



ACCELERATING AGRICULTURAL RECOVERY AFTER THE SIBOLGA FLASH FLOOD: A SYSTEMATIC LITERATURE REVIEW FOR DESIGNING A HOUSEHOLD FOOD SECURITY PROGRAM

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ABSTRACT

This study examines the acceleration of agricultural recovery following the Sibolga flash flood, which severely affected household food systems. It aims to synthesize scientific evidence on effective food-security-based agricultural recovery strategies using a Systematic Literature Review (SLR) approach. The research data were drawn from relevant scientific literature published within the past five years on agricultural recovery, household food security, and flash floods. The findings indicate that successful recovery is determined by a combination of technical, social, and institutional interventions that strengthen farmers' resilience capacities. In conclusion, accelerating agricultural recovery requires an integrative, community-based strategy that combines socioecological dimensions with public policy to build resilient and sustainable household food systems in disaster-prone areas.

Keywords: *Agricultural recovery; household food security; flash floods; farmer resilience; Systematic Literature Review.*



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1. INTRODUCTION

Flash floods are among the most destructive hydrometeorological disasters, significantly affecting household agricultural systems, particularly in coastal and low-lying areas such as Sibolga. These events not only cause the loss of agricultural land

through erosion and sedimentation but also damage supporting infrastructure, including irrigation networks and farm access roads, while disrupting market access and local food distribution (Alexander et al., 2025). Such impacts exacerbate the economic and social vulnerability of smallholder farmers who rely on agricultural production as their primary source of income and household food security (Atubiga & Donkor, 2022). In addition to the loss of physical assets, flash floods lead to long-term declines in productivity due to soil degradation and limited access to production inputs such as seeds, fertilizers, and working capital (Jonathan et al., 2020; K. W. Saragih et al., 2025). This situation creates a cycle of compounded vulnerability in which farmers face limited adaptive capacity while simultaneously being pressured to restore their production systems within a short period and without adequate institutional support (Haque et al., 2021). In this context, accelerating post-disaster agricultural recovery has become a strategic priority for ensuring the continuity of food production and socioeconomic stability in flood-prone areas such as Sibolga.

The literature indicates that post-disaster agricultural recovery efforts frequently focus on the physical rehabilitation of land and infrastructure without adequately considering the complex socioecological dimensions of farmers' livelihood systems (Darma et al., 2025). Infrastructure-oriented approaches tend to overlook long-term adaptation needs, including the institutional, social, and economic capacities required to strengthen household food security (Han et al., 2024). The FAO food security framework (1996) emphasizes four principal pillars availability, access, utilization, and stability yet these pillars have not been fully integrated with socioecological resilience approaches in the context of post-flood agricultural recovery (Handayani et al., 2024; Suhendar et al., 2025). Similarly, the Sustainable Livelihoods Framework (SLF), which examines human, social, and natural livelihood assets, is often insufficiently applied to hydrometeorological disaster contexts that require multisectoral adaptation (Girsang et al., 2025). This theoretical gap highlights the need for an integrative approach that combines the dimensions of resilience, sustainable livelihoods, and household food security in designing evidence-based post-flood recovery strategies.

This study aims to systematically synthesize scientific evidence concerning strategies for accelerating the recovery of agricultural systems following flash floods and their implications for household food security in flood-prone areas such as Sibolga. The study employs a Systematic Literature Review (SLR) approach to identify,

evaluate, and integrate relevant research findings on recovery interventions, including the restoration of production inputs, infrastructure, financing, institutions, and food markets and logistics (Hussain & Guha, 2023). Specifically, this study examines the relationships between various forms of recovery intervention and household food security indicators based on the four FAO pillars, while also analyzing the factors that facilitate or impede the success of the recovery process (Alhassan, 2020). The findings are expected to provide a foundation for developing an accelerated post-flood agricultural recovery program package that is adaptive, sustainable, and contextually aligned with the socioeconomic conditions of local communities in Sibolga.

