e-ISSN 2581-0405
Asian Journal of Applied Research for Community Development and Empowerment
Journal home page: http://ajarcde-safe-network.org ISSN 2581-0405

Empowerment of the Younger Generation through the Application of Stem Cutting Technology and the Four Pillars of Robusta Coffee Cultivation in Pupuan Village, Tabanan

Yohanes Parlindungan Situmeang[1], I Gede Pasek Mangku[1], Luh Putu Indiani[2], Naori Miyazawa[3]*

[1] *Master of Agricultural Science Program, Postgraduate Faculty, Warmadewa University, Denpasar, Indonesia,*
[2] *Master of Management Science Program, Postgraduate Faculty, Warmadewa University, Denpasar, Indonesia*
[3] *Faculty of Social Sciences, Waseda University, Japan*

ARTICLE INFO

Article History:
Received: 12 June 2026
Final Revision: 30 July 2026
Accepted: 5 July 2026
Online Publication: 7 July 2026

KEYWORDS

community service, Robusta Coffee, Stem Cutting, Four Pillars of Cultivation Technology, PGRs, Pupuan

CORRESPONDING AUTHOR

*E-mail: ypsitumeang63@gmail.com

A B S T R A C T

Robusta coffee productivity in Pupuan Village, Tabanan Regency, has not yet reached its optimal potential. The main obstacle lies in the use of conventional seed-based seedlings, which cause high genetic variability due to the self-incompatible nature of Robusta coffee. To address this, the Community Engagement program focuses on empowering the younger generation by transferring vegetative propagation technology (stem cuttings) and implementing the Four Pillars of Cultivation Technology. This program involved 30 students from SMA Negeri 1 Pupuan as target partners. Quantitative evaluation using pre- and post-test instruments showed significant changes in knowledge, with students' technical understanding scores increasing by 33.87% ($p < 0.001$) after the intervention. As a tangible result, participants demonstrated a deep understanding of the Standard Operating Procedures (SOPs) for stem-cutting propagation, including orthotropic shoot selection, the application of natural Plant Growth Regulators (PGRs) such as shallot extract, and microclimate regulation. To ensure sustainability, a collective Action Plan is needed that engages the younger generation in selecting and implementing this technology. This step is expected to encourage increased coffee plantation productivity in the future while strengthening the regeneration of young farmers.

Contribution to Sustainable Development Goals (SDGs):
SDG 2: Zero Hunger
SDG 12: Responsible Consumption and Production
SDG 13: Climate Action
SDG 15: Life on Land

1. INTRODUCTION

1.1. Research Background

Globally, coffee is one of the most actively traded agricultural commodities, with total global production projected to reach a record 178.8 million bags (60 kg per bag) in the 2025/2026 period [1]. Robusta coffee (*Coffea canephora*) is a critical component of this market, accounting for approximately 47% of the global output. Within this global landscape, Indonesia plays a vital role as the world's third-largest Robusta producer, with a production volume ranging from 9.3 to 11 million bags [1]. Despite this massive national potential and high global demand, productivity at the local smallholder level often remains sub-optimal. In Bali Province, Tabanan Regency stands out as a significant production center with substantial potential [2]. Pupuan Village is a prominent area in Tabanan. However, the local farming community faces systemic challenges, including stagnant yield rates and limited adoption of technology among the younger

demographic, which threaten the long-term sustainability of the regional coffee sector [3].

Furthermore, the long-term sustainability of the coffee sector is severely threatened by a crisis in farmer regeneration. Rural youth are increasingly reluctant to engage in agriculture, often perceiving it as an unprofitable and outdated profession. This lack of youth involvement significantly impedes the transition from conventional farming to modern agribusiness and slows down the adoption of Good Agricultural Practices (GAP) [4]. Addressing this demographic challenge requires empowering the younger generation by transforming traditional farming into a prospective modern agribusiness [5].

