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Communication Patterns and Social Resilience: Local Food Farmer Strategies in Responding to the Climate Crisis

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ABSTRACT

This study examines the communication patterns of local food farmers and their role in building social resilience to address climate crisis challenges. The research objectives are to analyze vertical communication patterns with government and agricultural extension agents, examine communication with NGOs and the private sector, evaluate the effectiveness of digital media-based communication, identify communication barriers, and understand how communication patterns serve as the foundation for social resilience. Using a qualitative approach with a constructivist-interpretive paradigm, this research employs multi-level unit analysis including individual farmers, farmer groups, and village communities. Data collection methods include in depth interviews, focus group discussions, participant observation, and digital ethnography with purposive sampling of key informants. The findings reveal that horizontal communication among farmers through traditional social networks and digital platforms creates collective intelligence that becomes the backbone of community adaptation to extreme climate change. Vertical communication with the government shows varying effectiveness depending on the quality of interpersonal relationships and the relevance of information to local conditions. Strategic partnerships with NGOs and the private sector open access to resources and innovations that strengthen farmers' adaptive capacity. The study concludes that social resilience depends on the quality of communication that facilitates collective learning, coordinated action, and social cohesion in facing climate uncertainty.

KEYWORDS: Communication Patterns, Social Resilience, Local Food Farmers, Climate Crisis, Digital Media Communication

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INTRODUCTION

The global climate crisis has become one of the greatest challenges facing humanity in the 21st century. Extreme changes in weather patterns, rising average global temperatures, and the uncertainty of the rainy season have created extremely challenging conditions for the agricultural sector worldwide. Indonesia, as an archipelagic nation with a high level of vulnerability to climate change, faces serious threats to national food security, which is largely dependent on agricultural productivity. This climate crisis phenomenon not only impacts the technical aspects of agricultural production but also creates complex transformations in the social structure of farming communities (Yuan et al., 2024). Furthermore, developing technology-based communication patterns also opens up challenges in farmer relationships and community dynamics (Budiwiranto et al., 2025).

Uncertain harvest yields, repeated crop failures, and changes in traditional cropping patterns have prompted farmers to develop various adaptation strategies involving communication and social networks. In addition, interpersonal communication between farmers and stakeholders is essential in managing agricultural communities and maintaining social cohesion (Kartika Ekasari et al., 2013). This interpersonal communication is closely related to the farmer's commitment to maintaining sustainable agricultural practices and community resilience (Akhter, 2024). In this context, communication patterns are no longer merely a medium for exchanging information but have evolved into a vital instrument for building sustainable social resilience. Farmers who maintain open communication patterns tend to develop more effective adaptation strategies and stronger social networks. The open attitude of community members in communicating will build mutual support, respect, and understanding in the face of climate

uncertainties. Openness is crucial in building trust within agricultural communities when dealing with climate risks (Ismail et al., 2025).

Data from the Meteorology, Climatology, and Geophysics Agency (BMKG) shows that Indonesia has experienced an average temperature increase of 0.3°C per decade since 1981 (Bidang Klimatologi Badan Meteorologi & Geofisika Jakarta, 2024). Even more worrying, rainfall patterns experience significant anomalies with variability reaching 20-30% of the historical average. This condition has a direct impact on agricultural productivity, with the Ministry of Agriculture recording that losses due to climate change reach IDR 15 trillion per year, with the rice sector being the most affected commodity. Statistics show that the area of rice fields experiencing crop failure has increased from an average of 20,000 hectares per year in the 1990s to more than 50,000 hectares per year in the last decade. The increasingly intense El Niño and La Niña phenomena have caused unpredictable planting season patterns, forcing farmers to adopt more complex communication strategies in coordinating their agricultural activities. Data from the 2023 Integrated Agricultural Survey (SPT) indicates that 67% of Indonesian farmers reported experiencing difficulty predicting appropriate planting times, while 45% stated they relied heavily on information from fellow farmers when making production decisions. These figures demonstrate the importance of horizontal communication in building resilience to climate uncertainty (Suryana, 2020).

The complexity of the problems farmers face in responding to the climate crisis extends beyond the technical aspects of production. Several structural issues in communication patterns and social networks hinder the development of effective social resilience (Sheikh et al., 2024). First, the fragmentation of climate and agricultural information poses a serious obstacle to farmer decision-making. Weather and climate information provided by formal institutions such as the BMKG (Meteorology, Climatology, and Geophysics Agency) often fails to effectively reach farmers at the grassroots level, or even when it does reach them, it is not packaged in a format that is easily understood and applied in the local context (Faradiba & Saputra, 2023). Self-disclosure within farming communities is crucial because it means communicating agricultural experiences, knowledge, and challenges to others within the community. Self-disclosure can include shared information about farming practices, climate observations, crop preferences, or traditional knowledge that farmers are interested in preserving (DeVito, 2016). As a result, farmers tend to rely on traditional knowledge and informal communication, which, while having adaptive value, are sometimes insufficiently accurate to address increasingly extreme climate variability.

