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Women's Adaptation Strategies for Ensuring Food Security to Response Climate Change: Good Practice from Rural Swamp in Indonesia

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ABSTRACT

This research examines rural women's strategies and adaptive capacity in the Rawa Lebak region in responding to climate change and ensuring family food security. As primary household food providers, rural women face growing challenges due to climate change, directly impacting food production and availability. Climate change is a global concern addressed in SDG 13 (climate action), while food security is a priority under SDG 2. A mixed methods approach is used in this research. The quantitative analysis evaluates rural women's adaptive capacity by assessing economic resources, human capital, production and marketing infrastructure, institutional support, social capital, and natural resources. The qualitative component explores their strategies and activities in maintaining family food security amid climate shifts. Findings reveal clear indicators of climate change in Muara Menang village, including seasonal shifts, prolonged droughts, floods, and land fires. However, women's understanding of climate change remains limited, often perceived only as seasonal variations. These environmental disruptions contribute to crop failures, exacerbating food insecurity and destabilizing household food supplies. Given their responsibility for food provision, rural women must adapt by developing innovative strategies to sustain food availability. Their resilience and adaptive measures play a crucial role in mitigating the adverse effects of climate change on family food security.

1. INTRODUCTION

Peatlands and swamps are crucial ecosystems that produce a variety ofvarious goods and services, store natural carbon, are useful for climate regulation, have hydrological functions, biodiversity, and provide large amounts of biomass through the cultivation of plants and livestock which are supported by the unique function of peatlands which have high water content [1-3]. Lebak swamps in South Sumatra are included in the tropical peatland category areas that have the capacity to absorb carbon, accommodate biodiversity and provide food and medicine ecosystems for local communities [4]. Tropical peatlands are required to play a role in increasing food security, mitigating climate change, as well as increasing resilience and supporting rural livelihoods [5]. Therefore, the important role of swamp lebak as a provider of community food sources continues to be encouraged to contribute to food security in a broader context.

Global food availability is closely related to climate change. Climate change is a global threat that has an impact on food security and food sovereignty, especially for people whose livelihoods depend on agriculture [6]. Climate change has a negative impact on nature, one of the most affected is the agricultural sector. These real impacts include high temperatures, pests and diseases and extreme weather [7, 8]. Indonesia is an agricultural country where most of the population depends on the agricultural sector for their livelihoods, including swampland farming. Therefore, climate change needs to be handled seriously at the national and local levels. Based on data from The Economic Intelligence Unit (EIU) in 2018, Indonesia's food security is most vulnerable to the impact of climate change compared to other countries in Southeast Asia. This is proven by the decline in Indonesia's food security value due to climate change factors, namely from 54.8 to 47.10 [9]. The issue of decreasing global food security and climate change has become a topic of discussion at the national, regional, and international levels, as well as being a sustainable development goal of the 13th SDGs on handling climate change and the 2nd SDGs on ending hunger and realizing food security. Decreased food security due to climate change impacts women. Women are socially constructed as being responsible for family food [10], so that when climate change occurs and disrupts food availability, women suffer the most, both socially, economically, and psychologically. Women experience a double burden when climate change occurs [11]. As the climate crisis continues, there is a critical

need to increase women's knowledge about climate change [12, 13], about adaptive capacity and the factors underlying it [14, 15].

A gender perspective in understanding the social-ecological system for climate resilience is very important because women are also one of the social groups most vulnerable to climate change and bear a significant burden of adaptation. Women's adaptive capacity is determined in part by learning and cognition, especially the ability to process, assess and react to climate change [16]. One of women's adaptation strategies to face climate change is to utilize social capital [17]. Adaptation can also be done by changes in meeting food availability, consumption patterns and women's daily work patterns as well as changes in lifestyle to ensure household food security [18]. Studies on women's adaptive capacity to climate change are increasingly important and crucial to be carried out through a collective approach that combines social, cultural, situational, locational, and historical contexts of gender-based climate vulnerability in society [19]. In addition, the parameters of women's adaptive capacity include aspects of economic resources, human resources, production and marketing infrastructure, institutions, social capital, and natural resources [20], which will produce comprehensive findings based on the realities of rural women in the Rawa Lebak area. Lebak swamps in South Sumatra are included in the tropical peatland category areas that have the capacity to absorb carbon, accommodate biodiversity and provide food and medicine ecosystems for local communities [4]. Tropical peatlands are required to play a role in increasing food security, mitigating climate change, as well as increasing resilience and supporting rural livelihoods [5]. Therefore, the important role of swamp lebak as a provider of community food sources continues to be encouraged to contribute to food security in a broader context.

