

RICE FARMING MITIGATION EFFORTS IN FACING THE CHALLENGES OF CLIMATE CHANGE IN BUDURAN DISTRICT, SIDOARJO REGENCY

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Abstract

Climate change poses a major challenge to the sustainability of rice farming, particularly in climate-vulnerable areas such as Buduran District, Sidoarjo Regency. Increasing rainfall variability, floods, and droughts affect planting schedules, productivity, and production efficiency, thereby increasing farming risks. This study aims to analyze mitigation efforts implemented by rice farmers in responding to climate change impacts. The research was conducted from December to January 2026 using a qualitative approach, with 78 rice farmers selected through multistage random sampling from five villages. Data were collected through interviews, field observations, and Focus Group Discussions (FGD) and analyzed descriptively with triangulation. The results show that farmers have adopted various mitigation strategies, including adjustments in cropping patterns and planting time, the use of climate-adaptive rice varieties, and the application of adaptive cultivation techniques such as the *jajar legowo* system and System of Rice Intensification (SRI). Additional measures include water resource management, integrated pest management, and the adoption of climate-smart agriculture practices, supported by collaboration among farmers, extension agents, and local government. These mitigation efforts contribute to maintaining production stability and promoting sustainable rice farming under climate change pressures.

Keywords: climate change, mitigation, rice farming, sustainability

1. INTRODUCTION

Climate change is a global phenomenon characterized by rising air temperatures, uncertainty in rainfall patterns, and increased frequency and intensity of extreme weather events such as droughts and floods (Syah *et al.*, 2025). This phenomenon not only affects the environment, but also has significant implications for the agricultural system, especially for strategic food commodities such as rice (*Oryza sativa*). The agricultural sector is one of the sectors most vulnerable to climate change due to its high dependence on relatively stable climatic conditions to achieve optimal productivity (Syafitri dan Harahap, 2023). Climate change has the potential to reduce crop yields by disrupting the growth phase of plants, increasing the risk of crop failure, and reducing the efficiency of production inputs, which ultimately impacts farmers' income and welfare.

Climate change is a phenomenon that cannot be controlled by farmers, so a planned and sustainable anticipatory strategy is needed through agricultural mitigation efforts. The implementation of appropriate mitigation and adaptation strategies has been proven to increase the resilience of agricultural systems (climate-resilient

agriculture) and reduce the risk of production losses due to climate pressures (Harahap *et al.*, 2025). Mitigation in the context of farming serves as a strategic effort to prevent and minimize various risks that have the potential to cause losses, both in terms of production and economics (Arsyadona *et al.*, 2025). Therefore, mitigation strategies are a key element in maintaining the sustainability of rice farming amid the increasingly complex dynamics of climate change.

Farmers' level of knowledge and awareness of climate change risks plays an important role in increasing adaptation capacity, so that farming systems become more resilient to various climate pressures (Emeliani *et al.*, 2025). Without the implementation of adequate mitigation strategies, farmers will become increasingly vulnerable to the risks of crop failure, decreased productivity, increased production costs, and reduced crop quality due to climate change and pest attacks. This condition is particularly relevant in Buduran Subdistrict, Sidoarjo Regency, which is one of the rice-producing areas with a high level of vulnerability to seasonal uncertainty and flooding. This climate vulnerability has a direct impact on cropping patterns, production stability, and the efficiency of rice farming.

Although various studies have examined the impact of climate change and adaptation and mitigation strategies on the agricultural sector, studies that specifically discuss rice farming mitigation efforts based on local conditions and climate vulnerability at the sub-district level are still limited. Therefore, this study is novel in that it examines rice farming mitigation efforts in a contextual manner in Buduran Subdistrict, Sidoarjo Regency, as a basis for formulating adaptive and sustainable rice farming mitigation strategies. Based on these issues, this study aims to formulate mitigation efforts undertaken by farmers in facing the impacts of climate change on rice farming activities in Buduran Subdistrict, Sidoarjo Regency, as a basis for developing recommendations for adaptive and sustainable rice farming management.

