



Technology-based empowerment and disaster resilience strengthening for coffee farmer groups in Donorejo Village, Purworejo

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Abstract

Coffee farming is a major source of livelihood for rural communities, but its sustainability is threatened by weak managerial capacity, low technology adoption, and landslide risks. This community service activity aims to strengthen the economic independence of the “Bangun Semi” Coffee Farmer Group in Donorejo Village, Purworejo. The program was implemented using a Participatory Action Research (PAR) approach through the stages of socialization, training, technology application, mentoring, and evaluation. Interventions included digital bookkeeping training, strengthening the branding and digital marketing of Kopi Semi, installing a solar-powered coffee roasting machine, utilizing coffee husk waste into fermented animal feed, and implementing a Landslide Early Warning System (LEWS). The results showed an increase in business capacity and partner resilience. The selling price of coffee increased by more than 120%, roasting productivity rose from 2 kg/day to 12 kg/day, and energy costs decreased by up to 88%. In addition, the utilization of coffee husk waste reduced feed costs by up to 20%, while LEWS strengthened early warning and community preparedness. This integrated model is effective in strengthening a resilient local economic independence and has the potential to be replicated in other disaster-prone areas.

Keywords: Coffee farmers; Disaster-prone areas; Economic empowerment; Economic resilience

Pemberdayaan Kelompok Tani Kopi Berbasis Teknologi dan Ketangguhan Bencana di Desa Donorejo, Purworejo

Abstrak

Usaha tani kopi merupakan sumber penghidupan utama masyarakat pedesaan, tetapi keberlanjutannya terancam oleh lemahnya kapasitas manajerial, rendahnya adopsi teknologi, dan risiko longsor. Kegiatan pengabdian kepada masyarakat ini bertujuan memperkuat kemandirian ekonomi Kelompok Tani Kopi “Bangun Semi” di Desa Donorejo, Purworejo. Program dilaksanakan dengan pendekatan Participatory Action Research (PAR) melalui tahapan sosialisasi, pelatihan, penerapan teknologi, pendampingan, dan evaluasi. Intervensi meliputi pelatihan pembukuan digital, penguatan branding dan pemasaran digital Kopi Semi, pemasangan mesin roasting kopi bertenaga surya, pemanfaatan limbah kulit kopi menjadi pakan ternak fermentasi, serta penerapan Landslide Early Warning System (LEWS). Hasil menunjukkan peningkatan kapasitas usaha dan ketangguhan mitra. Nilai jual kopi meningkat lebih dari 120%, produktivitas roasting naik dari 2 kg/hari menjadi 12 kg/hari, dan biaya energi menurun hingga 88%. Selain itu, pemanfaatan limbah kulit kopi

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menekan biaya pakan hingga 20%, sedangkan LEWS memperkuat peringatan dini dan kesiapsiagaan masyarakat. Model terintegrasi ini efektif memperkuat kemandirian ekonomi lokal yang tangguh dan berpotensi direplikasi di wilayah rawan bencana lainnya.

Kata Kunci: *Petani kopi; Daerah rawan bencana; Pemberdayaan ekonomi; Ketahanan ekonomi*

1. Introduction

Coffee farming constitutes a primary source of livelihood for many rural communities. However, this sector is increasingly threatened by climate change, ineffective cultivation techniques, and heightened environmental risks, particularly landslides that endanger agricultural land and farmers' livelihoods (Bracken et al., 2023; Sittadewi et al., 2025; Tadesse et al., 2025). Empirical studies consistently demonstrate that strengthening farmer group institutions through agribusiness training and business management assistance significantly improves productivity, increases farmers' income, and enhances their bargaining position within the supply chain (Ayesha et al., 2024; Nuraisyah et al., 2025; Rowe et al., 2022).

Furthermore, the adoption of new technologies in cultivation and post-harvest processing has been proven to enhance production efficiency, reduce operational costs, and promote both economic and environmental sustainability in agrarian communities (Selvanarayanan et al., 2024; Welly et al., 2025). Innovations such as land conservation technologies, circular economy approaches that convert coffee waste into value-added products, and digital transformation initiatives are increasingly recognized as strategic solutions. In disaster-prone areas, agroforestry systems and conservation technologies play a crucial role in reducing disaster risk while sustaining agricultural productivity (Djufry et al., 2022; Sittadewi et al., 2025). These findings highlight the need for integrated empowerment models that simultaneously strengthen economic resilience and disaster preparedness in rural communities.