From an agronomic perspective, the stagnant productivity of local smallholder plantations is primarily driven by the heavy reliance on conventional seed-based seedlings [6]. Because Robusta coffee is naturally self-incompatible, generative propagation by seed results in high genetic variability and inconsistent yields [7]. Therefore, technological interventions through vegetative propagation, specifically stem cuttings, are critical [8]. This method guarantees that the seedlings possess genetic characteristics identical to the superior mother tree, ensuring uniform harvest quality, accelerating the onset of fruiting, and enabling the mass propagation of adaptive clones such as BP 308 [9]. Beyond the genetic advantages of vegetative propagation, the implementation of the Four Pillars of Cultivation covering proper pruning, shade management, balanced fertilization, and sanitation is essential to remediate the currently prevalent issue of aging and damaged coffee plants [8], [10].

Despite having the second-largest coffee plantation area globally, spanning 1.2 million hectares, Indonesia's national average coffee productivity remains disproportionately low at approximately 625 kg/ha. This systemic national challenge closely mirrors the local reality in Pupuan Village, Tabanan, where smallholder productivity stagnates at only 400–600 kg/ha (averaging 509 kg/ha) [10]. By integrating vegetative techniques with the comprehensive Four Pillars of Robusta Coffee Cultivation Technology comprising (1) Production facilities, (2) Cultivation processes, (3) Post-harvest handling, and (4) Marketing this community empowerment program aims to equip the youth with precise technical competencies to elevate local yields toward the projected target of 800–1,000 kg/ha/year [3].

1.2. Research Objective

This program aims to equip Pupuan Village youth with technical expertise in stem cutting for vegetative propagation. By teaching the "Four Pillars of Robusta Coffee Cultivation," it seeks to modernize traditional farming practices and position agriculture as a viable, technology-driven career for the younger generation.

2. MATERIALS AND METHODS

The Community Engagement activity was held on Friday, June 5, 2026, at SMA Negeri 1 Pupuan, Tabanan Regency, Bali. The primary target beneficiaries of this program were exclusively 30 high school students who served as target partners in this empowerment initiative (Fig. 1). This intervention deliberately targeted the younger generation to address the crisis of farmer regeneration.

A group of 30 high school students from SMA Negeri 1 Pupuan actively participated in the Community Engagement program. This initiative specifically targeted the younger generation to overcome the farmer-regeneration crisis and secure the future of the local coffee agribusiness.

Fig. 1. Participants of the Community Engagement at SMA 1 Pupuan Tabanan.

The demographic profile of the participants is presented in Table 1. The participants consisted of 17 male students (56.7%) and 13 female students (43.3%), enrolled in the 10th and 11th grades (aged 15–17 years). They were selected specifically for their socio-economic background, as most belong to coffee-farming families in Pupuan Village.

Table 1. Demographic characteristics of the participants (n = 30)

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	17	56.7
Female	13	43.3
Education Level		
10th Grade	16	53.3
11th Grade	14	46.7
Age Range		
15 – 17 years old	30	100.0

2.1. Training Implementation and Evaluation Instruments

The educational materials provided to the students consisted of comprehensive printed modules and visual guidelines covering the Four Pillars of Robusta Coffee Cultivation Technology as well as Standard Operating Procedures (SOP) for vegetative propagation using BP 308 clones. The training was organized as an intensive one-day program, beginning with two hours of theoretical counseling and interactive discussions, followed by three hours of hands-on field demonstrations.

As illustrated in Fig. 2, the resource persons delivered presentations and led discussions on the technical aspects of cultivation, post-harvest processing, and modern management of Robusta coffee. This session was designed to align students' perceptions of entrepreneurial opportunities within the coffee agribusiness sector before transitioning to field activities. Subsequently, Fig. 3 depicts the students' enthusiasm during hands-on practice in coffee stem selection and vegetative propagation. This field exercise was intended to bridge the gap between classroom-based agricultural theory and practical operational realities in the plantation setting.

Fig. 2. Academic resource persons from Warmadewa University facilitating theoretical counseling and interactive discussions. The session aligns students' perceptions of modern coffee agribusiness management and the Four Pillars of Cultivation Technology before field practice.

Fig. 3. Practical field demonstration of Robusta coffee vegetative propagation. Students actively practice selecting healthy orthotropic shoots and high-quality scions from certified mother trees to ensure genetic uniformity.

