

Bridging Community Carbon Benefits and Village Revenue: Institutional Governance of Agroforestry-Based Carbon Credits in West Java, Indonesia

Sumarlan^{1*}, Meilinda Suriani Harefa^{2,3} , Amal H Aljaddani⁴ 

¹Ministry of Villages and Development of Disadvantaged Regions, Indonesia

²Department of Geography Education, Faculty of Social Science, Universitas Negeri Medan, Indonesia

³Yayasan Konservasi Pesisir Indonesia, Sumatera Utara, Indonesia

⁴Department of Physical Sciences Geography Information System Program, College of Science, University of Jeddah, Jeddah 21589, Saudi Arabia

ARTICLE INFO

Article History:

Received: June 15, 2026

Revision: August 19, 2026

Accepted: August 20, 2026

Keywords:

Carbon Governance;

Rural Institutions;

Community-Based Carbon Markets;

Agroforestry;

Village Economy.

Corresponding Author

E-mail: marlanirjen2@gmail.com

ABSTRACT

Agroforestry-based carbon credit development offers opportunities to combine climate change mitigation with rural economic development. However, existing studies have mainly examined carbon trading regulations, carbon sequestration valuation, and agroforestry productivity, leaving limited understanding of how carbon credit initiatives are implemented institutionally at the village level and connected to Village Original Income (PADes). This study examines village readiness, institutional governance, and community empowerment in agroforestry-based carbon credit development, particularly their role in connecting community economic benefits with village revenue systems. A qualitative descriptive approach was employed in five regencies in West Java Province. Data were collected through field observations, interviews with village governments, farmer groups, cooperatives, facilitators, and community members, discussions, and documentary studies. Outreach and technical training were treated as community capacity-building activities. Data were analyzed through data reduction, data presentation, interpretation, and conclusion drawing. The findings show that village readiness is supported by land availability, community literacy, technical capacity, and local institutions. However, community-level economic benefits from agroforestry-based carbon credit activities do not automatically translate into formal village revenue. Most benefits remain managed by farmer groups and cooperatives, while Village-Owned Enterprises (Bumdesa) and village regulatory mechanisms remain limited. This institutional gap constrains the connection between community carbon benefits and PAdes. The study contributes to carbon and rural institutional governance literature by demonstrating that the potential economic benefits of village-based carbon credits depend not only on land and community capacity but also on institutional arrangements that connect community benefits with formal village revenue systems.

copyright © by the author. This article is an open access article distributed under the term and conditions of the Creative Commons Attribution

<https://creativecommons.org/licenses/by/4.0/>

INTRODUCTION

Village status in national development is determined by the Village Index, as stipulated in Ministerial Regulation Number

9 of 2024 and several previous regulations, including Ministerial Regulation Number 2 of 2016, Ministerial Regulation Number 21 of 2020, and Minister of Finance Regulation

Number 146 of 2023 concerning High-Achieving Independent Villages. Villages are then classified into five categories: independent, advanced, developing, underdeveloped, and very underdeveloped (Lindawaty, 2023). This status determination concerns various aspects of village life, particularly based on the community's economic resilience and the village government's ability to sustainably manage its revenue sources. Village Original Income (PA Desa) is one of the metrics that continues to be monitored because it is related to development financing, community services, and empowerment activities at the village level (Hasan & Tanesab, 2021).

Law Number 6 of 2014 grants villages the authority to manage their resources in accordance with the characteristics of their respective regions. Village income can be obtained through village assets, business results, community self-reliance, natural resource management, collaboration, and grants (Novatiani et al., 2023; Pamungkas et al., 2022). In many rural areas, natural resources remain the primary pillars of community life. Agricultural land, community forest areas, water sources, and agroforestry systems have long been part of villagers' daily economic activities (Ardilah et al., 2023). Management of these resources is also related to environmental sustainability, as some communities still depend directly on the natural conditions around them (Sumaila et al., 2022).

Climate change has brought renewed attention to efforts to reduce carbon emissions through various green economy instruments (Adamowicz, 2022; Fu et al., 2024). One policy that has emerged in recent years is carbon trading, or carbon credits (Yu et al., 2022). The Indonesian government reinforced this policy direction through Presidential Regulation Number 98 of 2021 concerning the Implementation of Carbon Economic Value. The carbon trading scheme creates opportunities for villages to use green areas, agricultural land, and agroforestry systems for carbon sequestration. Tree planting, land rehabilitation, soil conservation, and community forest management are

increasingly being linked to the economic value of carbon, which holds significant future prospects (Wiati et al., 2022).

The implementation of carbon credits in villages still faces various challenges. Most communities are unfamiliar with carbon trading mechanisms, certification processes, or the long-term cooperation systems typically implemented in carbon programs (Tarigan et al., 2025). Another problem arises from the limited and dispersed nature of land ownership, particularly on the island of Java. This situation necessitates land aggregation to meet the minimum area requirements of carbon trading schemes. Issues in land administration, village institutions, the distribution of economic benefits, and the existence of village regulations also influence program implementation at the community level (Amin et al., 2024).

Agroforestry management is a relatively familiar approach to village life because it has long been applied in daily agricultural activities (Fikry & Sarjan, 2024). Crops such as coffee, avocado, cinnamon, suren, and eucalyptus are selected based on community experience with soil conditions, climate, and family economic needs. In some areas, main crops are combined with intercropping, livestock farming, and organic fertilizer processing to ensure community income remains stable during the growing season (Yusuf & Astiko, 2025). On the other hand, the implementation of carbon trading in villages still faces institutional challenges, primarily due to the limited involvement of village-owned enterprises (Bumdesa) and the existence of village regulations governing carbon credits, resulting in limited economic benefits linked to Village Original Income (Fenetiruma & Priyanto, 2025).