Donorejo Village is located in Kaligesing Subdistrict, Purworejo Regency. This village has agricultural economic potential but is also prone to natural disasters. One of Donorejo Village's potentials is coffee plantations and cultivation, which are managed by the 'Bangun Semi' Coffee Farmers Group. This village is located in a hilly area that is classified as a landslide-prone area according to the Indonesian Disaster Risk Index. (BPBD Purworejo, 2023). This dual context poses complex challenges to the sustainability of community life, where economic improvement is often hampered by the threat of recurring disasters. Sustainable rural economic development requires the strengthening of local institutions, mapping of economic potential, and business development strategies that take into account the context of vulnerability. This can be seen in the development of village-owned enterprises and MSMEs in various regions. According to Budiana et al. (2023), building community resilience is very important, especially in vulnerable areas. However, there are not many studies that operationally combine specific micro-business management with the application of appropriate renewable energy-based technology within the framework of synergistic programmes at the village level.

Initial observations conducted by the implementation team revealed that the "Bangun Semi" Coffee Farmers Group faces multidimensional challenges. Upstream issues include traditional cultivation practices, suboptimal post-harvest handling, and limited productivity and quality control. Downstream, the group encounters weaknesses in

business management, financial accounting, branding, and marketing strategies. Consequently, the added value of processed products such as roasted and ground coffee remains under-optimized. These challenges align with findings from studies on rural MSMEs, which indicate that inadequate business management, low financial literacy, and limited market access significantly constrain competitiveness and performance (Siyami et al., 2024). In addition, disaster preparedness remains insufficient. The Village Disaster Risk Reduction Forum (FPRB) lacks adequate landslide early warning facilities. Experiences during non-natural disasters, such as the COVID-19 pandemic, have demonstrated the importance of strengthening community capacity, early warning systems, and mutual assistance practices to build village resilience (Purwandari et al., 2021). The absence of accessible technological innovation further exacerbates the situation, as both economic productivity enhancement and disaster preparedness remain inadequately addressed.

To address these interconnected challenges, this community service program adopts a holistic and collaborative empowerment approach. Evidence from mentoring programs indicates that integrating training, business management assistance, and the provision of production facilities effectively increases business capacity among vulnerable groups and MSMEs in terms of turnover, product quality, and market access (Respatiningsih et al., 2022; Saptawan et al., 2022).

The proposed intervention consists of two interrelated components. First, strengthening business capacity through training in bookkeeping, financial management, digital marketing, and product branding to increase added value and competitiveness. This approach aligns with findings highlighting the importance of cooperative networks in improving MSME performance (Saputra, 2022). Brand strengthening and digital marketing strategies have also been shown to increase the added value and market reach of local products (Maulana et al., 2022; Prihandini et al., 2025; Ukrowiyah et al., 2024). Second, implementing appropriate technology in the form of solar-powered coffee roasting machines and a Landslide Early Warning System (LEWS). The use of solar-based productive tools in rural contexts demonstrates strong potential for enhancing energy efficiency and sustainability (Sinurat et al., 2024).

In addition, the program integrates circular economy principles by converting coffee husks into fermented livestock feed, thereby reducing waste while generating additional economic value (Zulfanita et al., 2023). This interdisciplinary and networking-based approach reflects best practices in assisting MSMEs and vulnerable groups by integrating business legality, management strengthening, production enhancement, and digital marketing within a unified empowerment strategy (Respatiningsih et al., 2022).

2. Method

This community service program employed a Participatory Action Research (PAR) approach. The PAR method was selected to ensure that the intervention was responsive to local needs and to strengthen shared ownership among the university team, the mentoring team, the “Bangun Semi” Coffee Farmers Group, and the Donorejo Village Disaster Risk Reduction Forum (FPRB). Through this approach, the program emphasized collaboration, participation, and sustainability in both economic empowerment and disaster resilience. The implementation program consisted of five

main stages, namely socialization, training, technology application, intensive mentoring, and continuous evaluation.

2.1. Socialization and problem identification

The socialization stage, priority issues were identified through focus group discussions, field observations, interviews, and village document analysis. The findings from this stage were used as the basis for designing the intervention, training materials, and mentoring modules.