To measure the effectiveness of the knowledge transfer, the program employed pre-test and post-test instruments. The assessment tool was a structured questionnaire comprising 10 technical questions on seed selection, stem-cutting procedures, and garden management. Participants' responses were measured on a 5-point Likert scale and then converted to a 0–100 quantitative scale. The evaluation criteria for the program's success were determined by the absolute percentage shift in students' positive comprehension categories and the statistical significance of the score improvement, analyzed using a paired samples t-test with a significance threshold of $p < 0.05$. The overall workflow of this implementation process, from preparation to evaluation, is systematically depicted in Fig. 4.

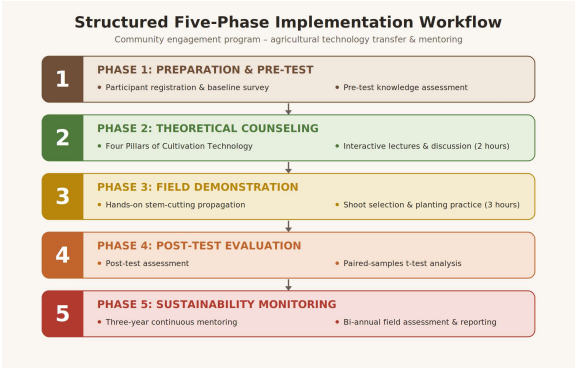

Fig. 4. The workflow diagram depicting the comprehensive implementation process of the community empowerment program, ranging from phase 1 (preparation and pre-test assessment), phase 2 (theoretical counseling), phase 3 (field demonstration of stem cuttings), phase 4 (post-test evaluation), to phase 5 (3-year sustainability monitoring).

2.2. Follow-up Plan and Mentoring (Sustainability Plan)

To guarantee the long-term sustainability of this empowerment program, a structured sustainability framework was established encompassing four key components [11]. First, the mentoring duration is designed for a continuous three-year period, aligning with the projected timeframe required to increase smallholder coffee productivity to the target of 800–1,000 kg/ha/year. During the initial phase, the academic team will closely monitor the development of the seedlings under shade throughout the maintenance period until they meet the criteria for planting in open fields at 4–6 months of age. Second, the monitoring indicators include the survival rate of the stem cuttings and the percentage of students actively applying GAP on their family farms. Third, the follow-up evaluation plan consists of bi-annual field assessments (every six months) conducted by the academic team. This process is supported by the integration of a digital reporting system that allows students to consult on technical obstacles during the independent maintenance phase online. Finally, institutional commitment is solidified through a continuous collaborative partnership involving Warmadewa University, SMA Negeri 1 Pupuan, and local coffee farming cooperatives.

3. RESULT AND DISCUSSION

3.1. Quantitative Evaluation of Knowledge Transfer

The effectiveness of knowledge transfer to participants was quantitatively evaluated using pre-test and post-test instruments administered to 30 students. Descriptive analysis revealed a substantial improvement in their technical comprehension. Prior to the intervention, the pre-test results showed limited understanding of modern coffee agribusiness: 35% of students reported having no knowledge or only some knowledge, 38% were hesitant, and only 27% reported prior understanding. After the intensive hands-on demonstrations and mentoring sessions, the post-test results indicated a remarkable paradigm shift, with 77% of participants reporting that they understand or strongly understand the technical materials.

https://doi.org/10.29165/ajarcde.v10i3.1123

Table 2. Paired Samples T-Test Results of Students' Technical Knowledge (n = 30)

Test Parameter	N	Mean	Standard Deviation (SD)	Statistical Test	p-value
Pre-test	30	57.67	11.91	Paired t-test	< 0.001
Post-test	30	77.20	15.88		

Based on the paired-samples t-test (Table 2), this intervention program resulted in a statistically significant increase in technical understanding ($p < 0.001$). The average comprehension score of the participants significantly increased from 57.67 (SD = 11.91) before the training to 77.20 (SD = 15.88) after participating in the educational sessions and field practice demonstrations. This reflects a 33.87% increase in capacity, providing robust empirical evidence that the intensive mentoring method was highly effective at transferring practical skills in vegetative cultivation to the younger generation [12]. This substantial gain in competency underscores the critical role of hands-on technical training in overcoming initial barriers to agricultural modernization, mirroring successful educational outcomes observed in similar community-based agricultural development initiatives [13], [14]. Furthermore, the shift from traditional practices to Good Agricultural Practices is essential for enhancing institutional capacity and securing the long-term viability of the coffee value chain [15]. These results corroborate findings that structured technical training, combined with active field engagement, is instrumental in elevating both agribusiness knowledge and practical skills among participants [16]. This positive trajectory in student achievement highlights the vital synergy between vocational education frameworks and agricultural outreach [17], laying the foundation for enhanced professional competency among emerging farmers [18].