2. METHODOLOGY

This study was conducted from December to January 2026 using a qualitative approach. The research location was in Buduran Subdistrict, Sidoarjo Regency, considering that this area has a relatively high intensity of climate change events, which has the potential to increase the vulnerability of rice farming. The research population included all rice farmers in five selected villages, totaling 357 farmers. Sampling was conducted using multistage random sampling, with a total sample size of 78. Samples were distributed proportionally in each village, and respondents were selected using simple random sampling. Data collection was conducted through interviews, field observations, and Focus Group Discussions (FGD). Data analysis was performed using qualitative descriptive methods, applying triangulation techniques to ensure data validity.

3. FINDINGS AND DISCUSSION

Climate change is a major challenge to the sustainability of rice farming, especially in areas that are highly vulnerable to flooding, drought, and seasonal uncertainty, such as Buduran D istrict, Sidoarjo Regency. Increasing climate instability requires mitigation efforts that focus not only on technical aspects of cultivation, but also include strengthening farmer capacity, economic risk management, and protection of the agricultural environment. These conditions require the active participation of various parties in anticipating the risks of climate change through the implementation of systematic and integrated mitigation efforts. These anticipatory efforts are directed at formulating adaptive mitigation measures to maintain the productivity, efficiency, and sustainability of rice farming.

3.1 Adjustments to Planting Patterns and Cultivation Techniques

Adjusting cropping patterns is an important adaptive strategy in addressing the impacts of climate change on agricultural systems in Buduran Subdistrict. Uncertainty in rainfall, the risk of flooding during the rainy season, and water shortages during the dry season have prompted farmers to adjust planting times and crop types in accordance with climatic conditions and water availability. Flexible cropping patterns enable optimal land use, reduced risk of crop failure, and increased efficiency in water resource use. Adjusting cropping patterns based on local conditions contributes to increased agricultural system resilience and farming sustainability amid increasingly uncertain climate dynamics (Nisa *et al.*, 2025).

Uncertainty in rainfall patterns requires flexibility in determining planting times and selecting rice varieties that are adaptive to climate stress. The Buduran subdistrict is an area that is vulnerable to extreme climate events in the form of flooding during the rainy season and drought during the dry season, thus requiring specific variety adaptation strategies for these conditions. In flood-prone conditions, the use of flood-tolerant rice varieties such as Inpari 3 and Inpari 29 is a relevant adaptive strategy. This is in line with the research by Nasrudin *et al.*, (2023) which states that Inpari 3 is able to maintain vegetative growth and yield formation in flooded conditions, making it suitable for development in flood-prone areas. In addition, research by Pramono dan Romdon, (2022) states that Inpari 29 has good resistance to flooding, as demonstrated by its stable growth and productivity under flood stress conditions. These findings reinforce that the use of the Inpari 3 and Inpari 29 varieties is an appropriate adaptive strategy in flood-prone areas. During seasonal droughts, the use of drought-tolerant varieties such as Inpari 42 Agritan GSR is considered more appropriate. This variety has a high productivity potential of up to 10.58 tons/ha and broad tolerance to drought conditions, enabling it to maintain stable yields in water-limited environments (Fajrullah *et al.*, 2019).

The application of adaptive cultivation techniques such as the legowo system and the System of Rice Intensification (SRI) are important mitigation efforts in addressing the impacts of climate change on rice farming. The legowo system

improves light utilization efficiency and air circulation, while SRI improves water use efficiency, soil aeration, and plant root strengthening. The combination of these two techniques has been proven to increase rice productivity while strengthening plant resistance to drought and flooding caused by uncertainty (Maulidi *et al.*, 2025; Maisuta *et al.*, 2020). Therefore, the application of *jajar legowo* and SRI is relevantly recommended as a technical mitigation strategy to maintain the sustainability of rice production, especially in areas with high climate dynamics such as Buduran District.