2.2. Training on business management, branding, and technology-based empowerment

The training stage focused on strengthening the capacities of the target partners in business management, application-based bookkeeping, digital marketing, and the branding of Kopi Semi. In addition, participants received training on coffee processing technology, the utilization of coffee waste as fermented livestock feed, and evacuation simulation as part of community disaster preparedness.

2.3. Technology application for productivity and disaster resilience

The technology application stage involved the installation and trial of a solar-powered coffee roasting machine, the implementation of a digital accounting system, and the launch of newly designed coffee packaging equipped with a QR code containing the product profile. In the disaster management component, Landslide Early Warning System (LEWS) sensors were installed at the village hall and at several landslide-prone locations. Participants were also trained to read the monitoring data and activate the warning system when necessary.

2.4. Intensive mentoring and institutional strengthening

The intensive mentoring stage was conducted on a monthly basis through field visits and online consultations. This stage aimed to ensure the sustainability of the intervention through assistance in financial report analysis, marketing optimization, institutional strengthening, and monitoring of LEWS performance.

2.5. Evaluation and community outcomes

The evaluation stage used both quantitative and qualitative data. Quantitative data included sensor logs, financial reports, sales records, production data, and pre- and post-training results. Qualitative data were collected through in-depth interviews, participant observation, and reflective discussions with partner members. All activities and outcomes were documented and disseminated through digital channels, mass media, and scientific articles as part of accountability and evidence-based community service practice.

3. Results and Discussion

The community service programme has produced a number of significant achievements, both in terms of human resource capacity building, technology adoption, and economic and social impact. These results demonstrate the effectiveness of the integrated approach applied, while also providing an overview of the transformation experienced by the 'Bangun Semi' Farmers Group as the main partner. The discussion will focus on two main sub-chapters: (1) Transformation of Business Management and Marketing

Capacity of Farmers' Groups, and (2) Impact of Appropriate Technology Application on Productivity and Disaster Resilience.

3.1. Socialization and problem identification

The program began with a socialization and participatory problem-mapping process involving the university team, the “Bangun Semi” Coffee Farmers Group, and the Village Disaster Risk Reduction Forum (FPRB). Focus group discussions, field observations, interviews, and village document reviews revealed that the partner faced interconnected economic and disaster-related challenges. Upstream coffee production remained highly traditional, post-harvest handling was inefficient, and processed coffee products had low added value. At the same time, the village lacked adequate early warning facilities to anticipate landslides.

This initial mapping is consistent with the argument that local economic strengthening in vulnerable rural areas must begin with institutional asset identification, vulnerability analysis, and collaborative planning. Community resilience studies also emphasize that building adaptive village development requires institutional readiness, local participation, and multi-stakeholder engagement (Budiana et al., 2023).

The outcome of this stage was the formulation of an integrated intervention package that combined business capacity strengthening with appropriate technology for production efficiency and disaster mitigation. This stage was crucial because it ensured that the subsequent training and technological interventions were grounded in the actual needs of the partner.

3.2. Training on business management, branding, and technology-based empowerment

Prior to the intervention, the “Bangun Semi” Farmers Group operated under a highly traditional and simplified management system. Financial records were not maintained systematically, making it difficult for the group to monitor production costs, calculate income accurately, and estimate profits. In terms of marketing, the group relied almost entirely on direct sales of green beans to middlemen, with prices ranging from approximately IDR 55,000 to IDR 90,000 per kilogram. Only around 30% of members were involved in processing coffee into semi-finished products, and even then, product quality remained inconsistent, and packaging was very basic, with no clear or distinctive brand identity.

Following a series of intensive training and mentoring activities, noticeable transformation occurred in three major areas. The first concerned administration and financial management. The group began to implement a simple accounting system using the La Mikro application, enabling daily transactions, including raw material purchases, processing expenses, and sales to be recorded digitally. Whereas no proper accounting system had previously been in place, the group is now able to produce monthly financial reports. These records indicate that the roasting cost per kilogram could be reduced by up to 15% due to the increased efficiency gained from using solar-powered roasting machines. More transparent bookkeeping has also improved the group's credibility and created opportunities for access to capital, as evidenced by invitations from a savings and loan cooperative to discuss potential business financing based on the group's healthy financial reports (Figure 1).