This research examines the Strategy and Adaptive Capacity of Rural Women to Response Climate Change in the Rawa Lebak Area to Achieve Family Food Security. This study is important to carry out considering that rural women play a crucial role in family food security [1], faced with the problem of global climate change which has an impact on food security [21]. Climate change is a global issue and is included in SDG 13 concerning handling climate change (climate action), while the issue of food security is included in SDG 2. Handling climate change to achieve food security needs to involve many parties, including rural women in the Lebak Swamp area. Based on this, this research was conducted to a). identify the activities of rural women in the Rawa Lebak area in fulfilling family food b). find strategies used by rural women to face climate change to achieve family food security c). Find the adaptive capacity of rural women in fulfilling family food in the face of climate change.

2. LITERATURE REVIEW

According to the Environmental Protection Agency (EPA), climate change is a significant climate change that occurs over a certain period of time. Climate change can also be interpreted as drastic changes in temperature, changes in rainfall, changes in wind patterns, and so on. The main causes include global warming which occurs due to emissions of Green House Gases (GHG) such as carbon dioxide, methane and other gases from various sources [22].

International articles related to climate change discuss topics regarding analysis of the impact of climate change on the environment and agroforestry [23], the potential of renewable energy to reduce climate change [24], national commitment and implementation of climate change [25], the socio-political context of climate change policy [26], global warming mitigation strategies [27], the role of the media in reporting climate change [28], climate change as a construction of reality [29], building climate resilience through disaster preparedness [30], and the influence of forest fires and climate change [22].

In 2023, through a competitive superior research scheme (funding from universities), researchers conducted a study on climate change in rural areas with the theme Community-Based Climate Change Adaptation and Mitigation through the Climate Village Program (Proklim). The findings of this research indicate that the role of women is very significant. Therefore, it will be followed up with fundamental research in 2024 which will examine more comprehensively the strategies and adaptive capacity of rural women in facing climate change to achieve family food security. The originality of this fundamental research lies in the use of women's and socioecological perspectives in understanding the topics studied.

This research aligns with global and national priorities in addressing climate change by emphasizing the pivotal role of women in rural areas. Women, particularly in agrarian communities, often bear the brunt of climate related challenges due to their reliance on natural resources for livelihood and their roles in ensuring family welfare and food security. However, their potential as key agents of change in climate adaptation and mitigation remains underexplored.

Several studies support the importance of integrating gender perspectives into climate change strategies. For example, previous study highlights that empowering women with knowledge and resources enhances household resilience to climate shocks [31]. Similarly, emphasizes that gender-inclusive policies in climate action lead to more sustainable outcomes by leveraging women's traditional knowledge and social networks [32]. Furthermore, more studies underline the effectiveness of community based approaches, like *Proklim* in fostering local capacity to address climate impacts while ensuring inclusivity and equity [33, 34]. The socioecological perspective used in this study bridges the gap between environmental changes and their social dimensions, particularly focusing on how rural women navigate the intersection of ecological vulnerabilities and societal roles. This approach not only enriches the understanding of adaptive behaviors but also informs policy development by providing a nuanced view of rural realities.

To build upon this, several recent studies further emphasize the need for gender-sensitive adaptation strategies in climate change policies [35]. The disproportionate impacts of climate change on women and marginalized groups in Southeast Asia are well documented, where social norms, restricted access to resources, and limited decision-making power exacerbate vulnerabilities [36]. Therefore, effective climate adaptation strategies must adopt gender-transformative approaches to ensure inclusivity and resilience. Participatory methods incorporating diverse perspectives, including gender and social inclusion, are essential in shaping robust climate policies [37].