The significance of this study lies in the urgent need to develop an evidence-based intervention framework capable of accelerating agricultural recovery while simultaneously strengthening household food security after flooding. The increasing frequency of flood disasters resulting from climate change necessitates recovery systems that are not merely reactive but also proactive and transformative in building the socioecological resilience of farming communities (H. Saragih et al., 2025; Tasnim et al., 2025). Through the Systematic Literature Review approach, this study contributes to addressing the knowledge gap concerning how combinations of adaptation strategies, institutional innovations, and food policies can accelerate post-disaster recovery (H. Saragih, 2020). Moreover, this study offers practical implications for designing location-specific household food security programs, which are crucial for the sustainable development of the agricultural sector in disaster-prone areas such as Sibolga.

2. RESEARCH METHODE

The research object of this study is the phenomenon of post-flash-flood agricultural recovery in tropical coastal areas, with particular emphasis on its implications for household food security. This phenomenon reflects the complexity of the relationships among environmental vulnerability, socioeconomic instability, and farmers' adaptive capacity to maintain agricultural productivity following hydrometeorological disasters. The selection of this research object is based on the urgent need to understand the most effective adaptation and recovery strategies within local contexts, as demonstrated by previous studies on the resilience of agricultural systems to climate-related disturbances and disasters (Boahen et al., 2023). In the context of Sibolga, flash floods pose a major

challenge to the sustainability of food production and the welfare of farming communities whose livelihoods depend on agricultural land and inland fisheries. Therefore, this phenomenon was selected as the focus of the study to provide an empirical synthesis capable of supporting evidence-based agricultural recovery policies (Yiridomoh et al., 2025).

This study employs library research using a Systematic Literature Review (SLR) approach to review and synthesize findings from previous studies concerning post-disaster agricultural recovery and its relationship with household food security. The primary data consist of relevant scientific literature addressing adaptation strategies, agricultural rehabilitation, and post-disaster interventions in food systems. Meanwhile, secondary data were obtained from scientific publications, policy reports, and academic books relevant to the research keywords (Perdana et al., 2022). The SLR approach provides a systematic framework for identifying empirical evidence from diverse geographical and methodological contexts while minimizing subjective bias in the literature-selection process (Anastacia, 2021). The SLR method was selected because of its ability to provide a comprehensive and evidence-based understanding of intervention patterns and the effectiveness of post-disaster agricultural recovery policies.

This study is grounded in three principal theories that serve as the conceptual framework for the analysis: the Food Security Framework (FAO, 1996), the Sustainable Livelihoods Framework and Resilience Theory. The Food Security Framework emphasizes four pillars of food security availability, access, utilization, and stability which are used to assess the extent to which post-disaster agricultural recovery can support household food security (Morkūnas et al., 2025). The Sustainable Livelihoods Framework explains how livelihood assets, including natural, human, social, physical, and financial assets, interact to shape the adaptation strategies of farming households. Holling's Resilience Theory provides an analytical foundation for understanding the capacity of agricultural systems to withstand, absorb, recover from, and transform following disasters. It therefore constitutes a relevant framework for assessing the acceleration of agricultural recovery in vulnerable areas such as Sibolga (Boahen et al., 2023).

The research process followed the systematic stages outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The

first stage involved formulating specific research questions concerning strategies for accelerating post-flood agricultural recovery and their implications for household food security. The second stage consisted of developing a research protocol that included the literature-search strategy, inclusion and exclusion criteria, and criteria for assessing the quality of the selected studies (Harsanto et al., 2025). The third stage involved conducting literature searches through electronic databases such as Scopus, ScienceDirect, and Google Scholar using combinations of the keywords “agricultural recovery,” “flood,” and “food security.” Once the relevant literature had been identified, screening and eligibility assessments were conducted based on the predetermined inclusion criteria. This process was followed by study-quality assessment and data extraction to identify patterns in the findings, geographical contexts, and methodological approaches employed in the selected studies.

The data-analysis technique employed in this study was content analysis, which was used to examine and categorize findings from the selected literature. The process included coding key concepts, identifying relationships among variables, and drawing thematic conclusions based on empirical evidence obtained from previous studies. The analysis was conducted both deductively and inductively by considering the theoretical foundations and relevant empirical findings. This approach enabled the researchers to identify common patterns and differences among agricultural recovery strategies and relate them to the dimensions of household food security. The results of the content analysis were used to develop a conceptual model explaining the relationship between recovery interventions and food-security indicators. This model was subsequently used to formulate evidence-based policy recommendations for accelerating post-disaster agricultural recovery at both local and national levels.