Several previous studies have explored carbon trading. Prihatiningtyas et al. (2023) Discussed the fairness aspect of carbon trading policy in Indonesia following the issuance of Presidential Regulation No. 98 of 2021. Farhan et al. (2025) reviewed the effectiveness of carbon trading regulations in supporting Indonesia's Nationally Determined Contributions (NDC) targets

and the challenges of their implementation in the regions. Another study [Siagian et al. \(2024\)](#) examined the economic valuation of carbon sequestration in agroforestry systems and the economic potential of social forestry management.

These studies focused primarily on carbon trading regulations, the economic valuation of carbon, and the technical aspects of land management. However, village readiness to implement carbon credits through strengthening local institutions, community land aggregation, the role of Village-Owned Enterprises (Bumdesa), and community empowerment patterns has yet to be comprehensively addressed. Yet, issues at the village level are often related to social relations, land ownership patterns, and the village government's ability to manage long-term partnerships. Based on these conditions, this study aims to examine the implementation of carbon credits in villages through an institutional approach and agroforestry management, and to identify opportunities to strengthen Village Original Income and the economic sustainability of rural communities.

RESEARCH METHODS

This study employed a qualitative multiple-case study design to examine the development of agroforestry-based carbon

credit initiatives across five regencies in West Java, Indonesia. The multiple-case design was selected because the study involved village aspects with different land conditions, institutional arrangements, community capacities, and stages of carbon-credit development. This design enabled cross-case comparison to identify common patterns and institutional differences in village readiness, institutional governance, community empowerment, and the potential integration of carbon-related economic benefits with Village Original Income (PADes).

The study focused on carbon-credit development and village readiness rather than the evaluation of a completed carbon-credit trading cycle. At the time of the study, the activities examined included agroforestry development, land aggregation, carbon measurement, community capacity building, and preparation for carbon-market participation. The study did not assess verified carbon-credit issuance or completed carbon-credit transactions where these had not yet occurred.

Research Location and Case Selection

The study was conducted in West Java Province, Indonesia, focusing on five regencies: Bandung, West Bandung, Garut, Cirebon, and Tasikmalaya (Figure 1).

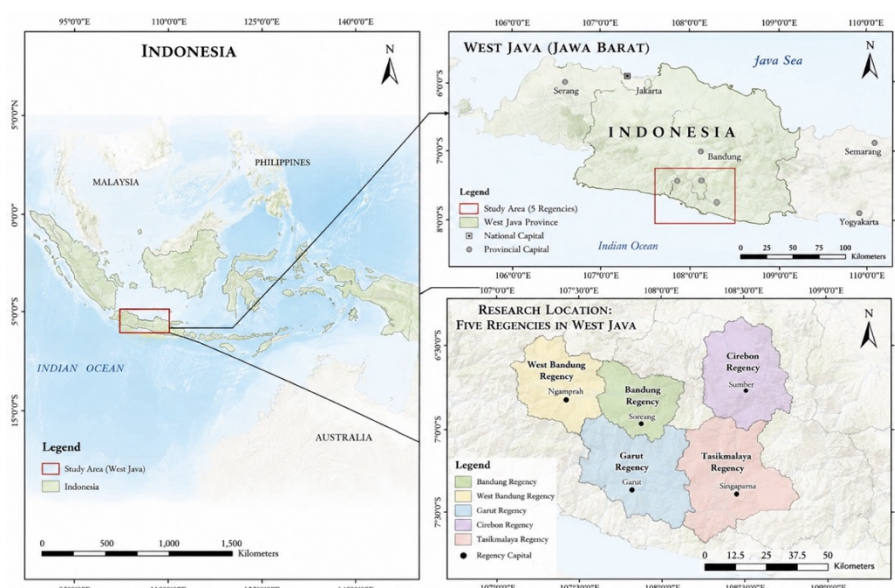


Figure 1. Map of Research Location (Source: Data Processing, 2026)

The five regencies constituted the geographical scope of the multiple-case study, while village-level agroforestry-based carbon-credit initiatives served as the primary units of analysis. Cases were selected purposively to capture variation in land conditions, institutional capacity, community participation, and stages of carbon-credit development. The selection was intended to support analytical cross-case comparison rather than statistical representation.

Case selection was based on four criteria:

- 1) the availability of land suitable for agroforestry and land rehabilitation;
- 2) the presence of active farmer groups, cooperatives, or other local institutions;
- 3) the existence of mixed-cropping or agroforestry practices; and
- 4) involvement in environmental conservation, carbon-project preparation, or activities related to carbon-market participation.

Within each selected case, informants were purposively selected based on their direct knowledge of and involvement in agroforestry-based carbon-credit development, including land management, institutional coordination, community empowerment, and village economic activities. The informants included village government representatives, farmer group and cooperative representatives, community members, and other actors involved in carbon project development and local institutional arrangements. Particular attention was given to farmer groups and cooperatives because they served as important local intermediaries in land management, cooperation arrangements, and coordination with external partners. Bumdesa was also considered in the analysis because its limited involvement emerged as an important institutional issue affecting the connection between community-level economic benefits and Village Original Income (PADes).