However, low female representation and entrenched power dynamics can impede effective participation, highlighting the need for more inclusive and equitable platforms. Local and community-based adaptation models, such as community

forestry in Myanmar and collective actions in Bangladesh, have shown promise in fostering women's engagement and knowledge [38]. However, further institutional support and inclusive decision-making processes are required. These efforts underscore the critical role of gender-sensitive adaptation in enhancing community resilience and providing a more comprehensive approach to climate adaptation. Integrating these gender-inclusive perspectives into policy development ensures more equitable and sustainable outcomes, particularly in rural and resource-dependent communities where the impact of climate change is most acute [39].

By building on the findings of the 2023 study, the 2024 research aims to deepen the understanding of adaptive capacities through a participatory methodology, engaging rural women as co-researchers and contributors to knowledge production. This approach aligns with sustainable development goals (SDGs), particularly SDG 5 (Gender Equality), SDG 13 (Climate Action), and SDG 2 (Zero Hunger). The outcomes of this research are expected to contribute significantly to the body of knowledge on climate change adaptation, providing practical recommendations for policymakers and stakeholders to design gender-responsive programs that enhance community resilience while ensuring food security at the household level.

The concept of food security has developed and changed over the last 50 years, where initially the introduction of four pillars of food security (availability, access, utilization, and stability) has evolved into six pillars (plus agency and sustainability) [40]. Food security is important for economic development and growth, social interaction, political stability, and security in society [41].

3. RESEARCH METHODOLOGY

This study used a mixed- methods approach that combines quantitative and qualitative analysis to assess the adaptive capacity of rural women in dealing with climate change and ensuring family food security in Muara Menang Village, Rawa Lebak, South Sumatra. This study lasted for 12 months (January- December 2024) and involved various data collection methods, including structured surveys, in-depth interviews, focus group discussions (FGDs), field observations, and secondary data analysis. The quantitative approach was used to measure adaptive capacity through various indicators, such as economic resources, human capital, infrastructure access, institutional support, social capital, and natural resource availability [20]. These six dimensions were selected based on established vulnerability and resilience frameworks. Preliminary discussions with local stakeholders also indicated that these factors significantly influence rural women's adaptive capacity in Muara Menang Village. Meanwhile, the qualitative approach explored women's adaptation strategies, household food security practices, and socio-cultural influences on food security. Audio recordings from interviews and FGDs were transcribed verbatim and coded following a thematic analysis framework. We engaged in open coding to capture emerging concepts, followed by axial coding to link related themes. Through iterative comparison with original transcripts and peer debriefing, we refined central themes that encapsulate women's adaptation strategies and household food security practices in the face of climate change. The research sample was selected purposively, including 100 rural women for the structured survey, three key informants for in-depth interviews, and FGDs to capture diverse perspectives within the community.

Muara Menang Village was chosen as the research location due to its high level of vulnerability to climate change and its dependence on peatland-based agricultural systems [42]. This area plays a vital role in food production, carbon storage, and biodiversity conservation but is increasingly impacted by changing weather patterns, including prolonged drought, flooding, and land degradation. The local economy is highly dependent on climate-sensitive agricultural activities, such as rice cultivation, rubber tapping, and oil palm plantations, which are increasingly impacted by erratic weather patterns [43]. The selection of this location also strengthens the relevance of the study, as the findings obtained can be a reference for other rural swamp communities in Indonesia and in similar areas facing the challenges of climate change.

Women in this community play a significant role in household food security and livelihood diversification. However, they face limited access to financial resources, formal education, and agricultural support, making them more vulnerable to the threat of food shortages due to climate change. Studying this often marginalized but strategically rich group provides essential insights into the coping mechanisms they have developed, such as income diversification, home gardening, food barter systems, and the use of informal social support networks. Data collection in this study included a structured survey to measure trends in economic adaptation and levels of food security, in-depth interviews to explore women's lived experiences, FGDs to validate collective adaptation strategies, and field observations to document direct responses to climate change. The entire research process was conducted in compliance with ethical principles, including informed consent, data confidentiality, and cultural sensitivity. This comprehensive methodological approach ensures a deeper understanding of rural women's adaptation strategies to climate change-induced food security challenges. By integrating empirical data and lived experiences, this study not only highlights women's resilience and innovation in the face of climate change but also identifies structural barriers that limit their adaptive capacity.