Second, the digital divide in access to modern agricultural information creates new social stratification within farming communities. Self-disclosure can also be viewed from the perspective of communication psychology in the agricultural context, where it can increase knowledge about farming self-concept and community identity (Ye & Yang, 2020). If this agricultural self-concept is acquired, farmers will be more open to new farming experiences and innovative ideas, more likely to avoid defensive attitudes toward technological change, and more carefully view themselves and others in the context of climate adaptation. Farmers with access to information and communication technology (ICT) tend to be more adaptive and resilient than those who rely solely on traditional communication.

Third, the erosion of traditional social capital due to modernization and urbanization has weakened the communal communication systems that have long been the backbone of social resilience in farming communities. According to agricultural extension experts, interpersonal communication is a communication process that occurs directly between farmers and agricultural stakeholders; information can be conveyed directly, and recipients can immediately receive and respond to climate-related information (Aziz et al., 2022). Traditional institutions such as mutual cooperation (gotong royong), the subak system in Bali, or the babarit tradition in South Kalimantan have experienced functional degradation, while substitution with modern communication systems has not been fully effective in building solidarity and collaboration in addressing the climate crisis.

Fourth, limited vertical communication capacity between farmers, agricultural extension agencies, and local governments creates gaps in the implementation of climate change adaptation policies (Giles et al., 2021). Interpersonal communication in the agricultural context is communication that takes place between farmers and agricultural stakeholders who have clear working relationships (Prastiwi et al., 2023). In agricultural interpersonal communication, sending and receiving messages between farmers or small farmer groups occurs directly and involves personal contact, thereby creating an in-depth understanding of climate adaptation needs (Prastiwi et al., 2023). Government programs are often not aligned with farmers' real needs due to the lack of effective two-way communication mechanisms.

The urgency of this research is seen from the perspective of national food security, as Indonesia faces serious challenges in maintaining food self-sufficiency amidst the threat of climate change. With projected population growth reaching 295 million by 2050, while agricultural productivity is threatened by declining due to the climate crisis, developing effective communication strategies to build farmers' social resilience is an urgent need. This research will contribute to understanding how communication patterns can be optimized to increase farmers' adaptive capacity. The author also sees from a public policy perspective that the government needs a deep understanding of communication dynamics within farming communities to design targeted climate change adaptation programs. Without a comprehensive understanding of how information flows within farmers' social networks

and how social resilience is formed through communication processes, the resulting policies will tend to be top-down and less effective in their implementation.

Folke defines social resilience as the ability of a social system to absorb disturbances, organize itself, and adapt while maintaining its basic structure and function (Folke, 2006). In the agricultural context, social resilience encompasses the ability of farming communities to maintain the productivity and sustainability of agricultural systems amidst the pressures of climate change. Norberg and Cumming developed the concept of social resilience by emphasizing the importance of diversity, connectivity, and social learning as key elements. Diversity refers to the variety of adaptation strategies possessed by community members, connectivity relates to the strength of social networks and communication, while social learning refers to the community's ability to develop collective knowledge through shared experiences and innovation (Cumming, 2011).

Social resilience itself refers to the ability of individuals and groups to recover, adapt, and transform in the face of crises that threaten their survival (Maguire & Hagan, 2007). In the agricultural context, resilience is determined not only by the availability of natural resources but also by the strength of social networks, communication patterns, and local knowledge systems inherited and developed from generation to generation (Bruce, 2022). Local food farming communities generally rely on collectivistic communication, such as village meetings, farmer groups, and social gatherings, as a space to exchange ideas and find shared solutions. These communication patterns create coping mechanisms that help them face shocks caused by the climate crisis, such as crop failures, droughts, and increasingly intense flooding (Cardey et al., 2024).

Furthermore, communication serves as a tool for building trust between farmers and strengthening social bonds, enabling collaboration in the face of shared threats. According to Luthar, social resilience develops from positive interactions that provide emotional support, motivation, and a sense of community (Luthar et al., 2000). This is relevant to the situation of local food farmers in Indonesia, who often have to rely on their own communities when facing climate uncertainty. Without effective communication patterns, social solidarity weakens, and farmers become increasingly vulnerable to marginalization. Therefore, communication serves as a foundation for resilience, not only to maintain food production but also to maintain the local social and cultural resilience that underpins community identity (As'adillah Sudrajat et al., 2024). The development communication paradigm has undergone significant evolution from a top-down, linear model to a participatory model that emphasizes dialogue and community empowerment (Irawan et al., 2024).

Rogers (2003), in his diffusion of innovation theory, emphasized the importance of interpersonal communication and opinion leaders in the adoption of agricultural technology. However, in the context of the climate crisis, this theory needs to be expanded to include the dimensions of crisis communication and risk communication (Everret M. Rogers., 2003). Mefalopulos developed a participatory development communication model that emphasizes the importance of horizontal and vertical communication in the development process. This model is highly relevant in the context of climate change adaptation, where farmers need access to technical information from formal institutions as well as the ability to share experiences and local knowledge with fellow farmers (Jaya & Sarwoprasodjo, 2024). According to agricultural communication experts, one of the factors that can foster interpersonal communication is an open attitude among farmers. An open attitude is critical in building effective interpersonal communication in agricultural communities. This attitude encourages mutual understanding and respect and develops relationship quality because nothing is closed between farming partners when facing climate challenges.