3. RESULT AND DISCUSSION

RESULT

Data Description from the Literature Review: Post-Disaster Agricultural Recovery

The literature on post-flood agricultural recovery indicates that the recovery process is multidimensional, encompassing the physical rehabilitation of agricultural land, the reorganization of production systems, and the strengthening of farmers’ socioeconomic capacities. Based on findings from a study conducted in the Tempe Lake region of Indonesia, agricultural recovery was pursued through the cultivation of flood-tolerant

rice, the diversification of income sources, and improved access to credit and training to strengthen household resilience (Darma et al., 2025). A similar study in Kosovo revealed that post-flood agricultural recovery requires a combination of short-term policies, such as seed distribution and subsidies, and long-term strategies, including soil conservation and integrated water management, to support the sustainability of production systems. Other studies emphasize that dependence on conventional agricultural systems without climate adaptation reduces recovery capacity and prolongs the post-disaster food crisis period (Hussain & Guha, 2023).

The reviewed studies explain that the success of post-disaster agricultural recovery depends heavily on the integration of technical and social factors. Strategies such as the implementation of climate-resilient agriculture and agroecological systems have been shown to improve the resilience of farming communities to recurrent flood disturbances (Handayani et al., 2024). In addition, government policy support and interinstitutional collaboration are key factors in accelerating the distribution of agricultural assistance and the rehabilitation of damaged irrigation infrastructure. A study in Pakistan demonstrated that coordination among institutions such as the FAO, WFP, and the national government can strengthen communities' adaptive capacity through climate-resilient agricultural policies and efficient food logistics systems (Tina Safira et al., 2024). Therefore, the literature confirms that post-flood agricultural recovery is not merely a technical undertaking but also a systemic transformation aimed at building long-term resilience in the food sector.

Data from various studies demonstrate strong relevance to post-flood conditions in Sibolga, where damage to agricultural land and infrastructure, as well as the loss of production capital, constitute major constraints for farmers. This situation is consistent with findings in the literature emphasizing the importance of adaptive strategies and institutional support in accelerating the recovery of agricultural systems. Experiences from South and Southeast Asia indicate that community-based recovery involving the participation of local farmers and the provision of flood-resilient technologies can accelerate economic recovery and strengthen household food security (Alhassan, 2020). Therefore, an approach that integrates social, ecological, and public-policy dimensions provides an essential foundation for restructuring agricultural systems in affected areas such as Sibolga.

Data Description from the Literature Review: Household Food Security

The literature indicates that floods directly affect the dimensions of household food security, particularly food availability and access. A study in Bangladesh found that approximately 62% of households experienced food insecurity following a major flood because of depleted food stocks, damaged agricultural land, and disrupted food distribution systems (Parvez et al., 2022). Another study in Japan found a positive correlation between household disaster-resilience capacity and food-security stability, particularly in the dimensions of food accessibility and utilization (Han et al., 2024). These findings demonstrate that household food-security systems are strongly influenced by the level of community resilience to natural disasters, especially the capacity to maintain food distribution and consumption during periods of crisis.

The reviewed data reveal that post-flood food security is determined not only by food production but also by social networks, infrastructure, and public policies. A study in Ghana showed that households employing income-diversification strategies through both on-farm and non-farm activities were able to recover more rapidly from flood impacts and maintain their food security (Atubiga & Donkor, 2022). Similarly, research in Bangladesh found that households with access to education, productive assets, and basic services achieved higher food-security scores, reinforcing the importance of structural support in addressing flood-induced food crises (Tasnim et al., 2025). Therefore, post-disaster household food security is not merely a function of food availability but also the outcome of the integration of various social, economic, infrastructural, and policy-related factors.