4. RESULT AND DISCUSSION

4.1 Signs of climate change and their effects

The signs of climate change in rural areas are diverse and manifest in various environmental and socio-economic impacts. These changes are often seen in shifting weather patterns, including changes and shifts in the dry and wet seasons. For three consecutive years, these patterns have continued, affecting agriculture, water availability and biodiversity. Villagers reported significant temperature, rainfall and seasonal changes that directly affect their livelihoods and local ecosystems.

Our research shows that climate change in rural areas can be physically observed, such as prolonged droughts, unpredictable rainfall patterns and rising temperatures. Based on Table 1, these conditions have caused significant disruptions in agricultural activities, including increased frequency of crop failures due to unpredictable weather, making it difficult for farmers to determine planting and harvesting times. Rubber production, which is highly dependent on climate stability, has also experienced significant declines due to heat stress affecting tree physiology

[44]. Similarly, oil palm yields have declined due to changes in rainfall and temperature patterns that disrupt flowering and fruiting cycles.

Previously, fertile agricultural land has become unproductive due to soil degradation exacerbated by flooding or extreme drought. Local vegetation, such as purun plants traditionally used in crafts and economic activities, is becoming increasingly scarce, reducing opportunities for income diversification [45]. These issues are in line with previous study which shows that subsistence farmers in developing countries are particularly vulnerable to climate stress because they rely on livelihoods that are highly sensitive to climate change [46].

Beyond agricultural challenges, climate change is also impacting public health. Outbreaks of diseases such as malaria, dengue fever and respiratory disorders are increasing, fueled by waterlogging caused by floods and the accumulation of waste. These vector borne diseases thrive in warmer conditions while deteriorating air quality caused by forest fires exacerbates respiratory problems [47]. These findings are consistent with research which explains how climate change creates conditions that favour the spread of infectious diseases, disproportionately impacting vulnerable rural populations [48]. The impacts of climate change on women in rural areas are significant. As those often responsible for ensuring the household's availability of food, water and fuel, women face more significant challenges due to increasingly limited resources. Declining agricultural output forces them to spend more time earning additional income or gathering necessities, reducing their opportunities to access education or participate in community decision-making processes [49].

Research shows that women in developing countries are more vulnerable to the impacts of climate change due to their roles in agriculture, caregiving and household resource management [50]. For example, the scarcity of purun crops has not only affected the village economy but has also significantly impacted women traditionally involved in weaving to support the family income [51]. In addition, disease outbreaks have increased their responsibilities as caregivers, which in turn increases physical and mental stress [52].

These findings are consistent with research on agricultural vulnerability in rural communities in Africa and South Asia, which has shown similar impacts in other rural areas. For example, declining crop yields due to erratic rainfall patterns, as experienced in rubber and oil palm cultivation in Southeast Asia, highlight the challenges to food security posed by limited access to climate adaptive agricultural practices [53].

In addition, the loss of ecosystem services and biodiversity, as found in studies in Latin America, is disrupting traditional livelihoods that depend on local biodiversity. This impacts economic resilience and the sustainability of cultural practices associated with traditional knowledge systems. Similar public health challenges are being identified in rural Bangladesh, where flooding and rising temperatures are exacerbating the spread of waterborne and vector-borne diseases [54]. These findings reinforce the link between climate change and increased vulnerability in the public health sector.

4.2 Rural women's knowledge of climate change

Rural women's understanding and interpretation of climate change are often rooted in their lived experiences and everyday interactions with the environment. They associate climate change with prolonged dry spells, erratic weather patterns, extreme heat, and water scarcity. Through their farming and household management roles, rural women observe how traditional seasonal signs are becoming less reliable. This firsthand knowledge is critical, based on lived experience rather than formal education or scientific frameworks. The following chart illustrates how women understand, interpret, and make sense of climate change while exploring its impact on them and the sources of their knowledge about climate change.