Unit of Analysis

The primary unit of analysis was the village-level agroforestry-based carbon-

credit initiative, encompassing land management, institutional arrangements, community participation, carbon-project preparation, and mechanisms for linking economic benefits to village revenue. Farmer groups, cooperatives, Bumdesa, village governments, facilitators, and community members were treated as relevant actors and sources of information rather than as separate units of analysis.

Data Collection Techniques

Data collection was conducted through several stages, namely:

- a) Field observations were conducted to examine land conditions, agroforestry practices, demonstration plots, institutional activities, and community-based economic activities.
- b) Semi-structured interviews were conducted with village officials, farmer group representatives, cooperative representatives, Bumdesa representatives, facilitators, and community members directly involved in agroforestry and carbon credit development.
- c) Group discussions were used to explore collective perspectives on understanding of the carbon market, land aggregation, cooperation arrangements, community participation, and perceived economic benefits. Unlike individual interviews, discussions were used to identify shared views, disagreements, and collective experiences among community members and farmer groups.
- d) Documentary data included village profiles, cooperation documents, land-related records, activity reports, relevant regulations, training records, and other documents related to agroforestry and carbon-credit development.

Outreach, environmental education, and technical training were conducted as community capacity-building activities rather than as primary data-collection techniques. Information obtained during these activities was used only as contextual evidence and was cross-checked with interview, observation, and documentary

findings. Participation was voluntary, and participants were informed about the purpose of the research and how their information would be used. Informed consent was obtained before interviews and discussions, and participants' identities were kept confidential in reporting the findings.

Data Analysis Techniques

Data were analyzed using thematic and cross-case qualitative analysis. The analysis proceeded through four stages.

- a) Data organization and coding. Interview transcripts, discussion records, field notes, and documentary materials were organized and coded according to the analytical framework. Initial codes included land readiness, social readiness, technical capacity, institutional readiness, regulatory readiness, economic integration, benefit-sharing, and PADes linkage.
- b) Category and theme development. Related codes were grouped into broader categories and themes representing village readiness, institutional governance, community empowerment, carbon-credit development, and economic integration.
- c) Cross-case comparison and interpretation. Themes were compared across the five regencies to identify recurring patterns, institutional differences, and case-specific conditions. The analysis examined how differences in land conditions, institutional arrangements, community capacity, and regulatory support shaped the development of agroforestry-based carbon-credit initiatives and their potential connection to village revenue.
- d) Triangulation and conclusion development. Findings from interviews, group discussions, field observations, and documentary sources were compared to identify consistent evidence and investigate discrepancies. The interpretation of key findings was also discussed among the research team to reduce individual interpretive bias. Information sufficiency was assessed when additional data no longer

generated substantially new themes relevant to the research focus.

PADes was treated as an institutional and potential economic outcome rather than a quantitatively measured impact. The analysis examined whether and how economic benefits generated through agroforestry and carbon-credit development were connected to formal village revenue mechanisms. Because the study lacked comparable pre- and post-program PADes data or verified carbon-related revenue figures, it does not claim that carbon-credit development empirically increased PADes.

Analytical Framework

The analytical framework was developed to examine how village readiness, institutional governance, and community empowerment shape the development of agroforestry-based carbon credit initiatives and their potential connection to Village Original Income (PADes). As presented in Figure 2, village readiness comprises land availability and security, community literacy and awareness, technical capacity and training, institutional presence, and regulatory support. Institutional governance covers the roles and collaboration of farmer groups, cooperatives, Village-Owned Enterprises (Bumdesa), village governments, and facilitators, as well as land aggregation, collective action, contractual arrangements, benefit-sharing mechanisms, and village-level regulations. Community empowerment is examined through skills development, agroforestry-based enterprises, market access, business development, job creation, and livelihood diversification.

These dimensions are analyzed in relation to agroforestry-based carbon credit development and its economic, institutional, and environmental outcomes. Government policies, market conditions, institutional coordination, and land-tenure security are considered contextual factors that may influence these relationships. The framework guides the formulation of interview questions, field observations, documentary analysis, and cross-case comparison (Figure 2).

