Agriculture Office.

Data analysis followed the Miles and Huberman (1994) model, consisting of three stages: data reduction through selection and simplification of relevant information, data presentation in narrative form and thematic matrices, and conclusion drawing and verification through pattern identification and data triangulation. To ensure data validity, triangulation was performed by comparing interview results, observations, and documentation. Member checking was also conducted by sharing preliminary findings with key informants to validate the researcher's interpretations.

C. RESULT AND DISCUSSION

C.1. RESULT

Impact of floods on the agricultural system

Figure 1 reveals that Ponorogo Regency recorded 347 natural disasters between January 1 and December 31, 2024, of which floods (89 incidents) were particularly devastating to the agricultural sector. Rice crops planted during the rainy season were the primary affected commodity, particularly those aged 1-1.6 months. Of the total 1,032 hectares of affected farmland, approximately 156 hectares suffered complete crop failure. Corn crops also sustained damage, though to a lesser extent.

Interviews with farmers and village officials revealed that floods caused significant damage to agricultural land, leaving it muddy and compacted, rendering it unsuitable for immediate replanting. In Purworejo Village, approximately 30 hectares of rice fields were inundated. When combined with affected areas in neighboring villages such as Tatung and Sedarat, the total impacted farmland reached approximately 200 hectares. With planting costs of approximately IDR 1 million per plot (approximately 0.14 hectares) and one hectare consisting of seven plots, the loss per hectare reached IDR 7 million. The average loss per farmer was estimated at IDR 5-15 million per planting season, with collective farmer losses totaling IDR 1.4-2 billion.

According to the Head of BPBD Ponorogo (Badan Penanggulangan Bencana Daerah), the floods occurred due to the breach of levees along the Bengawan Solo River despite early warnings. This situation indicates that mitigation infrastructure, such as levees, remains inadequate to anticipate heavy rainfall and river overflow, thereby exacerbating the disaster's impact on the agricultural sector.

Farmers' unpreparedness in the face of climate change

Interviews with farmers in Balong District revealed persistent misconceptions regarding climate change phenomena. Most respondents perceived extreme weather events, such as prolonged rainfall causing floods, merely as "delayed seasons" or even interpreted them as "divine tests." They failed to associate these occurrences with global climate change phenomena that have been widely discussed in academic literature and media.One farmer, Mr. Marno (54), stated:

"Since long ago, sometimes the seasons are , sometimes there's no rain. This is just how nature works. We must be patient." (Interview, April 2, 2025).

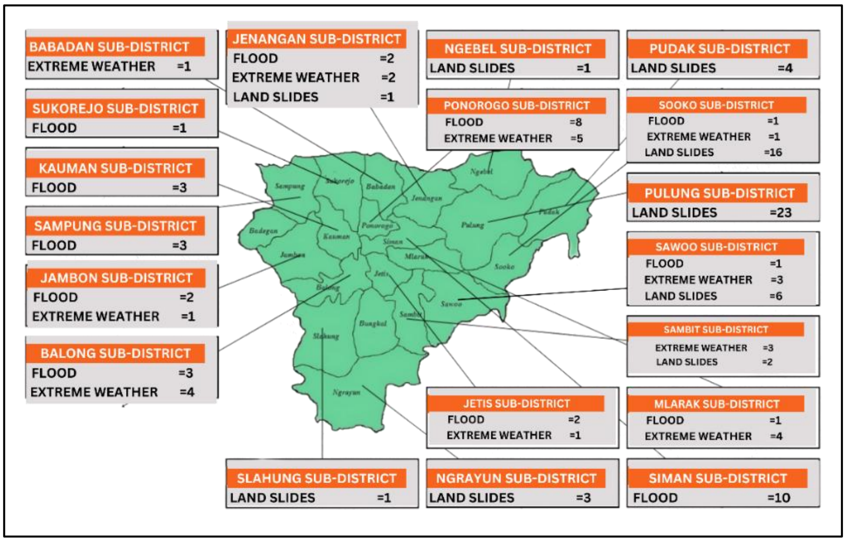

Figure 1. 2024 Natural Disaster Occurrences in Ponorogo Regency
(Source: BPBD, 2024)

This statement reflects limited understanding of climate change (Tabel 1. Below) as a scientific phenomenon with long-term patterns that can be studied for adaptation planning. Most farmers were unfamiliar with terms such as ENSO (El Niño Southern Oscillation) or concepts of weather anomalies causing irregular shifts in rainy and dry seasons.