Based on Table 2, the impacts of climate change on these women are profound, often exacerbating existing vulnerabilities. Crop failures and land droughts threaten food security, while reduced incomes and purchasing power limit their ability to invest in adaptive strategies or meet basic needs. In addition, the pressure to secure scarce water resources and manage health problems arising from extreme weather events increases their physical and emotional burdens. This aligns with research from developing countries highlighting how rural communities, especially women, face compounding risks from climate-related stressors [55]. For example, research on rural communities in Sub-Saharan Africa and South Asia shows similar challenges, highlighting the disproportionate impacts of climate change on marginalized groups [56].

Table 1. Signs of climate change and women effects

Sign of Climate Change	Effects on Women's Village Life
Shifting weather patterns	Changes in dry and wet seasons over three years, affecting agriculture, water availability, and biodiversity
Prolonged droughts	Disrupts agricultural activities, increases crop failures, and complicates planting and harvesting schedules
Unpredictable rainfall patterns	Declines in palm oil yields and rubber production due to disrupted flowering and physiological stress
Rising temperatures	Reduces rubber production and exacerbates heat stress on crops
Soil degradation	Previously fertile land becomes unproductive, limiting agricultural outputs
Scarcity of local vegetation	Decreases availability of purun plants, reducing opportunities for income diversification
Flooding and extreme drought	Causes soil erosion, further land degradation, and challenges agricultural productivity
Increased vector borne diseases	Outbreaks of malaria, dengue fever, and respiratory disorders due to warmer conditions and waterlogging caused by floods
Declining agricultural output	Women face increased challenges in securing food, water, and fuel, reducing access to education and participation in decisions
Scarcity of natural resources	Women spend more time earning additional income or gathering necessities
Increased caregiving responsibilities	Women face added stress due to disease outbreaks
Loss of ecosystem services and biodiversity	Disrupts traditional livelihoods, economic resilience, and cultural practices tied to traditional knowledge systems
Public health challenges	Flooding and rising temperatures increase waterborne and vector borne diseases

Source: Result Analysis

Table 2. Rural women's knowledge of climate change

Aspect	Findings
Impacts of Climate Change on Rural Women	Profound impacts exacerbate vulnerabilities; crop failures and droughts threaten food security, reduced incomes limit adaptive strategies; increased physical and emotional burdens due to water scarcity and health issues
Sources of Knowledge about Climate Change	Traditional media (radio, TV) convey simplified messages; social media and community networks contribute, though accuracy varies; reliance on oral traditions and local wisdom, especially in Indonesia, which may lack specificity for effective adaptation
Knowledge Gaps	Understanding rooted in lived experience often lacks scientific basis; limited understanding of long term climate dynamics; constrained adaptive capacity due to limited access to formal education, training, and resources

Source: Result Analysis

Sources of knowledge for rural women about climate change vary and depend on context. Traditional media, such as radio and TV, play an important role, often conveying simplified messages about weather patterns or adaptation measures. Social media and community networks, such as discussions with neighbours or relatives, also contribute to their understanding, although the depth and accuracy of information from these sources can vary. Comparing this to other studies, women in rural Indonesia, for example, often rely heavily on oral traditions and local wisdom, which may lack the specificity needed for effective climate adaptation [57]. This highlights a knowledge gap, as rural women's understanding of climate change, while rooted in lived experience, often lacks scientific basis, limiting their ability to understand long-term climate dynamics and implement robust adaptation strategies fully.

This knowledge gap significantly affects women's lives and capacity to adapt to climate change. While their experiential knowledge is valuable for identifying immediate risks, it may not be sufficient to address systemic issues such as changes in agricultural cycles or the need for water conservation technologies. The literature on rural women's climate awareness highlights that women's adaptive capacity is often constrained by limited access to formal education [58], training [59], and resources [60]. For example, studies in India and Kenya have shown that empowering women through targeted education programs and access to technology significantly increases their ability to mitigate climate impacts [61, 62].