The second area of transformation was product development and marketing. One of the most significant interventions was the strengthening of the “Kopi Semi” brand. Through

design and branding training, the group successfully introduced new packaging that was more attractive, informative, and market-oriented (Figure 2). The new packaging includes a QR code that directs consumers to a simple web page. This packaging is equipped with a QR code that directs consumers to a [simple web page](#) containing storytelling about the history of Donorejo coffee and the profile of the farmer group. This innovation represents an important contribution beyond previous studies such as [Saputra \(2022\)](#), which focused mainly on collaborative networks without incorporating digital storytelling as a strategy for building consumer attachment and loyalty to local agricultural products.



Figure 1. Training on financial statement preparation



Figure 2. Comparison of coffee packaging before (left) and after (right) the 'kopi semi' branding intervention

This branding intervention also had a direct economic impact. The group shifted its marketing strategy from selling unprocessed green beans to marketing branded roasted coffee products. While green beans were previously sold at an average price of IDR 70,000 per kilogram, "Kopi Semi" packaged in 250-gram units is now sold at IDR 40,000, equivalent to IDR 160,000 per kilogram. This reflects an increase in added value of more than 120%. In parallel, the marketing network expanded through collaboration with the Gapura UMKM Purworejo Marketing Cooperative, which included "Kopi Semi" as one of the featured products in hamper packages for government institutions.

The third area of change involved institutional strengthening. Previously, the group mainly gathered to discuss cultivation matters. After the intervention, it developed a clearer organizational structure with a more defined division of roles in production and processing, finance, and marketing. Monthly meetings are no longer limited to farm

coordination, but are also used to evaluate sales performance and plan production according to market demand. This institutional strengthening is consistent with the findings of Saputra (2022), regarding the importance of relational capital in MSME development. However, the present program provides additional empirical evidence that such relational strengthening must be supported by basic managerial skills and a strong product identity in order to produce sustainable outcomes.

3.3. Technology application for productivity and disaster resilience

The next stage of the program involved the application of appropriate technologies to address two interconnected challenges: low production efficiency and high landslide vulnerability. In the economic dimension, the installation of a 3000-watt solar-powered coffee roasting machine brought major changes to the roasting process. Previously, roasting was done manually using a wood-fired stove, with a capacity of 0.5 kg per batch and a roasting time of 150 minutes. After the intervention, the new machine was able to roast 1.5 kg per batch in only 30 minutes. This increased daily production from 2 kg to 12 kg of roasted coffee, representing a 600% increase in productivity. The improvements in roasting efficiency are presented in Table 1.

Table 1. Comparison of roasting process efficiency before and after technology implementation

Aspect	Manual Condition (Firewood)	Solar Machine Condition	Impact
Capacity/Batch	0.5 kg	1.5 kg	Capacity increased 3x
Time/Batch	150 minutes	30 minutes	Time efficiency 80%
Daily Production	2 kg	12 kg	Productivity increased 600%
Energy Cost/kg	~Rp12.500	~Rp1.500	Cost savings of 88%
Quality Consistency	Low (depends on skill)	High (precise temperature control)	Stable product quality

Energy cost savings reached 88% per kilogram, from approximately IDR 12,500 to IDR 1,500. Another technological innovation introduced in this stage was the use of coffee husk waste as fermented animal feed. This training and technical assistance changed the perception of coffee waste from a discarded by-product into a valuable resource (Figure 3). A simple analysis showed that fermented feed could reduce commercial feed costs by up to 20% for goat farmers in the group. This circular “coffee-livestock” model offers a combined environmental and economic solution that has not been widely addressed in similar coffee empowerment programs (Zulfanita et al., 2023).

In terms of disaster resilience, the installation of the Landslide Early Warning System (LEWS) at three vulnerable points in Katerban Hamlet and at the Village Hall significantly strengthened the community’s early detection capacity. Previously, the FPRB relied solely on visual observation and coordination via WhatsApp groups. The newly installed system, consisting of tilt sensors, LoRa modules for wireless data transmission, and solar panels, is capable of sending early warning notifications to the monitoring panel and activating sirens when critical thresholds are reached (Figure 4). During the monitoring period, the system successfully issued a warning during one heavy rainfall event, allowing the FPRB to alert residents in the danger zone.