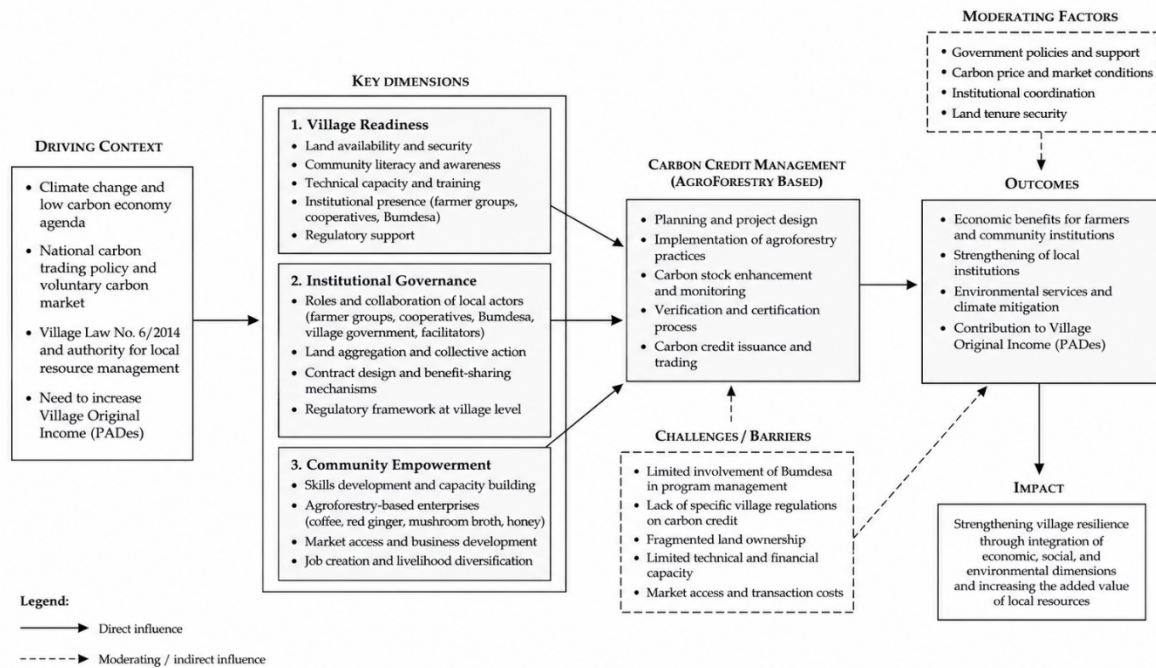


Figure 2. Analytical framework of agroforestry-based carbon credit development at the village level (Source: Data Processing, 2026)

RESULTS AND DISCUSSION

Village Readiness for Agroforestry-Based Carbon Credit Implementation

Implementing carbon credits at the village level requires readiness across social, institutional, and land-resource aspects. Program success is shaped by both an area's carbon sequestration potential and the community's and village government's ability to meet the prerequisites for a sustainable carbon trading scheme.

At the research sites in West Java, this readiness is reflected in village assets such as community-owned land, tanah bengkok, village forest areas, customary forests, and social forestry areas with potential for agroforestry development. These assets provide initial capital that can be converted into carbon-based economic value and support the long-term strengthening of village income sources. Building on this asset base, readiness is examined here across four dimensions embedded in the study's analytical framework: community literacy, land availability and security, management institutions, and regulatory support.

a) Community literacy regarding carbon trading, particularly its benefits,

cooperation mechanisms, and the rights and obligations of the parties involved.

b) Land availability and security, evidenced by land ownership certificates, Letter Cs, girik, village tanah bengkok, and legal documents for social forestry areas.

c) The existence of management institutions, farmer groups, cooperatives, or Bumdesa that serve as implementers of activities and liaisons with investors.

d) Support from village regulations governing natural resource use, environmental protection, and benefit-sharing mechanisms from carbon trading.

Building this readiness began with environmental education and outreach, carried out across 14 districts in West Java and involving village governments, farmer groups, youth organizations, and women's groups. Sessions introduced the concepts of carbon trading, certification mechanisms, agroforestry land management, management institutions, and the economic opportunities available to communities. Material on long-term cooperation contracts was delivered separately, since most programs run for 15 to 20 years, to reduce the potential for conflict during

implementation. Participants, particularly younger residents, actively engaged with content on the roles of trees in carbon sequestration, soil and water quality, erosion control, and climate resilience, as well as tree-planting activities and environmental

campaigns. General outreach reached approximately 420 people across the 14 districts, while more focused environmental education in Drawati and Nagreg Villages involved 70 participants, as detailed in Table 1.

Table 1. Implementation of Carbon Credit Environmental Education and Socialization in West Java

Activity	Location	Participants
Carbon credit and agroforestry outreach	14 districts in West Java	±420 people
Agroforestry-based environmental education	Drawati Village and Nagreg Village	70 people

(Source: Research Results, 2025)

Following this outreach phase, community capacity building continued through technical training directly tied to carbon-credit implementation. Carbon measurement and boundary delineation drew the highest turnout among the training types offered, with 26 participants in Mekarsari and 25 in Bumiwangi, respectively, indicating strong community interest in technical skills previously unfamiliar in rural settings.

Training in plant seedling production, composting, planting and maintenance, and intercropping each drew between 20 and 24 participants across the research villages, showing broadly consistent engagement across both technical and livelihood-oriented training rather than interest concentrated in one area. Composting, goat and sheep farming, and intercropping training in particular were seen as supporting land productivity while sustaining household income before the

main crop begins producing, with livestock waste used as raw material for organic fertilizer and intercropping providing short-term income that offsets economic risk during the crop growth period.

Field observations during these sessions suggested a visible presence of younger participants, especially in the more technical training sessions, though the study did not systematically record participant age distribution, so this remains a qualitative impression rather than a quantified finding. If confirmed through further data collection, it would suggest that carbon-credit implementation could open a new avenue for regenerating village development actors, as skills in carbon measurement, simple mapping, and agroforestry management may become valuable economic competencies over time. The full range of training activities and participation figures is presented in Table 2.

Table 2. List of Trainings in Carbon Credit Implementation in Villages

No	Types of Training	Village	Participants (People)
1	Plant seedling production	Kumpay	20
2	Compost production	Karangheleut	24
3	Planting, maintenance, and replanting	Kertajaya	21
4	Planting, maintenance, and replanting	Ranjeng	20
5	Carbon measurement	Mekarsari	26
6	Simple boundary measurement	Bumiwangi	25
7	Goat/sheep farming	Karyamukti	24
8	Intercropping	Cisampih	24

(Source: Research Results, 2025)

According to Table 2, the concentration of training participants among the productive age group, particularly those under 30, is based on participant registration records from the training sessions. The involvement of younger age groups suggests that carbon-credit implementation could open a new avenue for regenerating village development actors, as knowledge of carbon measurement, simple mapping, and agroforestry management could become economically valuable competencies for this cohort in the future.