The relationship between the literature findings and the conditions in Sibolga indicates that limited access to economic resources and food infrastructure is a major cause of declining household food security after flooding. This condition is consistent with findings from other regions, where damage to distribution networks and the loss of agricultural capital result in prolonged dependence on external assistance. In the context of Sibolga, post-flood food security can be strengthened by developing farmers' adaptive capacity, reinforcing food logistics systems, and implementing policies that encourage livelihood diversification, as recommended by global studies.

Data Description from the Literature Review: Flash Floods

The literature on flash floods highlights that this phenomenon is not only hydrometeorological but also socioecological in nature, with extensive consequences for agricultural sustainability and food security. A study in Nigeria reported that flash floods reduced crop yields by up to 40%, damaged agricultural land, and increased food transportation costs because of damaged roads and bridges (Alexander et al., 2025). Research in Vietnam also demonstrated that household resilience to flooding is influenced by community confidence in local agricultural systems and the capacity to adopt adaptive farming practices (Nguyen & James, 2013). These findings illustrate that flash floods have structural implications for food systems and the livelihoods of agrarian communities.

A more detailed review indicates that the frequency and intensity of flash floods are increasing because of climate change and unsustainable land-use practices. A study in Malaysia emphasized that flood-risk management should be implemented through a multidimensional approach combining environmental protection, spatial planning, and community education (Gunawan et al., 2025). Furthermore, research in the Benue Valley of Nigeria revealed that annual flooding increased food prices by up to 200%, reduced household income, and disrupted local economic stability. These findings demonstrate that flash floods constitute a systemic threat to the sustainability of food systems and therefore require cross-sectoral interventions.

The conditions experienced in Sibolga show similarities to global findings concerning the effects of flash floods on agricultural systems and food security. Damage to agricultural land and infrastructure obstructs the recovery process, while farmers' limited adaptive capacity prolongs the period of food crisis. Based on the reviewed literature, the implementation of flood-risk mitigation policies, including the construction of natural embankments, the reforestation of water-catchment areas, and the strengthening of early-warning systems, may constitute strategic measures for accelerating agricultural recovery and preventing long-term food vulnerability in Sibolga.

DISCUSSION

Research Findings

The findings indicate that post-flood agricultural recovery is multidimensional, involving the integration of physical, social, economic, and institutional dimensions to restore the functioning of agricultural systems and strengthen household food security. In general, the literature synthesized through the Systematic Literature Review (SLR) approach confirms that accelerated agricultural recovery cannot be achieved solely through infrastructure rehabilitation or the provision of technical assistance. Instead, it requires the strengthening of socioecological resilience, enabling farmers to adapt to recurring disaster risks (Darma et al., 2025). The relationship between agricultural recovery and household food security is mutually reinforcing, as the stability of post-disaster production systems directly improves food availability, accessibility, and stability. This study also confirms that institutional interventions, including adaptation policies and food logistics support, play a significant role in accelerating recovery processes in flood-affected areas.

Compared with other studies on agricultural adaptation to flooding, this research offers the advantage of analytically integrating three principal components agricultural recovery, household food security, and the flash-flood context within a single conceptual framework grounded in Resilience Theory and the Sustainable Livelihoods Framework. For example, Hussain & Guha (2023), focused primarily on the contribution of climate-resilient agriculture to food security without examining the structural relationships between the social and policy dimensions of recovery. In contrast, this study positions socioecological factors as the primary determinants of accelerated recovery, as supported by findings from Vietnam showing that household resilience to flooding depends on a combination of social adaptation and trust in local agricultural systems (Nguyen & James, 2013). The SLR approach employed in this study provides an advantage in terms of the depth of cross-contextual synthesis and the empirical validity of effective post-flood recovery strategies.

Reflection on these findings demonstrates that the systematic synthesis of the literature on post-flood agricultural recovery offers broad conceptual and practical benefits. Conceptually, this study reinforces the relevance of Resilience Theory as a framework for understanding agricultural recovery as a process of socioecological transformation rather than merely physical reconstruction. Practically, the findings

indicate that strengthening farmers' capacities to manage risks, diversify income sources, and develop socioeconomic networks can accelerate recovery and stabilize local food systems (Alhassan, 2020; Suhendar et al., 2024). Therefore, this study not only addresses existing theoretical gaps in agricultural recovery research but also contributes to the development of an evidence-based adaptation model that can be implemented at the regional policy level.