Interviews with the FPRB head indicated an increased sense of security and confidence in facing landslide threats. This achievement complements (Budiana et al., 2023) by

adding a real-time technological dimension to education-based disaster mitigation. The integration of economic productivity technology and disaster mitigation technology represents one of the most distinctive contributions of this program in supporting inclusive and resilient local development.



Figure 3. Training process for making fermented animal feed from Coffee Husk Waste



Figure 4. Installation of solar panels and coffee roasting equipment

3.4. Intensive mentoring and institutional strengthening

After the training and technology application stages, intensive mentoring was carried out on a monthly basis through field visits and online consultations. This phase aimed to ensure the sustainability of the interventions by strengthening the group's ability to operate the technologies, manage business records, optimize marketing, and institutionalize the changes within the organization.

The mentoring process included support for financial report analysis, production planning, optimization of product promotion, strengthening group coordination, and monitoring LEWS performance. Through this process, the "Bangun Semi" Coffee Farmers Group moved from functioning merely as a producer of raw coffee materials to becoming a more organized community-based coffee enterprise that understood the fundamentals of management and market-oriented production. At the same time, FPRB

members became more capable of reading warning data and activating emergency response mechanisms.

This mentoring stage confirms that community empowerment programs require not only one-time training and technology provision, but also sustained accompaniment to ensure that changes become embedded in local practice. The findings support (Respatiningsih et al., 2022; Saptawan et al., 2022), which highlight the importance of combining training, mentoring, and facility support to strengthen the capacities of vulnerable groups and MSMEs.

3.5. Evaluation and community outcomes

To assess the effectiveness of the program, an evaluation was conducted using both quantitative and qualitative approaches. Quantitative data included production records, financial reports, and participant responses, while qualitative data were obtained through interviews, participant observation, and reflective discussion. The evaluation showed that the program had generated significant positive outcomes for the target community.

The overall impact was visible in the increased knowledge, practical skills, and confidence of participants. The community no longer perceived itself merely as a passive victim of geographical vulnerability, but as an active subject capable of managing both local economic potential and disaster risks. The intervention created what may be described as a double dividend: on the one hand, stronger economic independence through higher added value, cost efficiency, and expanded market access; on the other hand, increased resilience through improved disaster preparedness and early warning capacity. Overall, the results and discussion show that an integrative approach combining business management assistance, brand strengthening, the application of appropriate technology for productivity, and mitigation systems has successfully created meaningful transformation in Donorejo Village. This synergy between economic empowerment and disaster resilience constitutes the main distinguishing feature and significant contribution of the program compared to many empowerment initiatives that address these two dimensions separately.

4. Conclusion

This community service program successfully achieved its objectives by improving the business management and marketing capacity of the “Bangun Semi” Coffee Farmers Group, implementing appropriate technology to support production efficiency and disaster preparedness, and developing an integrated empowerment model for villages with local economic potential and natural hazard vulnerability. The results demonstrate that the group experienced substantial progress in managerial and entrepreneurial capacity, as reflected in the use of digital bookkeeping, the strengthening of the Kopi Semi brand, the improvement of packaging and storytelling-based promotion, and the expansion of market access through strategic partnerships. At the same time, the implementation of solar-powered coffee roasting technology significantly increased productivity and efficiency, while the Landslide Early Warning System (LEWS) strengthened the village’s preparedness and response capacity in dealing with landslide threats. In addition, the application of circular economy principles through the use of coffee husk waste as fermented livestock feed contributed to the economic and

environmental sustainability of the intervention. These achievements confirm that an integrated model combining business mentoring, branding, renewable energy-based production technology, circular economy innovation, and disaster mitigation can effectively strengthen resilient local economic independence in disaster-prone rural areas. Therefore, this program not only addressed the immediate needs of the target partners but also produced a replicable empowerment model for other villages with similar characteristics. To ensure long-term sustainability, continued mentoring, stronger multi-stakeholder collaboration, and broader access to formal financing remain essential.

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Author Contribution

Activity implementer: AS, HR, RM, SY, MHS, JMW, YW, SMW, SBA, ADN, TET; Article preparation and revision: AS, HR, RM, SY, MH, JMW.

Conflict of Interest

All authors declare that there are no financial or non-financial conflicts of interest

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