The absence of specific climate-related training or extension programs further compounded this unpreparedness. Field observations revealed that farmers still relied on traditional planting calendars based solely on past experiences, without considering weather forecasts from BMKG (Meteorological, Climatological, and Geophysical Agency) or other institutions.

Table 1. Farmers' Unpreparedness Dimensions and Supporting Field Evidence in Flood-Prone Areas of Balong, Ponorogo

Form of Farmer Unpreparedness	Field Evidence	Supporting Data
Limited understanding of climate change	-Perceive extreme weather as "delayed seasons" or "divine tests" -Unaware of ENSO/anomaly concepts	- 87% of interviewed farmers held traditional perceptions (n=13) - Direct quote: "This is just how nature works" (Farmer Marno, 54)
Lack of adaptation strategies	-No crop pattern adjustments despite annual floods - No use of flood-resistant varieties - Minimal adaptive infrastructure	- 100% of observed farms lacked drainage systems - 0% adoption of short-duration cultivars - IDR 1.4-2 billion collective losses
Dependence on traditional planting calendars	-Use ancestral *pranata mangsa*-based calendars - Resist climate-informed calendars	- 92% farmers follow traditional timing (2024 planting season) - 30ha crop failure due to Oct-Dec mismatc

(Source: Data Analysis, 2025)

This significantly increased farmers' vulnerability as they lacked scientific basis for determining planting schedules, fertilization timing, and harvest periods. Under increasingly unpredictable climate conditions, this knowledge gap resulted in substantial losses, as evidenced during the late 2024 planting season when farmers who planted rice in October saw their fields flooded in December due to unexpected heavy rainfall.

Farmers had not implemented climate change adaptation strategies, particularly for seasonal floods. When questioned about crop pattern adjustments or land protection measures, most admitted maintaining conventional farming practices despite nearly annual flood occurrences. Several farmers reported never attempting to shift planting schedules to avoid peak rainy seasons. One farmer in Balong Village remarked:

"We plant as usual. If the harvest fails, so be it. The rainy season is unpredictable now, but we don't know what to do differently."

Furthermore, no efforts were made to adopt flood-resistant crop varieties or shorter-duration cultivars. Farmers predominantly continued planting traditional varieties perceived as economically safer, despite flood-related failure risks. Field observations noted minimal adaptive infrastructure; most agricultural lands lacked basic earth embankments or drainage systems, making crops vulnerable to waterlogging.

The study found that flood-affected farmers in Ponorogo Regency predominantly relied on ancestral planting calendars as their primary agricultural reference. These traditional calendars, based on inherited seasonal calculations, failed to account for increasingly dynamic climate variability. A Balong Village farmer explained:

"We've always planted after labuh [traditional season indicator]. That's our custom, never changed. If it fails, it's fate - perhaps not our fortune yet."

These findings demonstrate strong adherence to conventional seasonal patterns despite significant rainfall pattern changes in recent years. Observational data showed rainy seasons frequently arrived earlier or later than traditional predictions, causing crops to flood or underperform when planting schedules weren't adjusted. Interviews with local water management officials revealed that efforts to introduce climate-based planting calendars were rarely fully adopted by farmers. This resulted from strong trust in traditional methods coupled with limited understanding of available climate information technologies. This reliance on outdated practices represents a critical dimension of farmers' climate change unpreparedness, with the mismatch between traditional practices and new climate realities exacerbating flood risks and crop failure vulnerabilities.

Government policies and programs in supporting farmers' flood resilience

According to the 2024 Performance Report (LKJ) of the Ponorogo Regency Office of Agriculture, Food Security, and Fisheries, the institution has made significant contributions in supporting the agricultural sector and food security. Various strategic objectives have been implemented, encompassing regional food security stabilization, fisheries production enhancement, agricultural output improvement, and institutional governance and human resource development. In terms of performance achievements, the second and fourth objectives demonstrated excellent performance and budget efficiency, with indicator achievements reaching 102% and 100% respectively. Meanwhile, the third objective directly related to agricultural production also showed satisfactory results, with an average performance achievement of 90.99%, although assessed as less efficient in resource utilization.