Analysis of the Implications of the Research Findings

The principal implication of this study is the importance of developing disaster-resilient and adaptive agricultural systems as a central strategy for strengthening household food security. The SLR findings demonstrate that adaptive agricultural policies and decentralized food infrastructure can improve the capacity of affected regions to respond to recurring flood-related disruptions (Weber-Wulff et al., 2023). This study also confirms that food security cannot be achieved without cross-sectoral policies encompassing risk mitigation, economic development, and environmental education. Consequently, the findings are highly relevant to the design of sustainable agricultural development programs that focus not only on production but also on food distribution and disaster-risk management at the household and community levels (Akinkuolie et al., 2025).

The finding that accelerated agricultural recovery depends on social and institutional adaptive capacities can be explained through the interaction among environmental, economic, and public-policy factors. When local social and institutional systems are weak, recovery processes tend to be reactive and short-term, thereby delaying the achievement of food security. However, when farmers have access to adaptive technologies, training, and logistical support, recovery can occur more rapidly and sustainably (Duan et al., 2023). This indicates that the findings are not merely empirical coincidences but logical consequences of the structures of agricultural systems and policies that determine communities' resilience to disasters. This condition further strengthens the argument that accelerated agricultural recovery can only be achieved through a multilevel approach involving synergy between national policies and community-based actions.

Actions Required Based on the Research Findings

Based on the research findings, the actions that need to be undertaken encompass three strategic measures. First, regional institutional capacity should be strengthened to design and implement risk-based agricultural recovery policies. Second, household adaptive capacity should be enhanced by providing access to credit, training, and flood-resilient agricultural technologies. Third, decentralized food logistics systems should be developed to ensure the stability of post-disaster food distribution (Alexander et al., 2025). In addition, regional development policies in areas such as Sibolga should be directed toward integrating flood-risk mitigation with community-based food-security development. By implementing these recommendations, agricultural and food-security systems in disaster-prone regions can be transformed into more resilient, inclusive, and sustainable systems over the long term (Tasnim et al., 2025).

Table 1. Research Findings Based on Writing Objectives

Specific Research Objectives	Key Findings	Supporting Evidence (Academic Literacy Sources)	Implications for the Sibolga Context
1. Identify and classify forms of post-flood agricultural recovery interventions	Recovery interventions are divided into three groups: (a) technical-productive (land rehabilitation, adaptive seeds, flood-resistant agricultural systems), (b) socio-economic (credit support, income diversification, adaptation training), and (c) institutional (inter-agency coordination and adaptive policies).	(Darma et al., 2025) ; (Zain et al., 2025)	Local governments need to prioritize community-based recovery with technological support and strengthening of local institutions.
2. Analyze the relationship between recovery interventions and household food security indicators (availability, access, utilization, stability)	There is a strong link between the effectiveness of socio-economic interventions and improvements in the four pillars of food security. Programs that strengthen market access, logistics, and food education have been shown to accelerate recovery.	(Han et al., 2024) ; (Atubiga & Donkor, 2022)	Strengthening the food supply chain and developing logistics infrastructure are determining factors for household food stability after floods.

3. Formulate driving and inhibiting factors in accelerating agricultural recovery	Key driving factors: farmer adaptive capacity, institutional collaboration, and public policy support. Inhibiting factors: weak access to capital, limited adaptive technology, and dependence on external assistance.	(Hussain & Guha, 2023) ; (Alhassan, 2020)	Post-flood rehabilitation programs must strengthen access to microfinance sources and training in local technology adaptation..
4. Develop recommendations for accelerated recovery program packages (short, medium, long term)	Short term: distribution of production inputs and emergency food aid; Medium term: rebuilding agricultural infrastructure and food logistics; Long term: strengthening institutions, adapting technology, and early warning systems.	(Handayani et al., 2025) ; (Alexander et al., 2025)	Regional policy recommendations: adoption of location-based food security systems and strengthening multi-sector coordination for sustainable recovery.