3.2. Transformation of Understanding through the Four Pillars of Coffee Cultivation

The transformation of the participants' understanding was achieved through the comprehensive implementation of the Four Pillars of Robusta Coffee Cultivation Technology.

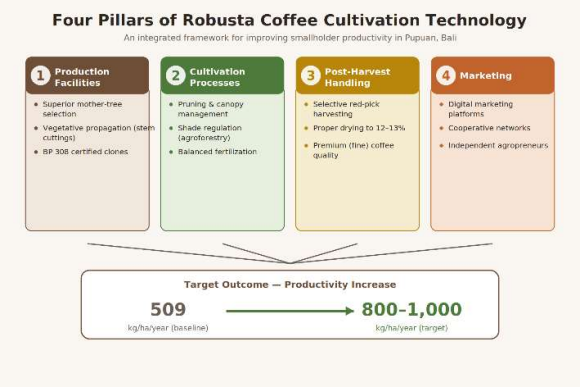

Fig. 5. Conceptual framework of the Four Pillars of Robusta Coffee Cultivation Technology, illustrating the systematic integration of production facilities (seedling propagation), cultivation processes (nutrient and shade management), post-harvest handling (red-picking and drying), and marketing (digitalization and cooperatives) to achieve optimal productivity.

As illustrated in Fig. 5, this conceptual framework integrates production facilities, cultivation processes, post-harvest handling, and marketing into a cohesive strategy. During the field practice, these four conceptual pillars were translated into specific technical activities:

The First Pillar (Production Facilities): Focused on securing high-quality seedlings through the selection of superior mother trees and effective vegetative propagation [19]. Participants followed standard procedures, selecting healthy 5–6 month-old orthotropic shoots and preparing 6–8 cm cuttings with a 45-degree angle [20]. To promote rooting, natural plant growth regulators such as young coconut water, shallot extract, and bovine urine were applied through a 1–2-hour soaking process, providing an eco-friendly alternative to synthetic hormones [21], [22]. The cuttings were then planted in a porous mixture of topsoil, cocopeat, and manure. To prevent physiological stress, students maintained 90–96% humidity using plastic covers (sungkup) under 30–50% paranet shading [23]. The propagation process is shown in Fig. 6. This systematic approach to seedling production effectively bridges the gap between theoretical agronomy and real-world agricultural applications, ensuring that students can relate laboratory practices to professional cultivation standards [24].

Fig. 6. The step-by-step procedure of Robusta coffee propagation through stem cuttings, demonstrating the 45-degree angle cut, the application of natural Plant Growth Regulators (shallot extract), planting in a 2:1:1 media ratio, and the installation of plastic covers (sungkup) to maintain 90–96% microclimate humidity.

The Second Pillar (Cultivation Processes): Involved the optimization of nutrient management and vegetative maintenance. The students learned the importance of pruning, shade tree regulation (agroforestry), and balanced fertilization to maintain soil health [25], [26]. This initiative may contribute to enhancing the resilience of coffee production systems against climate variability [27].

The Third Pillar (Post-harvest Handling): Emphasized the standardization of red-pick harvesting and proper drying procedures to produce premium quality (fine coffee) [28]. The

participants were educated to abandon "gleaning" (picking fallen fruit) practices to ensure the highest market value.

The Fourth Pillar (Marketing): Implemented by introducing digital marketing strategies and strengthening cooperative networks [30]. Participants were also introduced to financial literacy and digital branding tools such as the Business Model Canvas and QR codes to standardize product identity and broaden market access [29]. The students were trained to utilize digital platforms to shorten distribution channels, empowering them to become independent modern coffee agropreneurs [31], [32]. These efforts to modernize agricultural practices ultimately aim to increase production efficiency and foster a sustainable agribusiness ecosystem that creates higher added value for the younger generation [31].

