



Community Resilience Pathways in Smallholder Farming Systems toward Sustainable Agricultural Transformation

Rita Parmawati

Fakultas Pertanian, Universitas Brawijaya; PSDKU Universitas Brawijaya,
Kediri; Sekolah Pascasarjana Universitas Brawijaya, Indonesia

ABSTRACT: The transformation of sustainable agriculture in small-scale farming systems is becoming increasingly important as farmers' vulnerability to climate change, market pressures, and limited access to resources increases. This study aims to identify community resilience pathways in smallholder communities and explain how adaptive capacity, livelihood strategies, and institutional support contribute to the direction of sustainable agriculture transformation. The case study was conducted in Poncokusumo District, Malang Regency, with a qualitative approach and data collection techniques in the form of in-depth interviews with 12 informants, accompanied by field observations and documentation of local agricultural programs. Data were analyzed using thematic analysis techniques to trace patterns of community resilience and social-ecological dynamics formed at the local level. The results show that the path of community resilience develops through diversification of farming businesses, strengthening social capital in farmer groups, and increasing access to information, innovation, and institutional facilitation, which strengthens farmers' ability to manage agricultural risks. In addition, the role of extension workers and village institutions serves as a strategic link in accelerating the adoption of sustainable cultivation practices. This study concludes that community resilience is a fundamental foundation for accelerating the transformation of sustainable agriculture in smallholder systems and makes a conceptual and practical contribution to the formulation of agricultural development strategies based on community resilience.

Keywords: Community Resilience, Resilience Pathways, Smallholder Farming Systems, Sustainable Agricultural Transformation

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INTRODUCTION

Community resilience in smallholder farming systems is a pressing issue amid rising climate risks, market volatility, and resource pressures. Extreme weather changes are becoming more frequent and have a direct impact on the stability of small-scale agricultural production. This situation magnifies the vulnerability of smallholder farmers, especially in developing countries that rely on local inputs and family labour. Globally, smallholder farmers play an important role in food security but still face limited access to technology and information (Shikwambana et al. 2022). In Indonesia, these challenges are also seen in various production centers that do not have adequate adaptive capacity. Therefore, efforts to strengthen community resilience are a strategic step in realizing sustainable agricultural transformation.

Although the literature on farmers' adaptation to climate change is growing rapidly, studies on community resilience pathways are still limited. Most of the research highlights aspects of technical adaptation, but has not integrated social capital, livelihood strategies, and institutional support simultaneously. Azhari et al. (2023) identified that agricultural extension workers and farmer organizations have an important role, but empirical research describing the mechanisms of community resilience is still scarce. At the global level, studies of agroforestry show its potential as a pathway to resilience, but local social and institutional contexts are often overlooked (Taillandier, et al. 2023). Research that connects socio-ecological aspects holistically still has methodological limitations. This condition shows a significant research gap.

This research aims to identify and map community resilience pathways in smallholder farming systems. The research focus is directed at the relationship between adaptive capacity, livelihood strategies, and local institutional support in driving sustainable agricultural transformation. The resilience pathway is analyzed as a dynamic process that continues to evolve according to local conditions. In addition, this study examines how social and institutional factors interact to shape farmers' adaptive abilities. The local context of Poncokusumo District was chosen because it has active agricultural institutional dynamics. Thus, the purpose of the research emphasizes an in-depth understanding of the process of social-ecological transformation at the community level.

The research uses a qualitative approach through case studies to comprehensively explore the dynamics of community resilience. Data was collected through in-depth interviews with 12 key informants, field observations, and local program documentation. This approach allows researchers to capture farmers' subjective experiences and the institutional processes that influence farming decisions. Thematic analysis is used to identify key thematic patterns, relationships, and categories in the data. This technique makes it easier for researchers to understand the social structure and adaptation strategies that are developing. Thus, qualitative methods provide analytical depth that cannot be achieved through quantitative surveys.

Conceptually, this research contributes to the community resilience literature by formulating a contextual resilience pathway. This research emphasizes the importance of integrating social capital, local knowledge, and

institutional support in building community resilience (Pearson et al. 2024). Methodologically, the qualitative approach used enriches the understanding of socio-ecological dynamics at the smallholder level. Practically, this study provides recommendations for agricultural development policy makers. Strengthening farmer institutions, increasing access to information, and technical innovation are the main development strategies. Thus, the results of the research are beneficial for the development of community-based adaptation programs.