3.2 Water Resource Management

Water resource management is a crucial aspect of climate change mitigation efforts in rice farming, especially in areas with high rainfall fluctuations such as Buduran District. Field observations show that farmers have made various adaptive efforts in water management, although these have not been integrated into a planned system. In flooded paddy fields, farmers generally have pumps to drain water, but their use is still limited because they are not supported by a clear drainage system. In addition, farmers routinely work together to clear waterways of weeds and sediment that obstruct water flow, and implement rotational irrigation when water availability is limited. These findings indicate that water management at the field level has been carried out collectively and adaptively, but it is still reactive and not supported by systematic technical arrangements.

This condition requires the implementation of water management strategies that are not only oriented towards water conservation, but also capable of overcoming excess water due to high rainfall. In this context, the application of alternate wetting and drying (AWD) techniques combined with a controlled drainage system is a more adaptive and contextual approach than the application of AWD alone. Various studies show that AWD is effective in increasing water use efficiency and rice productivity, while reducing greenhouse gas emissions from rice fields. Research by Qiu *et al.*, (2022) shows that the application of the alternate wetting and drying (AWD) technique can increase average rice yields by 2.57%, while reducing irrigation water consumption by 30–50% compared to conventional irrigation systems.

However, the effectiveness of AWD implementation is greatly influenced by hydrological conditions and land drainage systems. In low-lying rice fields prone to flooding, such as in Buduran District, the implementation of AWD alone often faces limitations due to high groundwater levels and slow water drainage. Previous research shows that AWD will work optimally if supported by a drainage system that is capable of controlling excess water, especially during the rainy season (Husna *et al.*, 2018). Therefore, the integration of AWD with controlled drainage is a more relevant approach for Buduran District, where drainage serves to reduce excess flooding and maintain groundwater levels at an optimal level, while AWD is applied adaptively to regulate irrigation timing and volume. This combined approach has proven to be more effective in increasing water use efficiency, water productivity, and reducing greenhouse gas

emissions without decreasing rice yields compared to strict AWD implementation (Fathia *et al.*, 2024).

3.3 Control of Plant Pests (OPT)

The phenomenon of climate change has contributed to the rising intensity of plant pest infestations as a result of shifts in temperature, humidity, and rainfall patterns that influence pest population dynamics (Budyoko *et al.*, 2023). Observations of rice farming practices in Buduran District indicate that the predominant plant pests include birds, brown planthoppers (*Nilaparvata lugens*), rice field rats (*Rattus argentiventer*), rice stem borers (*Scirpophaga* spp.), and golden apple snails (*Pomacea canaliculata*). The prevalence of these pests reflects agroecosystem conditions that are becoming increasingly favourable for pest proliferation, particularly during seasonal transition periods. This circumstance necessitates well-planned and adaptive pest management strategies in response to climate change.

Mitigation measures to address the escalating intensity of pest attacks are focused on the implementation of integrated pest management (IPM) based on field-wide application, synchronization of planting schedules to disrupt pest life cycles, and the reinforcement of routine monitoring of land and crop conditions as an early detection strategy. The IPM approach has been shown to effectively suppress pest populations while preserving agroecosystem balance through reduced reliance on chemical pesticides (Wardoyo, 2025). Furthermore, field observation-based monitoring supported by climate information and pest forecasting facilitates more timely and efficient control actions in the face of climatic uncertainty (Widiarta, 2021).

3.4 Climate-Smart Agriculture

Climate Smart Agriculture (CSA) represents an approach to formulating long-term agricultural strategies aimed at enhancing productivity, strengthening adaptive capacity, and contributing to climate change mitigation, including the reduction of greenhouse gas emissions (Harahap *et al.*, 2024). The implementation of CSA in rice farming systems in Buduran District constitutes a strategic response to agroecosystem conditions that are highly susceptible to both flooding and drought. These regional characteristics necessitate a rice cultivation system that is not solely productivity-oriented, but also capable of adapting to fluctuations in water availability while simultaneously minimizing greenhouse gas emissions.