3.3. Distinguishing Actual Achievements and Projected Future Impacts

To provide a rigorous evaluation of this community empowerment program, it is essential to distinguish between the actual results achieved during the intervention and the projected long-term impacts. Actual Achievements: The immediate, verifiable outcome of this program is the successful technology transfer and capacity building of 30 high school students [33]. As demonstrated by the paired t-test analysis, participants experienced a statistically significant 33.87% increase in their technical understanding of modern coffee cultivation. Furthermore, the participants successfully demonstrated the practical ability to independently perform vegetative propagation using stem cuttings according to standard procedures [34].

Projected Future Impacts: The projected increase in Robusta coffee productivity, from 509 kg/ha to 800–1,000 kg/ha, is grounded in the shift to superior clones and the Four Pillars of Cultivation Technology, though immediate verification is pending due to the short training duration. To realize this goal, the program established a three-stage action plan: first, planting polyclonal seedlings, balanced fertilization, and selective harvesting; second, developing collective drying facilities and cooperatives; and third, pursuing export independence, agro-tourism, and youth regeneration. Supported by a three-year mentoring plan, this initiative builds a strong foundation for reaching these targets [35]. By utilizing autonomous farmer groups as local knowledge hubs, the program mirrors successful participatory models [12] and underscores that agricultural competitiveness requires both technical proficiency and long-term institutional capacity building [36], [37].

4. CONCLUSION

The Community Engagement Program successfully achieved its stated goal of transferring agricultural technology innovations to 30 students at SMA Negeri 1 Pupuan. This achievement was demonstrated by a statistically significant 33.87% increase in technical knowledge scores ($p < 0.001$) and participants' understanding of vegetative propagation through stem cuttings. Participants successfully mastered practical skills, including orthotropic shoot selection, 45-degree cutting, application of natural plant growth regulators (shallot extract and coconut water), preparation of an ideal growing medium at a 2:1:1 ratio, and microclimate control using plastic covers. Furthermore, they comprehensively adopted the Four Pillars of Robusta Coffee Cultivation Technology covering production facilities, cultivation processes, post-harvest handling, and marketing. The immediate result of this activity was increased technical capacity of the participants. At the same time, the long-term impact contributed to the sustainability of farming businesses, increased productivity of small-scale coffee plantations, and provided a solution to the regeneration crisis among young farmers.

Acknowledgements

We would like to thank the principal, teachers, and 30 students of SMA Negeri 1 Pupuan for their enthusiasm and active participation in the theory sessions and field demonstrations. Their collective support is crucial to ensuring effective technology transfer, increasing long-term productivity, and fostering an entrepreneurial spirit among local youth and coffee-farming communities in Bali.

REFERENCES

[1] "Coffee world markets and trade," USDA Cornell University Library, Nov. 2025. [Online]. Available: https://usda.library.cornell.edu/concern/publications/m900nt40f?locale=en

[2] N. P. D. P. Maharani, I. G. N. A. Aviantara, and I. P. S. Wirawan, "Analisis prioritas sarana pacapanen kopi robusta (*Coffea canephora*) untuk menurunkan susut kuantitas dengan menggunakan metode AHP (Analytical Hierarchy Process)," *Jurnal BETA (Biosistem dan Teknik Pertanian)*, vol. 12, no. 1, p. 180, Jan. 2024, doi: 10.24843/jbeta.2024.v12.i01.p20.

[3] P. W. Titisari *et al.*, "Bimbingan teknis dan pendampingan budidaya kopi robusta berbasis agroforestri pada kelompok petani muda Desa Ludai, Riau," *Jurnal Pengabdian Pada Masyarakat*, vol. 9, no. 2, pp. 320–327, May 2024, doi: 10.30596/jppm.v9i2.654.

[4] A. Wakhid and L. P. Suciati, "Penerapan dan faktor-faktor yang mempengaruhi Good Agriculture Practices (GAP) usahatani kopi rakyat di lereng Argopuro Kabupaten Jember," *JSEP (Journal of Social and Agricultural Economics)*, vol. 13, no. 2, p. 159, Jul. 2020, doi: 10.19184/jsep.v13i2.16140.