This research is also relevant in the context of Indonesia's agricultural transformation which emphasizes sustainability, food security, and smallholder empowerment. Recent literature shows that smallholders are the most vulnerable group in the face of pandemic disruptions and the climate crisis (Marsden et al. 2023). Therefore, the study of community resilience pathways is very important for an agrarian country like Indonesia. This research provides an empirical understanding of how farming communities can strengthen resilience while transforming towards a more sustainable agricultural system. In addition, this study confirms the importance of a holistic approach in assessing the resilience of smallholders. Thus, this research fills the research gap while offering a new conceptual model for strengthening community resilience.

THEORETICAL REVIEW

Community Resilience in the Smallholder Farming System

Community resilience in smallholder farming systems is an important concern due to the increasing climate and social pressures experienced by farming households. Research by Adger (2020) emphasizes that community resilience is formed through the interaction between social capacity, institutional support, and collective experiences of facing risk. He found that local social structures greatly determine the ability of communities to mitigate shocks and restore production functions. This approach shows that resilience depends not only on biogeophysical aspects, but also on social capital and community networks. In the context of smallholder farming, farmer relationships play a key role in the exchange of information and support. Therefore, understanding the path of community resilience must see resilience as a multi-layered socio-ecological process.

The Role of Climate Smart Agriculture Innovation and Technology

Climate-smart agriculture innovations play a crucial role in strengthening smallholder adaptive capacity to climate variability. A study by Khatri et al. (2021) shows that the adoption of technologies such as drought-tolerant varieties, water-saving irrigation, and agroforestry can significantly improve farmers' adaptation. The study underscores that successful adoption is influenced by access to information, training, and institutional support. In addition, Khatri et al. found that farmers who had access to strong social networks were quicker to adopt innovation. This innovation not only increases production, but also reduces vulnerability to extreme weather changes. Therefore, climate-smart technology is a strategic path in building community resilience.

Social Capital and Local Institutions

Social capital is an important foundation in the resilience of small farming communities because it strengthens collaboration and solidarity between farmers. Research by Norris & Stevens (2022) shows that strong social bonds allow communities to respond to risks in a more collective and organized manner. They found that social capital plays a role in increasing adaptive capacity through informal knowledge exchange and trust-based networks. In agricultural systems, social capital facilitates collective decision-making in the management of production risks. The study shows that communities with strong social capital are more resilient to drought and price fluctuations. Thus, the path of community resilience must include the role of social capital as a key element.

External Support and Development Intervention

External support through development programs has a significant influence on strengthening the adaptive and transformational capacity of smallholders. Mersha & Van Laerhoven (2021) show that community-based interventions can improve farmers' ability to access climate information, production technologies, and markets. The study emphasizes that the success of the program is largely determined by the level of local participation in the planning process. They also found that programs that are responsive to local contexts are more effective in encouraging the adoption of sustainable practices. The intervention is able to expand institutional networks that were previously unavailable to smallholders. Therefore, external support is an important pathway that strengthens community resilience structurally.

Diversification of Farming as a Resilience Strategy

Diversification of farming has proven to be an important strategy to reduce risk and increase the resilience of smallholders to uncertainty. Research by Rosenzweig et al. (2023) shows that diversification of crops and sources of income increases the economic stability of farming families. They found that more diverse farming systems provide resilience to climate change and market fluctuations. In addition to economic benefits, diversification also supports ecological functions such as soil conservation and increased biodiversity. This strategy provides flexibility for farmers in choosing commodities that suit local conditions. Therefore, diversification is one of the most sustainable agrarian transformation paths.

Strengthening Community-Based Agriculture Systems in Indonesia

The community-based farming model is increasingly seen as a strategic approach in strengthening the resilience of smallholders in Indonesia. Research by Prasetyo et al. (2024) shows that community approaches such as community-supported agriculture improve market access and income stability for farmers. They found that this model strengthens the relationship between farmers and consumers through long-term partnership mechanisms. In addition, this model creates space for social innovation and local knowledge exchange. The community approach also helps build social capital that supports long-term

resilience. Thus, community-based farming patterns are an important path in developing sustainable agricultural transformation.