The Climate Smart Agriculture (CSA) approach in rice farming in Buduran Subdistrict is implemented through the integration of water management practices, balanced fertilization, the application of organic inputs, and the utilization of climate-adaptive rice varieties. Adaptive water management plays a crucial role in reducing the duration of paddy field inundation, which can potentially elevate methane emissions, while simultaneously enhancing water-use efficiency during the dry season. In addition, balanced fertilization combined with organic matter application contributes to improved soil structure and increased water-holding capacity, thereby strengthening rice plant resilience under extreme environmental conditions (Putra *et*

al., 2024). The adoption of adaptive rice varieties further supports production stability amid climatic variability. The implementation of CSA in rice cultivation has been reported to lower greenhouse gas emissions by 7–23% compared to conventional farming systems, while also increasing economic returns by 42–129%, thus reinforcing both the environmental and economic sustainability of rice farming (Ariani *et al.*, 2018)

3.5 Strengthening Synergy Between Farmers, Extension Workers, and Local Governments

Coordinated collaboration among farmers, extension agents, local governments, and other supporting stakeholders constitutes a fundamental basis for enhancing the adaptive capacity of rice farming systems to the impacts of climate change. Through effective coordination, farmers obtain broader access to climate-related information, technological innovations, and technical assistance that are aligned with local agroecosystem conditions. The role of agricultural extension workers in translating policies and innovations into field-level practices, supported by local government initiatives and the involvement of other facilitating actors, enables the implementation of more targeted and sustainable mitigation strategies.

Collaboration among local governments, farmer organizations, research institutions, and the private sector plays a strategic role in enhancing rice farming performance, particularly through the optimization of planting areas, improved efficiency in the use of production inputs, and the accelerated adoption of modern agricultural technologies. The engagement of research institutions promotes the utilization of innovative rice varieties that are adaptable to climate change, while the private sector contributes by supporting the provision of more efficient production facilities and agricultural machinery. Such stakeholder synergy not only enhances production process efficiency but also directly contributes to increased rice productivity across various production centers. This finding is consistent with the statement of Rikardus, (2025), who noted that strengthened stakeholder collaboration has contributed to rising rice productivity in several production hubs, with average yields reaching 5.2 tons per hectare in recent years, approaching the 2020–2024 RPJMN target of 5.5 tons per hectare.

The policy implications of these findings suggest that the Sidoarjo District Government needs to strengthen its collaborative approach in formulating and implementing agricultural policies, particularly in rice-growing areas such as Buduran Subdistrict. Policy strengthening can be directed at increasing the capacity of agricultural extension workers, developing region-based climate change adaptation programs, and strengthening farmer group institutions to be more responsive to climate risks. In addition, the integration of regional programs with national policies, such as aligning regional agricultural development planning with the targets of the National Medium-Term Development Plan (RPJMN), is a strategic step to ensure the sustainability and resilience of rice farming in Sidoarjo Regency.

4. CONCLUSION

Mitigation efforts in rice farming in Buduran Subdistrict, Sidoarjo Regency, have been implemented through adjustments in planting patterns and adaptive cultivation techniques, contextual water resource management, pest control based on integrated pest management (IPM), the adoption of low-emission agricultural practices through Climate Smart Agriculture (CSA), and the strengthening of stakeholder synergies. These strategies play a significant role in enhancing farmers' adaptive capacity to climate change impacts, maintaining production stability, and supporting the sustainability of rice farming systems. The findings further indicate that strengthening collaboration among farmers, extension agents, local governments, research institutions, and the private sector must be continuously promoted through integrated and locally grounded regional policies in order to reinforce the resilience of rice farming in Sidoarjo Regency.