Taken together, these findings indicate that village readiness for carbon-credit implementation is not determined by land availability alone. Community engagement in outreach, participation levels in technical training, and the presence of active local institutions together form the foundation for agroforestry-based carbon-credit development at the village level, though attributing a direct increase in community literacy specifically to these activities would require evidence beyond attendance figures, such as pre- and post-training assessment or informant accounts of what participants understood differently afterward.

This finding is broadly consistent with Pratiwi & Suzuki (2019), who found that agroforestry training can expand farmers' knowledge and household-level business options; at the research sites, similar interest emerged around carbon measurement, simple land mapping, and agroforestry management, which participants regarded as relevant to future village economic

activity. It also relates to Tranchina et al. (2024), who note that limited technical knowledge remains a common constraint on agroforestry development elsewhere; the research sites suggest gradually implemented outreach and training may help address this constraint, though the current data describe program delivery and participation more directly than they demonstrate a resulting change in community understanding.

Institutional and Regulatory Governance of Carbon Credits at the Village Level

The implementation of carbon credits in villages depends on several factors, including land availability, carbon sequestration potential, and the village's ability to establish governance that ensures the program's sustainability. This governance includes management institutions, cooperation mechanisms with third parties, and regulatory support that provides certainty for all parties involved. Research findings indicate that institutional factors remain a major challenge to implementing carbon credits at the village level.

At the research sites, activity management is largely carried out by farmer groups and cooperatives established before the carbon trading program was introduced. This situation suggests that institutions with experience in natural resource management tend to be better prepared to act as liaisons between communities and investors or implementing partners.

Table 3. Demonstration Plot for Implementing Agroforestry-Based Carbon Credits

No	District	Subdistrict	Village	Name of KT	Area (ha)	Type of Plant
1	Bandung	Pangalengan	Margamulya	Mulyajaya	5,20	Eucalyptus, suren, Arabica coffee, avocado, and cinnamon
				Bojong	22,71	
				Mulyasari		
				Margamulya	2,22	
2	Bandung	Pasir Jambu	Cukang Genteng	Cemara	3,84	Eucalyptus, avocado, and Arabica coffee
				Nanglang	3,4	
				Pasirluhur	1,3	
3	Bandung Barat	Cililin	Karyamukti	Mukti Jabal	11,16	Rasamala, mddang-lid, Arabica coffee, and avocado

Based on Table 3, most community land ownership is relatively small, with only the Bojong Mulyasari Farmers Group exceeding 20 hectares while the remaining groups hold less than 12 hectares each. This fragmentation matters beyond mere plot size, since carbon-credit schemes generally require a minimum aggregated area to remain viable for validation and certification, and fixed costs such as measurement, verification, and certification do not scale down proportionally with land area. Under these conditions, none of the individual groups at the research sites could independently meet the area threshold expected by carbon-project developers, which is why aggregation becomes structurally necessary rather than merely preferable.

This situation gave rise to a land aggregation approach that combined several community- and village-owned parcels into a single management unit. Aggregation is particularly relevant in Java's landscape of narrow, fragmented smallholdings, and it addresses the problem in several interlocking ways.

- 1) it consolidates area, allowing the site to meet minimum project requirements without altering individual ownership status.
- 2) it lowers per-hectare transaction costs, since validation, verification, and certification are processed once for the aggregated unit rather than separately for each landowner.
- 3) it strengthens the community's collective bargaining position with investors, who otherwise face high coordination costs when negotiating with dozens of individual smallholders.

However, aggregation also introduces new challenges around tenure security and benefit distribution. Land under different legal statuses (SHM, Letter C/girik, and village-managed land) has varying levels of formal protection, raising questions about how carbon revenue should be apportioned when contributing plots differ in legal strength. Collective action of this kind further depends on sustained trust among

members, since disputes over individual contributions or exits can undermine the collective unit's standing in a long-term contract.

These administrative and coordinating roles show that farmer groups have evolved into local institutions with functions broader than those of conventional agricultural organizations. They function simultaneously as production platforms and as managers of community-based environmental and economic activities. However, this expanded role has not translated into a proportional contribution to Village Original Income (PADes). Because most collaboration with investors runs through farmer groups and cooperatives, Village-Owned Enterprises (Bumdesa) remain largely absent from carbon-trading management, even though PADes is formally channeled through Bumdesa rather than through farmer groups.

Normatively, Bumdesa holds a strategic position as the village's formal economic institution, directly connected to the village financial and development system. Its involvement could, in principle, create a stronger mechanism for channeling carbon-trading benefits into village government revenue.

In practice, however, Bumdesa at the research sites has been unable to take on this role, and the reasons point to a clear capacity gap rather than a simple lack of willingness. Farmer groups and cooperatives entered the carbon program with prior operating experience in natural-resource management, established legitimacy among members, working knowledge of land documentation and field coordination, and existing trust relationships built over time. Bumdesa, by contrast, faces limited business capital, underdeveloped business-management capacity, and no dedicated unit for environmental services. Given this asymmetry, management functions have defaulted to the institutions already equipped to perform them, leaving Bumdesa structurally sidelined despite holding the formal mandate to manage village economic assets.

Institutional asymmetry is compounded by a regulatory gap. At the time of this study, no research village had issued a specific regulation on carbon credits; implementation instead relies entirely on cooperation contracts among communities, farmer groups, cooperatives, and investors. Village regulation would normally serve several functions that private contracts cannot fully replace: providing legal certainty for all parties, transparently regulating the distribution of economic benefits, preventing land-use conflicts, ensuring program continuity amid changes in village government, and strengthening the village's negotiating position with investors. Field findings suggest that the substance of such regulation should cover natural resource management, soil and water conservation, carbon-credit management institutions, profit-sharing mechanisms, community participation, and dispute resolution.