[5] A. Pujiati *et al.*, "Penguatan agribisnis berkelanjutan komoditas durian dan kopi melalui teknologi budidaya di Desa Brongkol, Kabupaten Semarang," *Abdimas Dewantara*, vol. 8, no. 1, pp. 1–12, Jan. 2025, doi: 10.30738/ad.v8i1.18168.

[6] Y. Oktavia, A. Ishak, and A. Afrizon, "Efektivitas pelatihan teknologi penyambungan kopi terhadap peningkatan keterampilan petani (Kasus pada Kelompok Tani Paksi Jaya, Desa Tanjung Beringin, Kecamatan Curup Timur, Kabupaten Rejang Lebong)," *Buletin Agro-Teknologi*, vol. 1, no. 2, pp. 78–84, Nov. 2020. [Online]. Available: https://ejurnal.litbang.pertanian.go.id/index.php/bulagritek/article/download/12535/9585

[7] E. Kartika, "Tingkat keberhasilan sambungan dan pertumbuhan bibit kopi robusta (*Coffea robusta* L.) hasil grafting pada pemberian berbagai jenis mikoriza dan ketinggian batang bawah," *Biospecies*, vol. 12, no. 2, pp. 9–19, Sep. 2019, doi: 10.22437/biospecies.v12i2.6185.

[8] I. W. Sunanjaya, N. M. D. Resiani, and I. M. R. Yasa, "The utilization of coffee waste in supporting family food security," *E3S Web of Conferences*, vol. 306, p. 1025, Jan. 2021, doi: 10.1051/e3sconf/202130601025.

[9] E. Silamat, H. Siregar, R. Pambudy, and H. Harianto, "Adopsi teknologi sambung pucuk pada kopi rakyat berdasarkan faktor internal dan ekternal petani lokal di Provinsi Bengkulu," *Jurnal Penelitian Pendidikan IPA*, vol. 9, no. 11, pp. 10203–10211, Nov. 2023, doi: 10.29303/jppipa.v9i11.5677.

[10] N. M. D. Resiani, I. W. Sunanjaya, and N. Sugama, "Utilization of plant waste as a seed source to anticipate agriculture global environmental challenges and increase robusta coffee farmers' income," *E3S Web of Conferences*, vol. 444, p. 3005, Jan. 2023, doi: 10.1051/e3sconf/202344403005.

[11] S. Sundari, T. Kustiari, D. Agustinus, A. A. Kusuma, and W. Dhamayanthi, "Pendampingan pembuatan kebun pembibitan kopi bercita rasa unggul pada Kelompok Usaha Bersama Arum Sukmo Jember," *Jurnal Abdimas Sang Buana*, vol. 5, no. 1, pp. 25–34, May 2024, doi: 10.32897/abdimasusb.v5i1.3577.

[12] P. Ansiska, R. Fernandez, E. H. Windari, and G. Latuserimala, "Optimization of coffee hatchery in Sumber Rejo Village, Rejang Lebong District in Improving Productivity through Participatory Training," *Jurnal Pengabdian kepada Masyarakat Arumbai*, vol. 2, no. 2, pp. 195–203, Nov. 2024, doi: 10.30598/arumbai.vol2.iss2.pp195-203.

[13] L. Suriati *et al.*, "Accelerating the development of Arabica coffee production and processing to encourage business and economic improvement of the Kintamani Bali community," *AJARCDE (Asian Journal of Applied Research for Community Development and Empowerment)*, vol. 9, no. 1, pp. 195–199, Mar. 2025, doi: 10.29165/ajarcde.v9i1.633.

[14] A. Kharis, A. Abrori, and D. A. P. Listyanti, "Efektivitas pemberdayaan Kelompok Tani Subur Makmur oleh Lembaga Pengembangan Teknologi Pedesaan (LPTP) di Desa Mriyan Kabupaten Boyolali," *WELFARE Jurnal Ilmu Kesejahteraan Sosial*, vol. 11, no. 2, Dec. 2022, doi: 10.14421/welfare.2022.112-03.

[15] S. Sundari, A. A. K. Mawardi, and B. Irawan, "Penguatan fungsi kelembagaan dan adopsi teknologi tepat guna pada wirausaha tani kopi di Desa Panduman Kabupaten Jember," *Sejagat*, vol. 2, no. 1, pp. 42–50, Jun. 2025, doi: 10.25047/sejagat.v2i1.6092.