However, field findings reveal that these administrative successes and macro-level outputs have not fully addressed the practical needs of farmers at the grassroots level, particularly regarding climate change adaptation. While programs for agricultural disaster control and mitigation exist, along with plans for BMKG (*Badan Meteorologi, Klimatologi, dan Geofisika*) coordination to improve planting calendars, implementation has been inconsistent in flood-vulnerable villages like Balong. Practical climate adaptation training—such as weather-based cropping pattern adjustments, flood-resistant crop varieties, and wetland risk mitigation—remains limited. Most farmers only received initial socialization without subsequent technical assistance, and farmer groups have not been optimally utilized as agents of adaptive knowledge dissemination.

Field observations further indicate the absence of formal training modules or regular mentoring programs from the agricultural office or local extension workers specifically addressing climate change adaptation strategies. This highlights a disconnect between farmers' needs to understand and respond to climate change and the technical institution's capacity to provide comprehensive education and support. This gap persists despite clear climate change impacts—including shifting planting seasons, increased rainfall intensity, and frequent flooding—that significantly affect agricultural productivity and smallholder food security.

During the flood disasters from December 2024 to February 2025, the local government through the Agriculture Office responded promptly by distributing rice seeds to affected farmer groups. As of January 6, 2025, a total of 25.8 tons of seeds had been distributed to 108 farmer groups across 10 affected districts (Dinas Pertanian, Ketahanan Pangan dan Perikanan, 2024). Tri Budi Widodo, Head of the Food Crops and Horticulture Division, stated:

"The districts receiving this assistance include Balong, Jambon, Jetis, Bungkal, Siman, Ponorogo, Sukorejo, Kauman, Mlarak, and Sampung."

C.2. DISCUSSION

Floods in Ponorogo Regency have significantly impacted the agricultural sector, with both short-term and long-term consequences. Primary losses include agricultural inputs (seeds, fertilizers, and pesticides) and potential harvest failures, creating substantial economic pressure on farmers, worsening household welfare, and potentially disrupting local food security. Brémond et al. (2013) emphasize the importance of comprehensive economic evaluation of flood-induced agricultural damage, including input losses, recovery costs, and infrastructure damage.

These economic losses are not merely temporary but create long-term effects. As Olson et al. (2015) demonstrate, levee breaches can cause lasting soil productivity loss through erosion and sedimentation. Taylor (2022) further notes that post-flood land recovery requires extended periods, with improper intervention potentially causing permanent productivity declines of up to 15%. While nitrogen fertilization and organic amendments can accelerate restoration, scientifically grounded strategies are essential.

Regarding land degradation, findings indicate flood-induced siltation, soil compaction, and erosion adversely affect soil physicochemical properties. Olson & Morton (2017) highlight how floodwaters often carry pollutants and sediments that reduce soil fertility. In Ponorogo, this phenomenon complicates replanting, particularly in long-submerged paddy fields. Kulig (2000) stresses the need for proper submerged land reclamation to prevent further damage. Mitigation infrastructure assessment reveals low effectiveness of levees, dams, and drainage systems in Ponorogo, attributable to suboptimal design, poor maintenance, and increasing extreme rainfall intensity (Narmilan, 2018). Levee breaches pose critical problems, causing both major floods and direct agricultural land degradation (Olson et al., 2015). Nature-Based Solutions should integrate with conventional civil engineering approaches to develop adaptive, sustainable mitigation systems (Shokoohi et al., 2018).

As Shokoohi et al. (2018) demonstrate, flood losses exhibit spatiotemporal variability depending on crop growth stages during flooding events. Thus, integrated risk monitoring systems are crucial for local governments and farmers to minimize damage. Morris & Hess (1988) highlight the importance of cost-benefit analyses for flood control projects, including agricultural lands. Statistical modeling approaches like the Poisson-lognormal model (Liu et al., 2010) could assist policymakers in designing targeted risk reduction strategies. Historical and predictive loss data provide realistic assessments of agricultural sector vulnerability to floods.