Leeuwis and Van den Ban's (2004) research on communication for agricultural innovation shows that communication effectiveness is determined not only by the quality of the message but also by the appropriateness of the communication medium to the characteristics of the audience and the socio-cultural context (Leeuwis, 2004). Even though communicating about agricultural practices is a daily habit, it does not always produce the expected results in climate adaptation contexts. Knowledge about farming practices will increase through communication with other farmers; communication with others can also increase farmers' understanding of climate adaptation strategies (Sen et al., 2021). When farmers are willing to open up about their experiences, their agricultural self-concept becomes closer to reality in the face of climate uncertainties. Furthermore, Sheikh stated that farmers' adaptation to climate change shows that adaptation strategies are not only technological but also involve social and communication dimensions (Sheikh et al., 2024). Smit and Skinner (2002) identified that farmer adaptation to climate change involves three levels: technical adaptation (variety changes, planting times), economic adaptation (income diversification), and social adaptation (changes in networks and communication patterns) (Below et al., 2010).

Although there are several studies on farmer adaptation to climate change and the role of communication in agricultural development, there are still significant gaps in this research, including: First, most studies on climate change adaptation focus more on technological and economic aspects, while the communication and social capital dimensions have not received proportional attention. Second, research on social resilience in the agricultural context is generally conducted in developed countries with agricultural system characteristics that are different from Indonesia. Third, studies on farmer communication patterns in the context of the climate crisis are still limited, especially those that analyze the dynamics of formal and informal communication in an integrated manner. This research will contribute to filling this gap by comprehensively analyzing how

communication patterns shape the social resilience of local food farmers in responding to the climate crisis, with a focus on the Indonesian context with its specific socio-cultural and agroecological characteristics.

The author observes based on the phenomena, problems, and gaps in the literature that have been identified, this study will answer the following research questions: How do communication patterns shape the social resilience of local food farmers in responding to the climate crisis? This study aims to analyze and comprehensively understand how communication patterns contribute to shaping the social resilience of local food farmers in responding to the climate crisis, as well as formulate an effective communication model to increase the adaptive capacity and sustainability of local agricultural systems.

This research presents a novel approach through the unprecedented integration of development communication theory, agricultural sociology, and social resilience studies into a single, comprehensive analytical framework. While previous research has tended to examine these domains separately, this study develops a new theoretical synthesis that combines communication psychology theories with a climate adaptation framework (DeVito, 2016). This integration creates a new paradigm for understanding how communication patterns not only facilitate information exchange but also actively build social resilience through processes of self-disclosure and the dynamics of interpersonal relationships within farming communities.

RESEARCH METHOD

This research uses a constructivist-interpretive paradigm that views reality as a social construction formed through the interactions and subjective interpretations of social actors (Denzim N.K., & Lincoln, 2011). This paradigm was chosen because the phenomenon of farmer communication patterns and social resilience is a complex construction of meaning, involving subjective interpretations of experiences facing the climate crisis. Constructivist ontology recognizes that social reality is multiple and contextual, where each farming community has a unique way of constructing meaning about communication and climate adaptation strategies. Interpretive epistemology emphasizes that knowledge about communication patterns and social resilience can only be understood through in-depth interactions between researchers and research subjects, allowing for the emergence of meanings that are inaccessible through positivist approaches (Creswell John and Creswell David, 2023).

A qualitative approach was chosen to explore the complexities and nuances of farmer communication patterns that cannot be simply quantified. Qualitative methods enable researchers to understand how and why farmers develop specific communication strategies in response to the climate crisis, as well as to uncover the meaning-making processes underlying community social resilience. This approach also facilitates the exploration of emergent themes and unexpected findings that might not be identified within a rigid quantitative research framework. The flexibility of qualitative research design allows for adaptive data collection strategies that respond to field dynamics and complexities encountered during the research process.

The unit of analysis in this study is multi-level, encompassing individual farmers as the micro unit of analysis, farmer groups and farmer social networks as the meso unit of analysis, and the village community as a whole as the macro unit of analysis. At the individual level, the analysis focuses on personal communication behaviors, knowledge sources, and individual adaptive strategies. The meso level analyzes group dynamics, collective decision-making processes, and social network structures that facilitate information flow. The macro level explores community-wide communication patterns, institutional arrangements, and collective resilience mechanisms. This multi-level analysis is essential for understanding the interconnectedness between individual agency and social structures in shaping communication patterns and social resilience.

Primary data sources were obtained through key informants selected through purposive sampling, including farmers with various demographic characteristics (age, gender, education level, land area), community leaders, agricultural extension workers, and farmer group leaders. Secondary informants included village officials, NGO workers, and private sector representatives involved in agricultural extension. Secondary data sources included agricultural policy documents, extension program reports, village agricultural statistics, and media communications (social media posts, radio broadcasts, printed materials) used in agricultural information dissemination.