Although rural women have significant experiential knowledge about climate change, there are apparent gaps in their ability to connect these observations to broader adaptation strategies. Bridging this gap requires integrating their insights with scientific knowledge through accessible and culturally sensitive educational programs. Addressing this gap enhances women's adaptive capacity and contributes to broader community resilience, as women often play a key role in sustaining rural livelihoods [63]. These knowledge gaps, if not addressed, limit the development of effective long-term adaptation strategies, as women may struggle to implement proactive measures that require scientific understanding and technical knowledge.

4.3 Activities of rural women in ensuring family food security

Women are important in maintaining family welfare and food security, especially in rural areas. In various agricultural and non-agricultural sectors, women make significant contributions through economic activities that support family needs and community sustainability. However, these contributions are often under-recognized or under-appreciated in development policies and programs.

This study aims to understand the role of women in economic activities, covering agricultural sectors such as oil palm, rubber, and rice, as well as non-agricultural jobs such as trade and crafts. These contributions impact increasing household incomes and supporting food security through diversification of food sources, financial management, and conservation of local resources. Based on Table 3, in the agricultural sector, women actively participate in oil palm plantation management, rubber tapping, and rice cultivation. For example, their involvement in oil palm plantations helps increase household incomes, especially during the harvest season, which allows for the purchase of staple foods and diversification of diets. However, monoculture practices in oil palm often limit land for subsistence crops, so sustainable approaches such as intercropping are needed to support food security and reduce environmental impacts.

In addition, rural women earn income from rubber tapping and latex processing, the proceeds of which are often used to support agricultural activities or saved as family savings. Although the incomes are relatively small, these activities help meet basic food needs and provide financial stability, especially when combined with agroforestry practices. Women's role in planting, weeding, and harvesting rice is also critical, as the harvest meets family food needs and provides additional income through the sale of surplus. However, the undervaluation of women's labour and limited access to agricultural resources highlight the importance of policies favouring women to improve productivity and food security.

In addition, women are also involved in seasonal work, such as picking chillies or grass, which provides additional income during difficult times. This diversification reduces dependence on a single source of income but reflects a broader gender gap in the rural labour market. Fair wages and training programs can improve their economic security. Meanwhile, women's adaptability is evident in their roles in non-farm sectors, such as trading, handicrafts, vegetable collection, and village administrative work, all of which contribute significantly to household well-being. By selling goods at local markets, women earn a stable income to buy food and invest in education. Their participation in markets challenges traditional gender norms, fosters economic independence, and promotes sustainability through sourcing local products.

Furthermore, women's involvement in purun craft-making preserves cultural heritage and provides additional food security and savings income. Women in our research sites also collect vegetables from communal or forest lands, providing direct nutritional benefits and additional income. Women also work in village offices, earning a stable salary and strengthening food security through consistent household income. These roles also promote gender equality by increasing women's visibility in leadership and supporting community resilience.

Our research findings reveal the close relationship between gender, food security and sustainability. Women contribute to

household food security through diversified livelihoods, which provide resilience to economic shocks. However, systemic barriers such as unequal resource access and lack of decision-making power limit their impact. Addressing these inequalities is essential to empower women and maximize their influence on the well-being of their families and communities.

These findings align with previous research showing that women play a significant role in household food security through their involvement in various economic activities in the formal and informal sectors [64]. Women's contribution to food security is often more significant than that of men, especially in ensuring the availability and access to nutritious food [65]. However, as women often face systemic barriers such as limited access to resources such as land, credit and technology, which limit their effectiveness in managing diversified livelihoods [66]. Strengthening women's rights to resources and increasing their participation in decision-making can significantly improve household food security and environmental sustainability. Therefore, women's empowerment is key to achieving long-term food security and sustainability goals [67].

4.4 Climate change and food supply disruption in swampy areas: Women's adaptation strategies

Rural swamp areas are highly vulnerable to climate change impacts, such as water level fluctuations, declining agricultural yields, and biodiversity loss. These impacts directly affect food security, which is often the responsibility of women in the household. In this situation, women play an important role through adaptation strategies to maintain food security while facing limited resources. The efforts made by women can be seen more clearly in Figure 1.