Field findings in Ponorogo confirm farmers' climate change unpreparedness, mirroring global patterns. Farmers' perception of extreme weather as natural phenomena or "divine tests" reflects limited climate change awareness, consistent with Harmer & Rahman's (2014) findings in developing countries. These traditional perceptions hinder effective adaptation strategy adoption. Mujayin et al. (2024) corroborate this in Indonesian smallholder farmers, where limited access to information, financial resources, and government support reduces adaptive capacity. Ponorogo farmers similarly report difficulties obtaining adaptation training and technologies.

The lack of implemented adaptation strategies aligns with Adlina et al. (2024) in Indonesian agriculture. Despite climate change awareness, farmers maintain conventional practices due to technical knowledge gaps and entrenched traditional methods, as seen in Ponorogo's resistance to cropping pattern changes without technical support. Inadequate simple adaptive infrastructure (earthen embankments, artificial waterways) presents another barrier, consistent with

Saikanth et al. (2023) in India. Poor agricultural infrastructure exacerbates climate vulnerability when farming practices mismatch actual climate conditions.

Ponorogo's reliance on traditional planting calendars reflects Altieri & Nicholls' (2008) Latin American findings. While some traditional communities successfully employ local wisdom, many persist with outdated patterns despite changing climate dynamics. In Ponorogo, ancestral planting calendars often misalign with current weather, increasing crop failure risks. The adaptation support gap in Ponorogo mirrors Pires et al.'s (2014) Brazilian study. Limited access to credit, information, and technical assistance hinders adaptation implementation despite growing climate awareness. Similarly, Ponorogo farmers recognize climate impacts but lack mitigation capacity due to insufficient support. Verma et al. (2024) emphasize interdisciplinary approaches for agricultural resilience through smart farming technologies, updated climate information, and evidence-based policies - particularly relevant for Ponorogo's need for cross-sectoral support toward adaptive agricultural transformation.

The 2024 Ponorogo Agriculture Office Performance Report (LKJ) demonstrates significant agricultural support efforts with high achievement rates. However, field findings reveal macro-level achievements and grassroots needs disparities, particularly regarding climate adaptation - consistent with Suwardi et al. (2024) and Etana et al. (2021) on effective assistance challenges and smallholder adaptation capacity variations. Maladaptation issues, as identified by Asare-Nuamah et al. (2021), underscore the need for comprehensive adaptation programs.

The lack of practical climate adaptation training presents obstacles (Prasad et al., 2024). Farmer evaluations show varying extension effectiveness (Hanggana, 2024), with suboptimal farmer group utilization as knowledge dissemination agents (Osumba et al., 2021). While government seed aid responses were prompt, long-term evaluation is needed (Chapagain et al., 2017), and comprehensive adaptation programs remain essential (Malik et al., 2024). Adaptation policies must consider grassroots conditions (Gnanasubramaniam, 2020).

Collectively, Ponorogo's findings demonstrate government efforts but reveal persistent gaps in effective, sustainable climate adaptation program implementation. Integrated, collaborative approaches (Soubry, 2017) are necessary to enhance farmer adaptive capacity and mitigate climate change impacts.

D. CONCLUSION

This study reveals that flood impacts on the agricultural sector in Ponorogo Regency are multidimensional, encompassing short-term economic losses, land degradation, and threats to farmers' household food security. The findings demonstrate that farmers' unpreparedness for climate change stems from cognitive factors (traditional perceptions of extreme weather), rigid agricultural practices (reliance on conventional planting calendars), and inadequate adaptation infrastructure. While government responses show administrative success, they have yet to fully address farmers' practical needs at the grassroots level, particularly regarding technical assistance, climate information access, and institutional strengthening for adaptation.

The study underscores the necessity for an integrated approach combining technical solutions (infrastructure reinforcement, flood-resistant crop varieties), social interventions (community-based education), and policy measures (evidence-based adaptive programs) to reduce agricultural system vulnerability in flood-prone areas. These policy recommendations are not only relevant to Ponorogo's context but can also be adapted to similar regions across Indonesia, while simultaneously contributing to the global discourse on agricultural adaptation to climate change.

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