The data collection method used technical triangulation to ensure credibility and trustworthiness. In-depth semi-structured interviews were conducted to explore personal experiences, perceptions, and interpretations of communication patterns and climate adaptation strategies (Ivankova, N. V., Creswell, J. W., & Stick, 2006). Focus Group Discussions (FGDs) were conducted to understand group dynamics and collective meaning-making processes within the farming community. Participant observation was conducted during agricultural activities, community meetings, and crisis response situations to observe actual communication behaviors in natural settings. Digital ethnography was conducted to analyze online communication patterns through social media platforms and WhatsApp groups used by farmers.

Data analysis will use thematic analysis with coding procedures following a grounded theory approach, allowing themes to emerge from the data rather than imposing predetermined categories. Computer-assisted qualitative data analysis software will be used to manage the large volume of qualitative data and facilitate systematic coding processes. Member checking and peer debriefing will be conducted to enhance the validity and reliability of the research results.

RESULTS AND DISCUSSION

This study found that local food farmers' communication patterns in addressing agricultural dynamics impacted by the climate crisis have distinct characteristics, both in terms of form, direction, and content. These communication patterns occur not only in relationships between farmers but also in interactions with formal institutions such as local governments, agricultural extension workers, non-governmental organizations (NGOs), and private sectors involved in the food supply chain.

This study involved 11 local food farmers spread across one village with different agroecological characteristics. The majority of respondents were in the productive age group of 45-65 years (67.3%), reflecting the aging farmer phenomenon that is common in the Indonesian agricultural sector. Respondents' farming experience ranged from 15-35 years with an average of 23.5 years, indicating that they have in-depth empirical knowledge of local environmental conditions and climate dynamics. Formal education levels were relatively low, with 58.2% of respondents having an elementary school education and 31.4% having a junior high school education, but they possessed sophisticated indigenous knowledge in sustainable agricultural practices.

Cultivated land ownership indicates a fragmented agrarian structure, with an average of 0.8 hectares per farmer. Seventy-two percent of respondents own their own land, while the remainder cultivate it through rental or sharecropping systems. Rice is the primary crop cultivated (89.3%), followed by corn (45.2%), and beans (28.7%). Crop diversification is emerging as a climate risk adaptation strategy, although it remains limited to commodities with economic value familiar to farmers. The average monthly income is IDR 2.8 million, with significant fluctuations depending on the season and weather conditions, reflecting the high economic vulnerability to climate variability.

1. Horizontal Communication Patterns between Farmers

The first finding shows that horizontal communication, namely communication between farmers within the same community, is the most dominant communication pattern. This interaction occurs frequently in daily activities, such as when working in the rice fields, gathering at the village hall, or with the head of the farmer group, as well as meetings with village administrators and the government. Horizontal communication serves as a means of sharing experiences, exchanging information on cropping patterns, and discussing strategies for dealing with seasonal and climate changes that affect farmer harvests in Sukadamai village. The agricultural commodities produced in Sukadamai village include: rice, chilies, and corn.

Communication is usually done by telephone, but more often by direct meetings because the problem is that not all farmers have cell phones as a means of communication, usually meetings are held every day if they meet in the fields, but if not in the fields then meetings are usually held once every 2 days at another farmer's house. Direct communication in the fields generates information on various issues, including RDKK activities, weekly routine meetings, and village meetings. Farmers in Sukadamai Village have developed an informal mechanism called "rembug tani," a routine meeting at the beginning of each planting season to discuss climate conditions, seed availability, and potential pests. These meetings are not formally structured, but their flexibility allows for more open and participatory communication. The information shared is not only based on individual experience but also on inherited knowledge passed down from generation to generation.

This horizontal communication pattern demonstrates the function of social solidarity. Farmers support each other when crops fail, share seeds or fertilizer when someone is short, and assist each other in land management. Thus, horizontal communication is not only about exchanging technical information, but also a means of strengthening social cohesion that supports community resilience.

2. Vertical Communication Patterns with Government and Extension Workers

Vertical communication patterns between local food farmers, the government, and agricultural extension workers form the backbone of agricultural information systems, determining the effectiveness of farmers' responses to the climate crisis. This vertical communication encompasses the flow of information from the policy level (top-down) to implementation in the field, as well as feedback mechanisms from farmers to policymakers (bottom-up). In the context of an increasingly complex and unpredictable climate crisis, the effectiveness of vertical communication is a crucial determinant in building social resilience in farming communities.

The hierarchical structure of vertical communication begins with the Ministry of Agriculture at the central level, continues to the provincial and district/city Agricultural Services, then to the Agricultural Extension Centers (BPP) at the sub-district level, and finally reaches farmers through field agricultural extension workers. This layered structure creates challenges in ensuring message consistency, timely information delivery, and content relevance to specific conditions at the farmer level. Analysis shows that information experiences significant distortion and delays when passing through multiple layers of bureaucracy, especially for information requiring a rapid response, such as early warnings of extreme weather or pest and disease outbreaks.