This gap carries particular weight because carbon-trading cooperation contracts typically run 15 to 20 years, a duration long enough to span several village government terms and, in many cases, a generational transition among landholders. Without a governing regulation, several risks remain unresolved by contract alone: carbon rights are secured only through private agreement rather than codified village law; benefit-sharing terms are negotiated case by case instead of following a transparent public standard; there is no defined mechanism for resolving disputes between communities and investors; and changes in land ownership, farmer exit from an aggregated unit, or the distribution of risk over the life of the contract are not addressed by existing arrangements. Strengthening carbon-credit governance, therefore, requires more than land provision and planting activities. It requires institutional capacity and regulatory support that can guarantee legal certainty, transparent management, and equitable distribution of economic benefits to the village community.

This pattern is consistent with [Fischer et al. \(2023\)](#), who found that forest-based

community governance supported by strong local institutions tends to produce broader benefits, both for carbon sequestration and community well-being. At the research sites, farmer groups and cooperatives play a comparable role, serving as the operational bridge between communities, village government, and external partners, and helping sustain community trust in a program with a long implementation horizon.

[Rodríguez et al. \(2023\)](#) Studying agroforestry development in Colombia similarly found that scaling up such programs depends on the ability to build collaboration across community groups, cooperatives, government agencies, supporting institutions, and market actors. This finding reinforces the present study's conclusion that validation, verification, certification, and marketing processes cannot be completed by communities alone, and that a broader governance network, one still missing at the regulatory level in these villages, is a necessary condition for the program's long-term sustainability.

Community Empowerment and Strengthening Village Original Income through Carbon Credits

The implementation of carbon credits in villages is also intended to function as a community empowerment instrument that sustains rural household economies. This approach responds to a structural feature of agroforestry schemes. The main crops require a relatively long period before yielding economic returns, so communities need alternative income sources to bridge this growth period.

At the research sites, empowerment is pursued through productive businesses integrated into the agroforestry system, using the space under the main crop stands for intercropping, livestock farming, and product processing. These activities are further strengthened through collaboration between farmer groups, cooperatives, and local businesses, as summarized in Table 4.

Table 4. Institutional Cooperation in Community Business Development

No	Village	Cooperative/Group	Business fields
1	Margamulya	Koperasi Produsen Kopi Bandung	Mount Tilu coffee processing, marketing, and organic fertilizer
2	Mekarsari	Koperasi Sari Buah Kopi Garut	Mount Cikuray coffee processing and marketing
3	Sindang Kempeng	Kelompok Tani Hutan	Instant red ginger cultivation and processing
4	Karangwangi	KTH Citra Unggul Sejahtera	Mushroom broth production and marketing
5	Lengkongjaya	KTH Wanabakti Sadulur	Cultivation, packaging, and marketing of <i>Apis mellifera</i> and <i>Trigona itama</i> honey

(Source: Research Results, 2025)

Table 4 shows that carbon-credit implementation has fostered economic relationships beyond tree planting alone, giving communities the opportunity to process agricultural products, build marketing networks, and produce higher-value derivatives.

In Margamulya Village, Pangalengan District, Bandung Regency, farmer groups involved in the carbon-credit scheme collaborate with the Margamulya Coffee Producers Cooperative to develop Gunung Tilu Coffee, including processing derivative products and using coffee cherry skin waste as organic fertilizer. Established in 2005, the cooperative now has 36 members, manages approximately 194.5 hectares, and produces about 90 tons of red cherries annually. This production capacity indicates strong commercial viability for coffee-based agroforestry alongside the carbon program.

A comparable pattern appears in Garut Regency, where the Cikajang Coffee Fruit Cooperative develops Gunung Cikuray Coffee and has expanded marketing to various institutional buyers. Non-coffee businesses have also emerged: in Sindang Kempeng Village, Cirebon, the Mekar Rahayu Forest Farmers Group produces ready-to-drink red ginger powder at roughly 1.56 tons per year through a women-managed unit. In Karangwangi Village, the Citra Unggul Sejahtera group has developed a mushroom-broth product with a PIRT permit, halal certification, and BPOM registration. In the Tasikmalaya region, the Wanabakti Sadulur group has

integrated *Apis mellifera* and *Trigona itama* honey cultivation into the agroforestry area, with diverse plant cover supporting bee forage, while beekeeping adds to household income.

These outcomes need to be read carefully. However, they conflate three analytically distinct categories: direct revenue from carbon-credit transactions, income generated from agroforestry commodities such as coffee, ginger, mushroom broth, and honey, and the broader socioeconomic co-benefits that accompany carbon-oriented land management. The commercial success of coffee cooperatives, ginger processing, or beekeeping does not, by itself, demonstrate that the carbon-credit component of these programs is succeeding. These commodity businesses could plausibly develop through ordinary agroforestry extension work even without a carbon-trading scheme attached. Attributing this economic activity directly to carbon-credit implementation, in the absence of evidence of a causal link, risks overstating the carbon component's specific contribution.

A more accurate framing is that these carbon-oriented agroforestry initiatives coincide with, and in some cases support, livelihood diversification, since the available data indicate an association between the two rather than a demonstrated causal pathway. The genuine, more defensible contribution of carbon-credit implementation in this context lies in the institutional and land-management structure it introduces- long-

term contracts, aggregation arrangements, and validation processes- which creates a stable framework within which commodity-based businesses can then develop, rather than the commodity income being a direct product of carbon-credit revenue itself.