METHODOLOGY

Types and Approaches to Research

This study uses a qualitative approach with a case study design to understand community resilience pathways in depth and contextually. The qualitative approach was chosen because it is able to capture social dynamics, subjective experiences, and institutional interactions in the smallholder farming system. The case study is considered appropriate because it allows researchers to analyze the phenomenon of community resilience in the specific context of Poncokusumo District. This design is in line with the argument of Yin (2020), who explains that case studies are effectively used to delve into complex social processes. Additionally, this approach allows for the integration of various data sources such as interviews, observations, and documentation. Thus, this method provides a relevant analytical depth for sustainable agricultural transformation research.

Population, Location, and Informant Selection Techniques

The study population included individuals directly involved in the small-scale farming system in Poncokusumo District, including farmers, farmer group leaders, extension workers, and village officials. The informant selection technique uses non-probability sampling, namely purposive sampling, based on the consideration of the informant's involvement in agricultural decision-making. This technique is in line with the recommendations of Palinkas et al. (2020), who emphasize that purposive sampling is effective in obtaining informants with in-depth knowledge related to research phenomena. A total of 12 informants were selected, consisting of 8 smallholders, 2 heads of farmer groups, 1 field agricultural extension worker, and 1 village official. The selection of the number is based on the principle of information sufficiency or information power in qualitative research. Thus, the composition of these informants allows researchers to comprehensively capture perceptions, experiences, and institutional relationships.

Data Collection Techniques and Instruments

Data collection was carried out through in-depth interviews, field observations, and documentation of local agricultural programs. The interviews use semi-structured guidelines that are structured around the concepts of community resilience and sustainable agricultural transformation. The principles of question preparation follow the guidelines of Kallio et al. (2021), which emphasize the preparation of interview guidelines based on literature and local contexts. Observations were carried out to identify farming practices, patterns of social interaction, and institutional support at the village level. Documentation includes program reports, farmer group archives, and extension worker records as sources of triangulation. The instrument allows for triangulation of sources thereby increasing the credibility and consistency of the data.

Research Implementation Procedure

The research procedure is carried out through four main stages which include preparation, data collection, data verification, and analysis finalization. The preparation stage includes preparing instruments, managing field permits, and coordinating with village officials and agricultural extension workers. Furthermore, the data collection stage is carried out through interviews and observations that are scheduled according to the availability of informants. The verification process is carried out through triangulation, both through comparison between informants and with documentation data as recommended by Carter et al. (2021). The data is then transcribed and double-checked to ensure coherence and completeness. All field activities take place in stages to ensure the quality of the data obtained.

Data Analysis Techniques

Data were analyzed using thematic analysis to identify patterns, categories, and inter-thematic relationships within the community resilience pathway. Thematic analysis was chosen because it is flexible and able to accommodate the complexity of qualitative data in a socio-ecological context. The analysis procedure follows the stages of Braun & Clarke (2022), starting from data familiarization, initial coding, theme formation, theme review, to reporting results. Coding is done manually and assisted by NVivo 12 software to organize data and facilitate thematic visualization. This approach allows for a systematic and consistent interpretation of the dynamics of community resilience. Thus, this analysis technique is in line with the research objective of mapping community resilience pathways comprehensively.

RESULTS

Diversification of Farming as a Path to Community Resilience

The results of the analysis obtained through in-depth interviews and field observations show that farming diversification is the main adaptive strategy used by smallholders in Poncokusumo District in responding to climate change and market fluctuations. During the observation, farmers seemed to combine several commodities such as highland vegetables, horticulture, and perennials to stabilize income and reduce dependence on one commodity. A farmer stated that *"If you only plant one, the risk is great, so we usually intersperse with other commodities so that there are still those that can be harvested"* (PK-3, interview September 12, 2025). This is in accordance with the documentation of farmer groups that show shifting planting patterns following weather changes, as affirmed by other informants that *"The weather is now unpredictable, so the plants have to be adjusted, sometimes change quickly to be safe"* (PK-5, interview September 14, 2025). The head of the farmer group added that *"Our members usually give each other examples of safer planting patterns, so this diversification is indeed a sustainable culture"* (KK-1, interview September 17, 2025). These findings confirm that diversification is not only an economic strategy, but also a social mechanism built from field practices and collective experiences identified through triangulation of documentation data and interviews.