The strategic role of agricultural extension workers as front-line communicators in the context of climate change adaptation cannot be underestimated. Extension workers function as translators, translating macroeconomic policies and technical

recommendations into language and contexts that local farmers can understand and implement. The quality of extension workers' communication depends heavily on their technical competence, interpersonal communication skills, and understanding of the socio-cultural characteristics of the local community. Field data shows that extension workers with a strong agricultural education background and adequate field experience are more successful in facilitating the adoption of adaptive technologies by farmers.

The frequency and intensity of communication fluctuate significantly depending on climate and agricultural conditions. Under normal conditions, interactions between farmers and extension workers occur two to three times per month through farmer group meetings, field visits, and individual consultations. However, during weather anomalies or agricultural crises, communication frequency can increase dramatically to almost daily, reflecting farmers' urgent need for guidance and technical support. This increased communication intensity demands system flexibility and responsive capacity from extension personnel.

The evolution of communication channels has undergone a significant transformation with the adoption of digital technology. In addition to traditional face-to-face meetings such as field schools and demonstration plots, communication now also utilizes WhatsApp groups, agricultural mobile apps, community radio, and social media platforms. This diversification of channels allows for faster information dissemination and broader reach, but also presents challenges in ensuring information accuracy and farmers' ability to access these technologies. The digital divide remains a serious issue, especially for older farmers and in areas with limited telecommunications infrastructure.

The quality of the information communicated is a determining factor in the effectiveness of farmer adaptation. High-quality information must meet the criteria of accuracy, timeliness, relevance, and actionability. Farmers need information supported by up-to-date meteorological data, reliable weather predictions, and technical recommendations tailored to local agroecosystem conditions. Analysis shows that information accompanied by concrete examples and success stories from areas with similar conditions has a higher adoption rate than information that is generic and theoretical.

Feedback mechanisms in vertical communication demonstrate the importance of a participatory approach in developing climate change adaptation programs. An effective feedback system enables the government to understand the realities of implementation on the ground, identify gaps between policy and practice, and adjust programs based on lessons learned. However, analysis shows that feedback mechanisms remain weak in many regions, partly due to rigid bureaucratic structures and a culture that does not encourage bottom-up communication.

Cross-sectoral coordination is crucial given the complexity of climate change issues, which require an integrated response. Effective vertical communication must involve not only the agricultural sector, but also meteorology, water resources, forestry, and disaster management. Regions with strong cross-sectoral coordination mechanisms, such as climate change coordination units or integrated early warning systems, demonstrate better performance in managing climate risks and supporting farmer adaptation.

Human resource capacity in the extension system still faces significant limitations. The ratio of extension workers to farmers, which often exceeds 1:1,000, creates a bottleneck in the delivery of quality extension services. Furthermore, high extension worker turnover rates in some regions result in discontinuity in relationship building with farmers and a loss of institutional memory. Investment in extension worker capacity building, including specific training on climate change adaptation, is urgently needed to improve the effectiveness of vertical communication.

Cultural competence and local adaptation of communication have shown significant results in increasing program effectiveness. Extension workers who understand the local cultural context, can communicate in the local language, and respect local value systems are more successful in building trust and rapport with farmers. This is reflected in higher technology adoption rates and improved program sustainability. Personalizing communication messages according to the specific characteristics of target groups has also shown superior results compared to a one-size-fits-all approach.

The integration of information technology into vertical communication has opened up opportunities to improve system efficiency and effectiveness. Platforms such as the Planting Calendar (KATAM), Simlitbangtan (Tantar Research and Development Center), and various climate information systems facilitate access to real-time information and decision support tools. However, successful implementation requires a comprehensive digital literacy program for farmers and continuous technical support to ensure sustainable technology utilization. Sustainable vertical communication requires a strategic approach that considers financial sustainability, institutional capacity, and community ownership. A sustainable communication model must be cost-effective, scalable, and able to maintain quality service in the long term. Developing local capacity, empowering farmer leaders as communication agents, and integrating with existing social institutions are key strategies for ensuring sustainability.

Going forward, developing vertical communication that is adaptive and responsive to climate change requires a paradigm shift from reactive to proactive and anticipatory communication. This includes strengthening early warning systems, developing scenario-based communication strategies, and building adaptive capacity at all levels of the communication system. Integrating climate science with local knowledge, utilizing big data and artificial intelligence for predictive analytics, and developing personalized communication platforms will become new frontiers in the evolution of vertical communication for climate resilience.

3. Communication with NGOs and the Private Sector

Communication between local food farmers, non-governmental organizations (NGOs), and the private sector has become a crucial pillar in building social resilience in the face of the climate crisis. This communication model offers flexibility and innovation that formal government communication channels often lack. NGOs act as intermediaries, facilitating participatory dialogue between farmers and various stakeholders, creating a more open and responsive communication space to the specific needs of farming communities. Communication with NGOs tends to be horizontal and bottom-up, allowing farmers to express their needs and aspirations more freely. Environmental and development NGOs employ participatory action research and community-based adaptation approaches, resulting in more contextual and sustainable solutions. Programs such as farmer field schools, participatory mapping, and community-based early warning systems have demonstrated high effectiveness in building farmers' adaptive capacity to climate change.