Research findings also point to emerging labor demand associated with carbon-credit implementation, spanning three broad categories: increased economic value of agricultural products through processing, diversified income sources through agroforestry derivative businesses, and new roles connected to carbon trading, including land measurement and mapping, carbon validation and verification, certification assessment, geospatial information system operation, tissue culture work, and coffee processing and grading.

It should be noted that these roles are best understood as potential employment opportunities that have emerged alongside program activities, rather than a confirmed count of positions formally created and sustained through carbon-credit revenue; the data available do not establish how many of these roles are currently paid, full-time, or carbon-funded specifically as opposed to embedded in existing agricultural work. Most of these roles do appeal to younger community members, given their technical and technology-oriented nature, suggesting a plausible channel for youth involvement in village economic development even if the current evidence supports this as a potential rather than a fully realized outcome.

Taken together, these findings point to the central empirical finding of this section. Economic benefits generated through carbon-credit-adjacent activities accrue primarily to farmer groups and cooperatives, while the formal link to Village Original Income (PADes) remains weak. This is not simply a matter of Bumdesa being under-involved, as discussed in the governance section above. It reflects a broader pattern in which community-level economic gains do not convert into formal village revenue, regardless of how commercially successful the underlying businesses become.

This pattern can be framed as an institutional conversion gap, a structural limitation in the mechanisms available to transform community-level economic activity into formal village-level income, rather than a failure of the economic activity itself. Coffee cooperatives can expand, ginger production can scale, and new technical jobs can emerge, yet none of this automatically increases PADes as long as the institutional channel connecting community enterprise to village treasury, normatively the role of Bumdesa, remains underdeveloped. This framing offers a more substantive contribution than a general claim that carbon credits benefit village economies, because it identifies precisely where the benefit stalls and why.

This distinction between community-level gain and village-level conversion also refines how the study's findings relate to prior literature. [Desmiwati et al. \(2020\)](#) Found that agroforestry systems meaningfully diversify household income in state forest areas by reducing dependence on a single commodity; the coffee, ginger, mushroom, and honey businesses observed here fit this pattern. [Sudomo et al. \(2023\)](#) Similarly, describe agroforestry as a means of strengthening rural livelihood resilience through combined economic and ecological benefits. The research sites here support that claim at the community level, while also indicating that resilience gains do not, on their own, resolve the governance gap identified above. Read together, these comparisons suggest that agroforestry-based carbon credit programs can strengthen the village economy in practice, but only insofar as institutional mechanisms, particularly Bumdesa's role, are deliberately developed to capture and formalize the benefits that farmer groups and cooperatives currently generate.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION

S. Conceptualisation, methodology, investigation, data curation, formal analysis,

writing – original draft, visualisation, and project administration. **M.S.H.** Methodology, formal analysis, validation, investigation, and writing – review & editing. **A.H.A.** Validation, visualisation, resources, and writing – review & editing. All authors have read and approved the final version of the manuscript.

CONCLUSION

This study shows that the development of agroforestry-based carbon credit initiatives in rural West Java depends on the interaction of land readiness, community capacity, local institutions, and regulatory support. The findings indicate that communities have established foundations for carbon project development through agroforestry practices, technical training, farmer groups, cooperatives, and land management arrangements. However, these conditions do not automatically translate into formal village revenue. Economic activities and cooperation arrangements remain largely concentrated among farmer groups and cooperatives, while the involvement of Bumdesa and village-level regulatory mechanisms remains limited. Therefore, the contribution of agroforestry-based carbon initiatives to Village Original Income (PADes) should be understood as a potential contribution, rather than as an empirically demonstrated increase in village revenue. The central finding is the existence of an institutional conversion gap, defined as the difference between economic benefits generated at the community level and the institutional mechanisms needed to convert part of these benefits into formal village revenue. This finding contributes to understanding of local institutional governance in community-based carbon projects by showing that carbon project development requires not only land and community capacity but also effective institutional linkages between community organizations and village-level institutions.

The findings suggest that strengthening Bumdesa may provide a pathway to link community-level economic benefits to village development, but

Bumdesa should not necessarily be positioned as the sole manager of carbon-related activities. A collaborative governance model involving farmer groups, cooperatives, Bumdesa, village governments, and external actors may provide a more appropriate institutional arrangement, supported by clear roles, benefit-sharing mechanisms, land-use rights, and accountability. Village-level regulations are also needed to provide greater clarity for long-term cooperation and community rights. At the same time, this study is limited by its qualitative multiple-case design, selected geographical coverage, absence of verified carbon-credit revenue data, lack of quantitative PADes measurement, and the early stage of some carbon-project initiatives. Future research should therefore quantify the contribution of carbon-related activities to household income and PADes, and compare institutional governance models, benefit-sharing mechanisms, and the economic feasibility of land aggregation.

FUNDING

This research does not receive external funding.

ACKNOWLEDGMENT

The author expresses his gratitude to all individuals and parties who have provided support and valuable contributions during the implementation and completion of this research.

REFERENCE LIST

- Adamowicz, M. (2022). Green deal, green growth and green economy as a means of support for attaining the sustainable development goals. *Sustainability*, 14(10), 5901–5910. <https://doi.org/10.3390/su14105901>
- Amin, K., Paramitha, D. I., & Al Farauqi, M. D. A. (2024). Menakar Koherensi Tata Kelola Perubahan Iklim Atas Hak Masyarakat Adat Dalam Program Perdagangan Karbon Di Kalimantan Timur. *Dinamika Global: Jurnal Ilmu Hubungan Internasional*, 9(2), 335–350.