[16] K. Sumarwono, S. Sukardi, and S. Soenarto, "The effectiveness of agrobusiness technical training and education model for the field agricultural extension officers," *Jurnal Pendidikan Vokasi*, vol. 7, no. 2, p. 214, Jul. 2017, doi: 10.21831/jpv.v7i2.13937.

[17] L. Colis and C. J. Domingo, "From bean to cup: Assessing the effectiveness of a coffee processing module," *Journal of Interdisciplinary Perspectives*, vol. 3, no. 8, Jan. 2025, doi: 10.69569/jip.2025.405.

[18] M. Cahayani *et al.*, "Dari biji ke cita rasa: Pelatihan brewing dan cupping untuk pemberdayaan petani kopi Desa Bayan Kabupaten Lombok Utara," *Jurnal Pengabdian UNDIKMA*, vol. 7, no. 1, pp. 251–260, Feb. 2026, doi: 10.33394/jpu.v7i1.18433.

[19] R. Apriantonedi, E. Fransisko, D. Effendi, R. Fernandes, and P. Parwito, "Pemberdayaan Kelompok Tani Jaya Bersama melalui inovasi pembibitan kopi dengan ekstrak bawang merah dan metode setek," *Jurnal Pengabdian*, vol. 3, no. 1, pp. 29–34, Jan. 2024, doi: 10.58222/jp.v3i1.789.

[20] L. G. K. Dewi and U. Joka, "Analisis pengelolaan penjualan penyambung (entres) kopi berdasarkan penerapan social oriented, kebun induk kopi robusta, Desa Sai, Kecamatan Pupuan," *AGRIMOR*, vol. 5, no. 2, pp. 28–31, Apr. 2020, doi: 10.32938/ag.v5i2.1011.

[21] M. Mariana, A. H. H. Basri, W. Manullang, R. T. Harahap, and A. Novita, "Optimalisasi Zat Pengatur Tumbuh (ZPT) alami dan bahan setek pada pertumbuhan vegetatif setek kopi robusta," *AGRIUM Jurnal Ilmu Pertanian*, vol. 26, no. 1, Apr. 2023, doi: 10.30596/agrium.v26i1.13730.

[22] E. Emilda, "Potensi bahan-bahan hayati sebagai sumber Zat Pengatur Tumbuh (ZPT) alami," *Jurnal Agroristek*, vol. 3, no. 2, pp. 64–72, Aug. 2020, doi: 10.47647/jar.v3i2.261.

[23] B. H. Simanjuntak and R. D. P, "Penggunaan Indole-3-Butyric Acid (IBA) untuk meningkatkan pertumbuhan stek batang kopi robusta," *Agrin*, vol. 24, no. 2, p. 111, Mar. 2021, doi: 10.20884/1.agrin.2020.24.2.505.

[24] M. A. Á. Lara, N. A. B. C. Gil, and G. León, "Educational project as a biological-agricultural model for the teaching of agronomy at the Universidad Veracruzana in Orizaba-Córdoba Región," *Journal of Higher Education Theory and Practice*, vol. 21, no. 15, Dec. 2021, doi: 10.33423/jhetp.v21i15.4901.

[25] N. W. Suniti, W. Windia, N. L. R. Purnawan, and I. A. Arthayani, "Pengembangan hutan adat Tarupramana di Desa Batubulan Kecamatan Sukawati Kabupaten Gianyar," *Buletin Udayana Mengabdi*, vol. 17, no. 1, p. 61, Jan. 2018, doi: 10.24843/bum.2018.v17.i01.p10.

[26] I. Fardiansyah and K. P. Wicaksono, "Respon pertumbuhan dan produksi tanaman kopi (*Coffea arabica*) pada tingkat manajemen budidaya yang berbeda dalam sistem agroforestri," *Jurnal Produksi Tanaman*, vol. 7, no. 11, Feb. 2019, doi: 10.21176/protan.v7i11.1272.