REFERENCES

- Ariani, M., Hervani, A., & Setyanto, P. (2018). Climate Smart Agriculture to Increase Productivity and Reduce Greenhouse Gas Emission – a Preliminary Study. *IOP Conference Series: Earth and Environmental Science*, 1–7. <https://iopscience.iop.org/article/10.1088/1755-1315/200/1/012024>
- Arsyadona, Manik, D. T. S., Olivia, M. F. R., Ananda, W., & Hasibuan, S. R. (2025). Analisis Risiko: Langkah Strategis Untuk Mencegah Kerugian Dan Meningkatkan Profitabilitas Suatu Perusahaan. (Studi Kasus: Perkembangan Pariwisata Di Kota Medan). *Jurnal Sains Student Research*, 3(1), 264–277. <https://www.ejurnal.kampusakademik.co.id/index.php/jssr/article/view/3473>
- Budiyoko, B., Rachmah, M. A., Verrysaputro, E. A., & Wulandari, E. R. (2023). Budiyoko Rachmah, Malinda Aptika Verrysaputro, Exwan Andriyan Wulandari, Eko Ratna. *Prosiding Seminar Nasional Fakultas Pertanian dan Perikanan*, 5, 195–202. <https://doi.org/10.30595/pspfs.v5i.723>
- Emeliani, M., Kurniati, D., & Komariyati. (2025). Pengetahuan Petani Padi Terhadap Perubahan Iklim di Kecamatan Balai Kabupaten Sanggau. *Jurnal Sosial Ekonomi Pertanian*, 22(1), 1–15. <https://journal.unhas.ac.id/index.php/jsep/article/view/47102>
- Fajrullah, A. S. N., Kapila, D. H., & Nugroho, D. (2019). Peningkatan Produktivitas Tanaman Padi Melalui Penggunaan VUB Inpari 42 Agritan GSR di Kecamatan Gapura Kabupaten Sumenep. *Seminar Nasional Optimalisasi Sumberdaya Lokal di Era Revolusi Industri 4.0*, 76–86. <https://ejournal.wiraraja.ac.id/index.php/PROSD/article/view/821/743>
- Fathia, A. N., Hadianto, A., & Raswatie, F. D. (2024). Strategi Mengurangi Emisi Gas Rumah Kaca pada Budidaya Padi di Indonesia. *Indonesian Journal of Agricultural, Resource and Environmental Economics*, 3(1), 49–58.