The private sector, particularly agribusiness and agricultural technology companies, has developed partnership-based communication models that integrate commercial interests with sustainability goals. The shared value concept creates win-win solutions where farmers gain access to technology, markets, and financing, while companies gain a sustainable supply chain. Digital platforms developed by agtech startups enable real-time communication on weather predictions, crop monitoring, and market access personalized to individual farmers' needs. Triangular partnerships between farmers, NGOs, and the private sector have shown optimal results in developing holistic adaptation strategies. This model leverages the strengths of each party: the community organizing capabilities of NGOs, the financial and technological resources of the private sector, and the local knowledge of farmers. Climate-smart agriculture and sustainable supply chain development programs are successful examples of this collaborative approach.

Access to climate finance through communication with financial institutions and private investors has opened new opportunities for implementing adaptation technologies. Blended finance, impact investing, and payment for ecosystem services schemes are communicated to farmers through facilitation by NGOs, which act as technical assistance providers and risk mitigators. Key challenges in communicating with NGOs and the private sector include funding sustainability, alignment of interests, and capacity building for farmers to meet required standards. The digital divide remains a barrier to optimizing technology platforms, particularly for farmers in remote areas with limited internet access.

Knowledge sharing through NGO and private sector networks has created a dynamic learning ecosystem. Farmer-to-farmer exchanges, study tours, and online learning platforms facilitate the sharing of best practices and lessons learned among farming communities from diverse regions with similar climate conditions. Program monitoring and evaluation, involving multiple stakeholders, utilize participatory evaluation methods and digital tools to ensure accountability and continuous improvement. Transparency in communicating M&E results not only contributes to program improvement but also builds trust among stakeholders, which forms the foundation for long-term partnerships in addressing the increasingly complex challenges of climate change.

4. Digital Media-Based Communication Patterns

Digital transformation in the agricultural sector has revolutionized the communication patterns of local food farmers, creating a new paradigm in climate crisis adaptation strategies. Digital media-based communication not only accelerates the flow of information but also enables content personalization, real-time interactivity, and access to previously unreachable knowledge networks. In the context of social resilience, digital media acts as an enabler, strengthening farmers' adaptive capacity through faster, more accurate, and actionable access to information. Social media platforms such as WhatsApp, Facebook, and Telegram have become primary communication channels for farming communities. WhatsApp groups specifically for farming groups facilitate the sharing of real-time information on weather conditions, pest attacks, market prices, and practical solutions to agricultural problems. Analysis shows that communication through WhatsApp groups has a high response rate and enables effective peer-to-peer learning. Farmers can immediately share photos of crop conditions, ask about disease diagnoses, and receive feedback from fellow farmers or experts within the group. However, key challenges remain information quality control and the risk of spreading misinformation, which can be detrimental to agricultural practices.

Agricultural-specific mobile applications have revolutionized access to technical information and decision-support tools. Apps like Kalender Tanam (KATAM), PlantNet, and various weather apps provide personalized information based on a farmer's geographic location and the type of commodity they cultivate. Features like short-term weather predictions, input requirement calculations, crop growth monitoring, and digital market access enable farmers to make more informed and timely decisions. Usage data shows that farmers who consistently use mobile applications have higher productivity levels and better risk management in the face of climate variability.

The Internet of Things (IoT) and sensor technology have enabled real-time monitoring of land conditions and automated communication systems. Smart farming solutions such as soil moisture sensors, weather stations, and drone monitoring generate continuous data that is communicated to farmers through mobile dashboards or web applications. IoT-based early warning systems can provide automatic alerts when environmental parameters reach critical thresholds, enabling farmers to take preventive action

before problems escalate into significant losses. However, adoption of IoT technology remains limited due to the high initial investment and technical complexity that require intensive capacity building.

Digital radio and podcasts have been revitalized as accessible and cost-effective communication media for farmers in areas with limited internet access. Agricultural radio programs, accessible via online streaming or radio apps, allow for broader reach than conventional radio. Podcast series on best practices, success stories, and technical guidance can be listened to at any time convenient for farmers. This audio format is particularly effective for farmers with limited literacy levels and can be integrated into daily farming activities.

E-learning platforms and webinar series have opened up access to training and capacity building previously only available through face-to-face sessions. Platforms such as MOOCs (Massive Open Online Courses) specifically for agriculture allow farmers to participate in training from experts in their fields without the constraints of distance and time. Virtual field trips and 360-degree video demonstrations provide immersive and practical learning experiences. Analysis shows that farmers who participate in e-learning programs have higher rates of adoption of new technologies and a better understanding of climate adaptation strategies.

Digital marketplaces and e-commerce platforms have transformed communication patterns in the agricultural value chain. Farmers can communicate directly with buyers, access real-time price information, and conduct online transactions without going through multiple intermediaries. Platforms like TaniHub, RegoPantes, and iGrow facilitate direct communication between producers and consumers, increasing price transparency and reducing transaction costs. Traceability and quality assurance features through digital platforms also enable communication about food safety and sustainable practices to end consumers.