[27] D. Anesa, R. Qurniati, Y. R. Fitriana, and I. S. Banuwa, "Budaya dan kearifan lokal dalam pengelolaan lahan dengan pola agroforestri di Kesatuan Pengelolaan Hutan Lindung Batutegi Provinsi Lampung," *Jurnal Ilmiah Kehutanan Rimba Kalimantan/ULIN: Jurnal Hutan Tropis*, vol. 6, no. 1, p. 26, Feb. 2022, doi: 10.32522/ujht.v6i1.5840.

[28] H. R. Ratnaningsih *et al.*, "Peningkatan kualitas kopi melalui teknologi pascapanen Kelompok Tani Mekar Sari, di Desa Kemawi, Kecamatan Somagede, Kabupaten Banyumas," *Jurnal Abdi Insani*, vol. 12, no. 10, pp. 5467–5477, Oct. 2025, doi: 10.29303/abdiinsani.v12i10.3021.

[29] W. B. Sunarharum, "Capacity building for Poncokusumo farmers and Malang Raya coffee enthusiasts toward quality standardization," *Journal of Innovation and Applied Technology*, vol. 11, no. 2, pp. 111–121, Dec. 2025, doi: 10.21776/ub.jiat.2025.011.02.16.

[30] D. A. Oktaviani, N. Lidyana, T. B. Pratama, and R. Sulistiyowati, "Peningkatan produktivitas dan nilai tambah melalui perbaikan teknik budidaya, pengolahan, dan pemasaran digital kopi di Desa Sumberduren," *Lumbung Inovasi: Jurnal Pengabdian kepada Masyarakat*, vol. 10, no. 4, pp. 1274–1282, Dec. 2025, doi: 10.36312/h3b9kr05.

[31] J. F. H. Saragi, S. Siahaan, F. T. H. Sinaga, A. A. S. Marbun, and R. H. Putra, "Technological and digital transformation for sustainable coffee farming in rural North Sumatra," *Jurnal Pengabdian Masyarakat Bestari*, vol. 4, no. 10, pp. 789–796, Nov. 2025, doi: 10.55927/jpmb.v4i10.457.

[32] M. Debra, H. Wulanningrum, Muhsoni, A. Suranto, A. N. Furoida, and I. Susilowati, "Rantai nilai kopi robusta pada Kelompok Tani Ngudi Rahayu XI Desa Kebondalem, Kecamatan Jambu, Kabupaten Semarang," *JURNAL AGRICA*, vol. 18, no. 2, Oct. 2025, doi: 10.31289/agrica.v18i2.15364.

[33] A. E. Jayati, R. T. Nalarsih, and P. Muliandhi, "Empowering farmers through the implementation of smart automatic agriculture spray," *Community Empowerment*, 2025, doi: 10.31603/ce.14740.

[34] P. Habibah *et al.*, "Budidaya tumpang sari kopi liberika di kebun sawit Desa Temiang, Kecamatan Bukit Batu, Kabupaten Bengkalis," *Jurnal Aplikasi Sains dan Teknologi Agrisevika*, vol. 2, no. 2, pp. 65–72, Dec. 2025, doi: 10.33005/agrisevika.v2i2.34.

[35] R. Fernandez, S. Wulandari, R. S. Utami, and P. Ansiska, "Recommendations for the development of coffee plantations in Rejang Lebong Regency to improve the quality and quantity of production results," *International Journal of Sustainable Social Science (IJSSS)*, vol. 2, no. 2, pp. 105–118, Apr. 2024, doi: 10.59890/ijsss.v2i2.1630.

[36] H. M. P. Simarmata, H. D. Pardede, D. Y. Saragih, F. Togatorop, and D. N. Banjarnahor, "Empowering rural communities through coffee bean processing training for competitive value creation in Motung Village, Toba Regency," *ARDHI: Jurnal Pengabdian Dalam Negeri*, vol. 3, no. 4, pp. 124–132, Aug. 2025, doi: 10.61132/ardhi.v3i4.1417.

[37] H. Novitasari, P. Handoyo, and R. D. Mulyaningtiyas, "Pengembangan rantai nilai kopi lokal Kabupaten Magetan melalui intervensi budidaya, teknologi, dan manajemen keuangan," *DIKEMAS (Jurnal Pengabdian Kepada Masyarakat)*, vol. 9, no. 2, Oct. 2025, doi: 10.32486/dikemas.v9i2.962.