Strengthening Social Capital in Farmer Groups

Strengthening social capital is identified as an important foundation in building community resilience. Data from interviews and observations show that farmer groups function as an arena for adaptive knowledge exchange, especially related to integrated pest management, stress-resistant variety selection, and market information. A farmer group leader explained that *"If there is a pest problem or crop failure, we usually get together first to discuss the solution, so we don't go alone"* (KK-2, interview September 13, 2025). This information is in line with the farmer group's documentation records regarding regular meetings and technical discussions held every month. A farmer also confirmed that *"We often get information on incoming fertilizer or market prices from group friends, so we can make decisions quickly"* (PK-6, interview September 15, 2025). The village apparatus emphasized that *"Farmer groups are the door of village coordination, so if there is a program or assistance, it must pass through them so that it is right on target"* (PD-1, interview September 18, 2025). From the triangulation between interviews, group interaction observations, and documentation of village programs, social capital proved to be a central element in strengthening collective adaptation strategies.

Access to Information, Innovation, and Institutional Facilitation

Through in-depth interviews and verification of counseling documents, increased access to information has proven to be a key factor in strengthening community resilience pathways. Agricultural extension workers play an active role in providing technical information and cultivation innovations, as emphasized that *"Farmers are now faster to catch innovation, especially about environmentally friendly pest control and how to regulate water"* (PP-1, interview September 11, 2025). Field observations show that some farmers have implemented efficient irrigation techniques and the use of plant-based pesticides. This is reinforced by the farmers' statement that *"If there is counseling, we will find new ways that are more cost-effective, so we can try it in the field."* (PK-2, interview September 10, 2025). In the village documentation, several programs are recorded that provide access to superior seeds, cultivation training, and technology socialization. The village apparatus added that *"Villages help access to agricultural programs, such as seed assistance or training, so that farmers can participate in technological changes"* (PD-1, interview September 18, 2025). These findings show that information, innovation, and institutional support work synergistically to strengthen farmers' adaptive capacity.

The Strategic Role of Extension Workers and Village Institutions in Sustainable Transformation

The role of extension workers and village institutions is identified as a strategic link between farmers and external resources. Through interviews and observations of extension workers' interactions with farmers, it can be seen that extension workers provide direct assistance in adopting sustainable cultivation practices. The extension officer emphasized that *"We direct farmers to slowly implement more sustainable farming methods, such as reducing chemical pesticides"* (PP-1, interview September 11, 2025). This statement was reinforced by farmers

who said that *"If you are confused about pests or fertilizers, extension workers usually come to help see the conditions"* (PK-7, interview September 16, 2025). Documentation of village programs shows that institutional coordination supports the acceleration of innovation adoption through training, assistance with production facilities, and cross-agency meetings. The village apparatus said that *"Villages that arrange assistance or training routes to meet the needs of farmers"* (PD-1, interview September 18, 2025). Triangulation of data from interviews, field observations, and documentation shows that extension workers and villages play an important role as facilitators of sustainable agricultural transformation that strengthen community resilience pathways.

DISCUSSION

The results of the study show that farming diversification is an important path in building community resilience. Commodity diversification practices undertaken by smallholder farmers in Poncokusumo involve horticulture, perennials, and highland vegetables being an adaptive response to climate and market uncertainty. These findings are in line with the concept of livelihood capital-based resilience, where diversification strengthens natural capital and human capital and reduces dependence on one commodity (Andani et al., 2022). By spreading risk across a range of commodities, farmers build a socio-ecological buffer that supports post-shock recovery and reflects transformative resilience strategies in agricultural systems.

Strengthening social capital through farmer groups has also proven to be very decisive for community resilience. Farmer groups function as an arena for knowledge exchange, collective coordination, and problem-solving when faced with pests, climate change, or decreased production. This dimension of social capital bonding is in line with research showing that social cohesion strengthens the adaptive capacity of local communities in dealing with environmental pressures (Syaif et al., 2024). These internal social mechanisms reduce dependence on external assistance and strengthen the ability of communities to respond to change independently, as also described in studies of social capital in various agricultural contexts (Purwanti & Huang, 2022).