The adaptation strategies carried out by women play an important role in household economic adaptation, especially amid conditions full of limitations. They demonstrate creativity and resilience through various strategies, including economic diversification. One form of diversification is purun crafts, where traditional skills increase family income while preserving local culture. However, limited production scale and difficult market access often limit its potential.

Women are also involved in rubber farming and trading, which shows a pragmatic adaptation to local livelihoods. However, this work has a high labour intensity, which can cause physical exhaustion, especially if women also have to take care of the household. Another strategy is home-based farming, where women grow vegetables and herbs for kitchen needs. In addition to increasing family food security, this step also reduces household expenses. Unfortunately, its impact on income remains limited. In addition, to economic diversification, women implement cost-saving measures to manage household finances. One step is to reduce the intensity of consumption, although this can potentially reduce the quality of family nutrition in the long term. Reducing the purchase of goods that are considered non-essential shows women's priority for the family's basic needs. On the other hand, informal financial solutions are also often used, such as reliance on high-interest loans from mobile banks. This reflects women's limited access to more affordable formal financial services, which often traps them in a cycle of debt.

Table 3. Activities of rural women and their impact on food security

Activity	Contribution to Food Security	Challenges/Barriers
Oil palm plantation management	Increases household income during harvest season, enabling food purchase and diet diversification; intercropping can support sustainability. Income may decrease during the off-season	Monoculture practices limit subsistence crops; sustainable approaches are needed.
Rubber tapping and latex processing	Provides income used for food needs, agricultural support, and family savings; agroforestry enhances sustainability. Seasonal income fluctuations may occur, with lower earnings during off-peak tapping periods.	Low income and undervaluation of women's labor; limited access to resources.
Rice planting, weeding, and harvesting	Ensures family food supply through rice harvests and generates additional income by selling surplus. Income can vary significantly based on harvest timing, affecting food security during lean periods.	Undervaluation of labor and limited access to resources; policies favoring women needed.

Source: Result Analysis

Figure 1. Climate change and food supply disruption in swampy areas: Women's adaptation strategies

This phenomenon of change has an impact on the social and economic aspects of rural communities. Socially, there have been changes, including an increasing number of people borrowing money from loan sharks and mobile banks (Mekar BTPN) with interest of 30% - 40%, and thefts of goods and livestock have increased relatively. However, women also take advantage of social relationships through food barter with neighbours, evidence of social solidarity in overcoming economic difficulties.

Community-based practices, such as food barter and household cooperation, reflect strong social solidarity. In addition to helping families cope with food shortages, this step also strengthens social ties, which are crucial in dealing with crises. This adaptation strategy has advantages and limitations. Economic diversification reduces dependence on a single source of income, while home-based farming supports sustainable food security. Community solidarity also strengthens social capital and lightens the burden on individuals. However, reliance on high-interest loans increases financial risks, and the labour intensity of strategies such as farming and craft-making often compromises women's health. Crafts and home-based farming income is often insufficient to meet more extensive household needs. In addition, increasing women's workloads without addressing gender inequalities creates additional stress.

Women's strategies demonstrate significant strengths, particularly in economic diversification, food security, and community solidarity. However, challenges such as reliance on high-interest loans, labour intensity, and limited scalability must be addressed. Recommendations that can be implemented include strengthening access to formal finance by providing low-interest microcredit to reduce reliance on mobile banks. In addition, training and marketing can be provided to improve the quality of purun craft products and expand market access. Infrastructure support is also important, such as providing superior seeds and agricultural technique training to support home-based farming. Finally, a more equitable division of labour must be implemented by involving other family members, including men, to reduce women's workload. With these steps, the effectiveness of women's adaptation strategies can be increased while addressing the systemic challenges they face.

The adaptation strategies implemented by these women demonstrate several significant strengths. Economic diversification, such as involvement in crafts and agriculture, helps reduce dependence on a single source of income. This directly reduces economic risk from the impacts of climate change or economic fluctuations. In addition, sustainability in home-based farming practices is another advantage, where growing food in the home garden increases food security and reduces dependence on markets. Community solidarity through barter and mutual assistance is also a significant strength, as it strengthens social networks that are crucial during times of crisis.