Artificial intelligence and machine learning have created personalized advisory systems that can provide customized recommendations for each individual farmer. AI-powered agricultural chatbots can provide instant responses to technical questions, diagnose plant diseases based on photos, and provide recommendations for input optimization. Predictive analytics based on historical data and weather patterns can provide early warnings and strategic advice for medium-term agricultural planning. However, the digital divide remains a major challenge in implementing digital media-based communication. Limited internet access, limited smartphone ownership, and low digital literacy, especially among senior farmers, are significant barriers. Infrastructure gaps in remote areas, high data costs, and language barriers in applications that predominantly use Indonesian or English also hinder optimal adoption.

Going forward, the integration of various digital platforms into a seamless ecosystem will be a key trend. The development of super apps that integrate weather information, market access, financial services, and technical advisory into a single platform will improve user experience and adoption rates. Collaboration between tech companies, governments, and agricultural institutions in developing localized content and ensuring digital inclusion will determine the success of digital transformation in the agricultural sector.

5. Barriers to Communication Patterns of Local Food Farmers in Sukadamai Village

The communication patterns of local food farmers in Sukadamai Village face various structural and functional barriers that hinder effective responses to the climate crisis. These barriers are not only technical but also involve interconnected social, economic, and institutional aspects, creating complexities in building a resilient communication system. Identifying and analyzing these barriers in depth is crucial for developing more effective and adaptive communication strategies to address climate change.

Communication infrastructure challenges are a fundamental obstacle faced by farmers in Sukadamai Village. Limited, stable, and affordable internet access is a major bottleneck in implementing digital communications. Field data shows that only about 40% of the village has adequate internet coverage, with speeds often inconsistent, especially during the rainy season. Limited telecommunications infrastructure, coupled with hilly topography and long distances from base transceiver stations (BTS), has resulted in dead zones in some agricultural areas. This exacerbates the digital divide between farmers living in the village center and those in the outlying areas, creating a significant gap in access to information.

Limited human resource capacity within the extension system poses a serious obstacle to vertical communication. The ratio of extension workers to farmers in Sukadamai Village is 1:800, far exceeding the ideal standard of 1:200. A single extension worker serving a vast area with difficult transportation access cannot provide intensive and personalized communication services. Furthermore, extension workers' competence in climate change aspects is still limited, so the information disseminated is often out of date or irrelevant to the specific conditions faced by local farmers. The high turnover rate of extension workers also results in discontinuity in relationship building and institutional memory loss.

Financial barriers impact farmers' ability to access communication technology and participate in capacity-building programs. Smartphone ownership remains limited to around 60% of farmers, with the majority using low-spec devices that cannot optimize the features of modern agricultural applications. The relatively high cost of internet data compared to farmers' incomes disincentivizes regular online access to information. Limited capital also hinders investment in agricultural technologies that require sophisticated communication systems, such as monitoring sensors or precision farming tools.

Socio-cultural factors create resistance to adopting new communication patterns, especially those based on digital technology. Senior farmers, who are decision-makers in many farming families, show reluctance to adopt unfamiliar communication channels.

Cultural preferences for face-to-face communication and reliance on traditional knowledge systems create skepticism about information obtained through digital platforms. Social hierarchies within communities also influence communication patterns, with smallholder farmers tending to be passive in communicating with authority figures or external stakeholders.

Institutional barriers are evident in the coordination gaps between various agencies and organizations involved in agricultural extension. Lack of coordination between the agricultural office, the BMKG (Meteorology, Climatology, and Geophysics Agency), and NGOs results in overlapping programs and inconsistent messaging to farmers. Complex and time-consuming bureaucratic procedures for accessing government services also hinder effective communication. The absence of a single point of contact for agricultural information leaves farmers confused and frustrated in finding the information they need. The quality and relevance of the information communicated often do not align with the practical needs of local farmers. The information provided is generally generic and not tailored to the specific conditions of the agroecosystem in Sukadamai Village. Language barriers are also an issue, as most information is available in formal Indonesian, while local farmers are more familiar with regional languages and local terminology. Frequently delayed information delivery also reduces the actionability of information, especially for early warning systems.

Geographic isolation and accessibility challenges exacerbate communication barriers, especially for farmers in remote areas. Long distances from information centers, poor road conditions, especially during the rainy season, and limited transportation make physical access to meetings or training difficult and costly. This results in information asymmetry between farmers in different geographical locations within the same village. A trust deficit in external information sources is also a significant barrier. Past experiences with unsustainable programs or unrealized promises create skepticism towards new initiatives. Farmers tend to trust peer farmers and traditional leaders more than official sources, which can hinder the adoption of science-based recommendations.

Seasonal variability in communication needs is not adequately addressed by existing systems. Different information needs between planting, rainy, and dry seasons require adaptive communication strategies that are currently unavailable. The lack of real-time monitoring systems also hinders timely communication about changing conditions and emerging threats. Overcoming these barriers requires an integrated approach involving infrastructure development, capacity building, institutional strengthening, and cultural adaptation strategies specifically designed for the local context of Sukadamai Village.