- <https://journal.ipb.ac.id/ijaree/article/view/54757>
- Harahap, L. M., Manurung, Y. I. B., Situngkir, J. B., & Simanungkalit, N. A. (2024). Pengelolaan Risiko Iklim dalam Sektor Pertanian: Strategi dan Implementasi. *JIMBE: Jurnal Ilmu Manajemen, Bisnis dan Ekonomi*, 1(5), 117–125. <https://malaqbiipublisher.com/index.php/JIMBE/article/view/217>
- Harahap, L. M., Sitanggung, C. B., Tambunan, D. M., Pinem, D. A., & Hasugian, A. B. (2025). Pengaruh Perubahan Iklim Terhadap Strategi Manajemen Agribisnis: Studi Kasus Di Wilayah Pertanian Indonesia (the Effect of Climate Change on Agribusiness Management Strategies: a Case Study in Indonesian Agriculture). *Jurnal Ilmiah Ekonomi Dan Manajemen*, 3(3), 451–462. <https://ejurnal.kampusakademik.co.id/index.php/jiem/article/view/4220/3775>
- Husna, T., Putra, D. I., & Kasoep, W. (2018). Sistem Pengatur Irigasi Sawah Menggunakan Metode Irigasi Alternate Wetting and Drying Berbasis Teknologi Internet of Things. *Journal of Information Technology and Computer Engineering*, 02(02), 92–100. <http://jitce.fti.unand.ac.id/index.php/JITCE/article/view/16>
- Maisuta, Jamidi, & Husna, A. (2020). Respon Pertumbuhan dan Hasil Tanaman Padi (*Oryza sativa* L.) Varietas IPB 3S pada Beberapa Sistem Jajar Legowo. *Jurnal Agrium*, 17(1), 33–44. <https://ojs.unimal.ac.id/index.php/agrium/article/view/2353>
- Maulidi, Warganda, Listiawati, A., & Asnawati. (2025). Penerapan Sistem Tanam Jajar Legowo Dan SRI pada Budidaya Tanaman Padi di Kecamatan Sungai Kakap. *Jurnal Pengabdian kepada Masyarakat Nusantara (JPkMN)*, 6(3), 3768–3775. <https://ejournal.sisfokomtek.org/index.php/jpkm/article/view/6456>
- Nasrudin, Isnaeni, S., & Ramadhan, R. A. M. (2023). Hubungan Karakter Agronomi dan Hasil Padi Berdasarkan Umur Bibit Menggunakan Metode Sawag Apung di Kabupaten Pangandaran. *Jurnal Agrotek Tropika*, 11(3), 419–427. <https://jurnal.fp.unila.ac.id/index.php/JA/article/view/6483/4885>
- Nisa, N. F., Mustaghfiroh, N. F., Agustin, C., & Munafa'ah, L. F. (2025). Ritme Musim yang Bergeser pada Dinamika Kehidupan Petani Desa melalui Society Action Research. *ABDI AKOMMEDIA :Jurnal Pengabdian Masyarakat*, 3(4), 1–8. <https://jurnal.ekomedia.net/index.php/ABDIKOMMEDIA/article/view/138/86>
- Pramono, J., & Romdon, S. A. (2022). Peningkatan Produktivitas Melalui Perbaikan Sistem Budidaya Padi Sawah Di Tengah Ancaman Perubahan Iklim. *Jurnal KaliAgri*, 3(2). <https://jurnal.uss.ac.id/index.php/kaliagri/article/view/409/192>
- Putra, R. E., Rayes, M. L., Kurniawan, S., & Ustiatik, R. (2024). Pengaruh Kombinasi Pupuk Organik dan Anorganik terhadap Sifat Fisik dan Kimia Tanah serta Produksi Padi pada Lahan Kering yang Disawahkan. *Jurnal Agrikultura*, 35(1), 136–150. <https://jurnal.unpad.ac.id/agrikultura/article/view/53686>
- Qiu, H., Yang, S., Jiang, Z., Xu, Y., & Jiao, X. (2022). Effect of Irrigation and Fertilizer Management on Rice Yield and Nitrogen Loss: A Meta-Analysis. *Plants*, 11(13), 1–16. <https://www.mdpi.com/2223-7747/11/13/1690>
- Rikardus, E. (2025). Penguatan Kebijakan Ketahanan Pangan: Sinergi Multi-

- Pemangku Kepentingan dalam Peningkatan Produksi Padi. *Jurnal Ilmu Sosial dan Humaniora*, 1(2), 302–315.
<https://indojournal.com/index.php/jisoh/article/view/338/274>
- Syafitri, N., & Harahap, M. I. (2023). Sektor Pertanian dalam Menghadapi Perubahan Iklim. *Communnity Development Journal*, 4(4), 7479–7483.
<https://journal.universitaspahlawan.ac.id/index.php/cdj/article/view/18578/13731>
- Syah, M. A., Defri, I., Panpipat, W., & Chaijan, M. (2025). Assessing Coffee Farmers' Awareness of Climate Change Through the Climate Change Awareness Index Approach in Tukur, Pasuruan, Indonesia. *Agriverse*, 1(1), 23–33.
<https://agriverse.upnjatim.ac.id/index.php/agriverse/article/view/5>
- Wardoyo, C. A. (2025). Strategi Pengendalian Hama Terpadu pada Tanaman Padi Sawah. *Circle Archive*, 1(7), 1–10. <https://circle-archive.com/index.php/carc/article/view/357>
- Widiarta, I. N. (2021). Sistem Pendukung Pengambilan Keputusan Pengendalian Hama Terpadu Pada Tanaman Padi Berbasis Teknologi Informasi. *Jurnal Penelitian dan Pengembangan Pertanian*, 40(1), 9–20. <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://files01.core.ac.uk/download/pdf/401892958.pdf>