However, these strategies also have several limitations. Reliance on high-interest loans is one significant financial vulnerability, where women are often trapped in a cycle of debt that burdens their financial condition. In addition, this adaptation strategy requires high labour intensity, which can lead to physical and mental exhaustion, especially when women have other responsibilities, such as taking care of the household. The scalability of this strategy is also limited, as the output from home-based farming and purun crafts is often insufficient to meet all household needs. Furthermore, this strategy increases women's workload without addressing the systemic inequalities at the root of the problem.

Through this evaluation, although women's adaptation strategies have great potential, more systemic interventions are needed to address the limitations and challenges. This includes a more inclusive approach, reducing workloads, and providing equitable access to financial services.

More systemic interventions are relevant at the local level and can be compared with women's adaptation practices across countries. Women's experiences addressing economic and environmental challenges across contexts show similar patterns, with creativity and solidarity at the heart of their strategies. This comparison provides a broader perspective on how women in different parts of the world address similar challenges while offering opportunities to learn from each other and share best practices. In Bangladesh, women engage in gardening and poultry farming to address food insecurity due to flooding [68]. In Sub-Saharan Africa, women leverage informal savings groups and labour exchange systems [69]. Meanwhile, in the highlands of Indonesia, women are increasing their incomes through weaving and small-scale agroforestry [70].

Although women in swampy areas demonstrate resilience and adaptability, additional efforts are needed to address resource constraints and challenges posed by climate change. Adaptation strategies need to be further developed to achieve long-term sustainability. However, successful adaptation is often linked to external support. In Bangladesh, a low interest microfinance program has economically empowered women [71]. In Kenya, a government initiative has provided drought-resistant seeds, reducing dependence on unpredictable rainfall [72].

Women in rural areas have demonstrated remarkable resilience in adapting to the impacts of climate change on food supplies. However, their strategies are often less sustainable in the long term and require external support to address structural vulnerabilities. Collaborative efforts by governments, NGOs, and local communities are essential to ensure that women's contributions to household and community resilience are effectively supported and scaled up [73].

5. CONCLUSION

The impacts of climate change are increasingly visible in Muara Menang Village, which is marked by shifting seasons, prolonged dry spells, flooding, land fires, and other environmental phenomena. However, women's understanding of climate change remains limited, often focused only on the seasonal changes they experience directly. This lack of awareness negatively affects agricultural productivity, resulting in crop failures, food insecurity, and disruptions to household food supplies. Given that women are traditionally responsible for ensuring family food security, they must adapt to climate change by developing strategies to meet their household needs through agricultural and non-agricultural approaches. Several policy interventions are necessary to enhance women's capacity to adapt, such as microfinance programs that provide women with access to capital for climate-resilient agricultural practices, water management tools, and income diversification. Additionally, agricultural training on climate-smart practices, sustainable farming, and water management will help increase productivity and reduce risks associated with changing weather patterns. Supporting

market access for women's agricultural products through cooperatives and local networks can also increase income and strengthen economic resilience. Furthermore, introducing social safety nets, such as crop insurance and food assistance, is critical to protect women from shocks like crop failures or extreme weather events. Gender-sensitive policies should be integrated into climate adaptation programs to address women's needs, particularly regarding land rights, resource access, and decision-making roles. Strengthening social networks and cooperatives will empower women through knowledge-sharing, collective action, and advocacy for climate-responsive policies. Future research should examine the effectiveness of these strategies in improving women's resilience and explore the role of multi-stakeholder collaboration involving government agencies, NGOs, and the private sector. Moreover, prioritizing simple technological innovations, such as watersaving techniques or drought-resistant crops, is essential. Educational programs to increase women's understanding of climate change and its connection to food security should also be prioritized. In conclusion, addressing these policy areas will provide a comprehensive framework to support women's adaptive strategies to climate change and food insecurity, ultimately enhancing the sustainability and resilience of rural communities.

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