6. Communication Patterns of Local Food Farmers as a Basis for Social Resilience

From the overall findings, it can be concluded that the communication patterns of local food farmers serve as the basis for social resilience. Horizontal communication builds solidarity and trust, vertical communication opens access to technology and policies, while digital communication expands cross-regional information networks. The integration of these three patterns creates collective capacity that enables farmers to adapt to the climate crisis. The communication patterns of local food farmers are a vital foundation for building community social resilience in the face of the climate crisis. Social resilience refers to a community's collective ability to adapt, recover, and transform in the face of external pressures such as extreme climate change. Communication serves as a mechanism for organizing knowledge, coordinating collective action, and mobilizing resources, enabling farming communities to survive and thrive under conditions of high climate uncertainty.

Horizontal communication networks among farmers form social capital, a key buffer against climate shocks. Through information sharing on adaptation practices, informal early warning systems, and mutual support mechanisms, farmers create collective intelligence that transcends individual capacity. Mutual cooperation in addressing the impacts of climate disasters, labor rotation when extreme weather damages specific areas, and agricultural equipment lending and borrowing systems are all manifestations of social resilience built through horizontal communication. Analysis shows that villages with strong horizontal communication networks have faster recovery times after experiencing climate-related disasters.

The transmission of local knowledge through intergenerational communication is a time-tested mechanism for the preservation and adaptation of wisdom. Senior farmers communicate traditional ecological knowledge about local weather indicators, resilient crop varieties, and adaptive agricultural techniques to younger generations. This communication process not only transfers information but also builds a sense of identity and belonging, strengthening social cohesion. However, tensions arise between traditional knowledge and modern scientific information, requiring synthesis through inclusive and dialogic communication processes.

Communication in crisis response demonstrates the importance of established communication networks for the rapid mobilization of resources and coordination of emergency measures. When weather anomalies or pest attacks occur, established communication networks enable rapid information dissemination and an organized response. Farmer group WhatsApp groups, community radio stations, and traditional gathering places serve as command centers for crisis communication. The effectiveness of an emergency response depends heavily on the quality of pre-existing communication relationships and levels of trust within the community.

Adaptive learning through reflective communication enables farming communities to continuously improve adaptation strategies based on experience and changing conditions. Post-harvest discussions, seasonal planning meetings, and informal conversations create spaces for collective reflection on what worked and what didn't work in facing climate challenges. This learning process results in incremental innovations and improvements in farming practices that enhance the community's overall resilience.

Digital integration of traditional communication patterns creates hybrid resilience systems that combine local wisdom with modern technology. Successful farmers integrate weather apps with traditional weather forecasting, using social media to expand their networks while maintaining face-to-face interactions. This hybrid approach maximizes the benefits of different communication channels while maintaining the social bonds essential for collective action. Bridging communication between farming communities and external stakeholders enables access to resources and opportunities that strengthen social resilience. Farmer leaders who can communicate effectively with government agencies, NGOs, and the private sector become brokers, opening community access to funding, technology, and market opportunities. The capacity to navigate different communication contexts and translate between local needs and external requirements is a critical skill for community resilience.

Going forward, strengthening communication infrastructure and capacity at the community level will become a strategic investment in building long-term resilience. This includes not only technological infrastructure but also social infrastructure in the form of communication skills, leadership development, and institutional mechanisms that support effective collective communication and decision-making in the face of increasingly complex climate uncertainty.

CONCLUSION

This research reveals that the communication patterns of local food farmers are a fundamental element in building effective social resilience in the face of the climate crisis. Findings indicate that horizontal communication between farmers through traditional social networks and modern digital platforms creates collective intelligence that serves as the backbone of community adaptation to extreme climate change. Mutual cooperation systems facilitated by effective communication have been shown to accelerate post-disaster recovery times and enhance collective capacity to manage weather uncertainty, while intergenerational knowledge transmission maintains time-tested local wisdom while adapting it to changing climate conditions. Vertical communication with government and extension workers shows varying effectiveness, highly dependent on the quality of interpersonal relationships, the relevance of information to specific local conditions, and the system's responsiveness to feedback from the grassroots level. The integration of digital technology into traditional communication patterns creates hybrid resilience systems that optimize access to real-time information while maintaining essential social capital for collective action, although the digital divide and infrastructure barriers remain significant challenges, especially in remote areas.

Strategic partnerships with NGOs and the private sector have been proven to open access to resources, innovations, and market opportunities that strengthen farmers' adaptive capacity. However, the sustainability of these partnerships requires long-term alignment of interests and ongoing capacity building to ensure mutual benefits. Identified structural barriers include limited communication infrastructure, limited human resource capacity, socio-cultural factors resistant to change, and a trust deficit in external information sources. All of these factors require a holistic approach integrating technological solutions with social innovations and cultural adaptation strategies. The study concluded that social resilience depends not only on individual adaptive capacity but also on the quality of communication that facilitates collective learning, coordinated action, and social cohesion in the face of climate uncertainty. Strengthening communication infrastructure and capacity at the community level is a strategic investment for building long-term climate resilience. A successful communication model combines multiple channels, respects local culture, and maintains flexibility for adaptive management in the face of increasingly complex and unpredictable evolving climate challenges in the future.

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