Access to information, innovation, and institutional support are also critical factors in building community resilience. Agricultural extension workers and village institutions facilitate technology transfer, information dissemination, and link farmers with external support programs. These findings reinforce the argument that information and technology are important determinants of adaptation capacity, especially in the face of climate risks (Chetri et al., 2021). The implementation of innovations such as efficient irrigation, plant-based pesticides, or soil conservation in Poncokusumo shows that appropriate institutional interventions can accelerate the transformation towards sustainable agricultural practices.

The role of extension workers and village institutions is not only as a conveyor of information, but also as a social capital link that connects the farmer community with formal actors at the district or national level. This relationship increases access to government resources, training, and programs. The

importance of linking capital is reinforced by research findings on how relationships with formal institutions can improve the bargaining position and adaptation opportunities of smallholders (Nurfadillah et al., 2024). The implementation of innovation in Poncokusumo shows that institutional networks are an important catalyst in strengthening the community's resilience path.

The significance of these findings shows that diversification and social capital are not only survival strategies, but also lead to a more sustainable transformation of agricultural systems. Community resilience is understood as a proactive process that combines long-term ecological and social aspects. In addition, the role of institutional intervention and counseling further emphasizes that sustainable support is needed to maintain the sustainability of innovation adoption, strengthen adaptive capacity, and ensure that agricultural transformation takes place in an inclusive manner (Zainal Abidin, 2024).

This research provides a theoretical contribution through mapping community resilience pathways in the context of smallholder farming in Indonesia. The pathway includes business diversification, social capital, and institutional support to integrate the theory of life capital and social capital in the agricultural system. Practically, these findings resulted in policy recommendations such as institutional strengthening of farmer groups, capacity building of extension workers, flexibility of village programs, and improving community-based agricultural information systems to support transformation from the bottom.

However, this study also found supporting and inhibiting factors for the resilience pathway. Supporting factors include strong social cohesion in farmer groups, farmers' motivation to learn, and relatively responsive village institutional support. Obstacles include limited financial capital, resistance to innovation among some farmers, and limited institutional capacity of villages to reach all farmers equally. These differences can be explained through variations in the level of access to information, socio-economic conditions, and previous farming experiences.

Because research is based on case studies in one region, generalization of findings to other contexts is still limited. The reliance on interviews and observations also opens up the possibility of perceptual bias from informants. For further research, a mixed-methods approach is recommended so that resilience pathway models can be tested in different socio-ecological contexts and can be quantitatively validated on a broader scale. Overall, this study shows how smallholders can activate resilience pathways through diversification, social capital, and institutional support, as well as how formal institutions play an important role in accelerating the transformation of practices towards sustainable agriculture. These findings enrich the literature and provide an important policy basis for strengthening community-based food security.

CONCLUSION AND RECOMMENDATIONS

This study confirms that community resilience pathways in small-scale farming systems are formed through a combination of farming diversification

strategies, strengthening social capital, and increasing access to information and innovation through institutional support. Commodity diversification has proven to be an important adaptive mechanism that allows farmers to reduce agrarian risks and improve livelihood stability. Social capital in farmer groups strengthens collective action, accelerates knowledge exchange, and builds community capacity to respond to shocks independently. On the other hand, the role of extension workers and village institutions is a strategic link that provides access to technology, training, and support programs that encourage changes in cultivation behavior towards more sustainable practices.

Conceptually, this research shows that community resilience serves not only as a survival strategy, but also as a foundation for sustainable agricultural transformation in the long term. The resilience pathways identified provide an understanding that sustainability in smallholder systems must be built through synergy between farmers' adaptive capacity, social cohesion, and responsive and inclusive institutional support. Practically, the results of this study recommend strengthening local institutions, increasing extension capacity, and developing community-based agricultural information systems to support a more participatory and sustainability-oriented transformation. These findings are expected to be the basis for the formulation of agricultural development policies that place community resilience at the core of strategies to improve smallholder welfare and regional food security.

FURTHER STUDY

This study positions community resilience as a transformative mechanism in small-scale farming systems, emerging from the interaction of adaptive diversification strategies, strong social capital, and responsive institutional support. Beyond short-term risk management, resilience is shown to function as a foundation for sustainable agricultural transformation, highlighting the importance of synergizing farmer agency, collective action, and inclusive governance in strengthening smallholder welfare and long-term food security.

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