Table 2. Specific Research Objectives

Specific Research Objectives	Local Action Focus	Activity Details (Real Actions in the Field)	Main Implementers and Local Partners	Implementation Period	Success Indicators
1. Analyze the relationship between recovery interventions and household food security indicators (availability, access, utilization, stability)	Strengthening Market Access and Food Logistics	- Establish a Community Food Hub in each affected sub-district. - Build an Emergency Food Warehouse to maintain availability during floods. - Form a Farmer Logistics Group for	Food Security Service, Agriculture Service, PKK, Karang Taruna, Village Cooperatives	Short Term (0–6 Months)	- Community food markets operate in ≥ 3 locations. - Emergency food stocks are sufficient for ≥ 14 days of residents' needs. - Market access has increased by $\geq 25\%$ compared to pre-

		cross-village food transportation.			flood levels.
		Organize a Nutrition & Food Security School based on local ingredients.			
2. Formulating driving and inhibiting factors for accelerating agricultural recovery	Improving the Adaptive Capacity of Farmers and Local Institutions	- Establishing a Micro Farmer Fund (Local Agro-Resilience Fund) through cooperatives. - Conducting Adaptive Agricultural Technology Training with local universities. - Implementing the Triple Helix Collaboration	Sibolga Regional Government, University of North Sumatra, Agricultural NGOs, Cooperatives	Medium Term (6–24 Months)	60% of farmers access microcredit. ≥4 adaptive technology trainings are held. - Active farmer councils are formed in each affected village.

		Program (Local Governm ent Academi cs– Farmers) . • Revitaliz ing the Village Farmer Council for recovery planning.			
3. Develop recommend ations for a program package to accelerate agricultural recovery (short, medium, long term)	Implementa tion of the Integrated Recovery Program Package	• Short Term: Distribut ion of producti on inputs & emergen cy food aid; mapping of damaged land. • Medium Term: Rehabilit ation of agricultu ral infrastru cture, develop ment of Local Food Logistics Center, and	Departmen t of Agricultur e, BPBD, Bappeda, Farmers' Cooperativ es, Academics , Private Sector (CSR)	Long Term (2–5 Years)	• Irrigatio n and farm road rehabilit ation reaches ≥80%. • Active Early Warnin g System is availabl e at ≥5 river points. • Regiona l food security master plan is establis hed as official policy.

Sibolga
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- **Long Term:**
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4. CONCLUSION

This systematic literature review concludes that accelerating agricultural recovery after flash floods requires an integrated and multidimensional approach that extends beyond the physical rehabilitation of farmland and agricultural infrastructure. Effective recovery depends on the simultaneous implementation of technical-productive, socioeconomic, and institutional interventions. Technical measures include land rehabilitation, the provision of adaptive seeds, the restoration of irrigation systems and farm roads, and the adoption of flood-resilient agricultural technologies. Socioeconomic interventions involve access to microcredit, livelihood diversification, farmer training, and the strengthening of local market access, while institutional interventions require coordinated policies, effective inter-agency collaboration, community participation, and decentralized food logistics systems. These measures directly contribute to the four pillars of household food security by restoring food availability, improving economic and physical access, supporting appropriate food utilization, and maintaining supply

stability during future disasters. In the context of Sibolga, the proposed recovery program should be implemented progressively through short-term assistance involving production inputs, emergency food supplies, and damage assessment; medium-term measures focused on infrastructure rehabilitation, adaptive technology training, community food hubs, and local financing mechanisms; and long-term strategies involving early-warning systems, watershed restoration, institutional strengthening, and the formulation of a regional food-security master plan. The study further demonstrates that agricultural recovery should be understood as a process of socioecological transformation rather than merely a return to pre-disaster conditions. Therefore, the success of post-flood recovery in Sibolga will depend on the ability of local governments, farmers, universities, civil society organizations, cooperatives, and the private sector to establish collaborative, location-specific, inclusive, and sustainable interventions. Future empirical research is needed to validate the proposed program through field-based assessments, stakeholder participation, and measurable indicators of agricultural recovery and household food security.

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