- <https://doi.org/10.36859/jdg.v9i2.2768>
- Ardilah, N., Lesmana, W., Nurfalah, R., Syaadia, N., Nurlela, S., & Nurseha, A. (2023). Pengelolaan Sumberdaya Alam Dalam Menyanggah Perekonomian Warga Desa Cibeusi. *Al-Tarbiyah: Jurnal Ilmu Pendidikan Islam*, 1(4), 195–210. <https://doi.org/10.59059/al-tarbiyah.v1i4.417>
- Desmiwati, D., Veriasa, T. O., Aminah, A., Safitri, A. D., Wisudayati, T. A., Hendarito, K. A., Royani, H., Dewi, K. H., Raharjo, S. N. I., & Sari, D. R. (2020). Contribution of agroforestry systems to farmer income in state forest areas: A case study of Parungpanjang, Indonesia. *Forest and Society*, 5(1), 109–119. <https://doi.org/10.24259/fs.v5i1.11223>
- Farhan, M., Purnama, M. D., Haris, M. F. I., & Fatahillah, I. A. (2025). Efektivitas Regulasi Nasional dalam Mendukung Target Nationally Determined Contributions (NDCS) Indonesia Sesuai Perjanjian Paris: Analisa PERPRES No. 98/2021 tentang Penyelenggaraan Nilai Ekonomi Karbon. *Journal of Indonesian Comparative of Syaria'ah Law*, 8(1), 119–136. <https://www.doi.org/10.21111/jicl.v9i1.7>
- Fenetiruma, D., & Priyanto, I. M. D. (2025). Pengaturan Hukum Dan Implementasi Perdagangan Karbon Di Indonesia. *Jurnal Media Akademik (JMA)*, 3(3), 1–10. <https://doi.org/10.62281/v3i3.1653>
- Fikry, M. Y., & Sarjan, M. (2024). Peran agroforestri dalam mendukung pengelolaan sumberdaya alam berkelanjutan. *LAMBDA: Jurnal Ilmiah Pendidikan MIPA Dan Aplikasinya*, 4(1), 16–22. <https://doi.org/10.58218/lambda.v4i1.846>
- Fischer, H. W., Chhatre, A., Duddu, A., Pradhan, N., & Agrawal, A. (2023). Community forest governance and synergies among carbon, biodiversity and livelihoods. *Nature Climate Change*, 13(12), 1340–1347. <https://doi.org/10.1038/s41558-023-01863-6>
- Fu, C., Lu, L., & Pirabi, M. (2024). Advancing green finance: A review of climate change and decarbonization. *Digital Economy and Sustainable Development*, 2(1), 1–10. <https://doi.org/10.1007/s44265-023-00026-x>
- Hasan, K., & Tanesab, M. E. (2021). Pengaruh pendapatan asli desa, dana desa, dan alokasi dana perimbangan desa terhadap belanja desa. *Jurnal Manajemen Sains Dan Organisasi*, 2(3), 166–178. <https://doi.org/10.52300/jmso.v2i3.3632>
- Lindawaty, D. S. (2023). Pembangunan desa pasca Undang-Undang No. 6 Tahun 2014 tentang desa [Village development post Law No. 6 of 2014 on villages]. *Jurnal Politika Dinamika Masalah Politik Dalam Negeri Dan Hubungan Internasional*, 14(1), 1–21. <http://dx.doi.org/10.22212/jp.v14i1.4120>
- Novatiani, R. A., Christina, V., Asikin, B., Sarumpet, T. L., & Novianto, R. A. (2023). Kualitas pengelolaan aset desa dalam meningkatkan pendapatan asli desa (survei pada desa di Kabupaten Bandung dan Bandung Barat). *Jurnal Ekuilnomi*, 5(1), 38–43. <https://doi.org/10.36985/d1n1ay80>
- Pamungkas, L. T., DJ, E. W., & Widiyahseno, B. (2022). Pengelolaan Aset Desa Sebagai Sumber Pendapatan Asli Desa (PAD) Di Desa Ngebel, Kecamatan Ngebel, Kabupaten Ponorogo. *VILLAGE: Journal Rural Development And Goverment Studies*, 1(1), 93–102. <https://doi.org/10.24269/vlg.v1i1.5863>
- Pratiwi, A., & Suzuki, A. (2019). Reducing agricultural income vulnerabilities through agroforestry training: evidence from a randomised field experiment in Indonesia. *Bulletin of Indonesian Economic Studies*, 55(1),

- 83–116.
<https://doi.org/10.1080/00074918.2018.1530726>
- Prihatiningtyas, W., Wijoyo, S., Wahyuni, I., & Fitriana, Z. M. (2023). Perspektif Keadilan Dalam Kebijakan Perdagangan Karbon (Carbon Trading) Di Indonesia Sebagai Upaya Mengatasi Perubahan Iklim. *Refleksi Hukum: Jurnal Ilmu Hukum*, 7(2), 163–186.
<https://doi.org/10.24246/jrh.2023.v7.i2.p163-186>
- Rodríguez, T., Bonatti, M., Löhr, K., Bravo, A., Del Río, M., Lana, M., & Sieber, S. (2023). Upscaling agroforestry in the tropics through actor-networks: A comparative case study of cacao farming systems in two regions of Colombia. *Sustainability Science*, 18(4), 1631–1648.
<https://doi.org/10.1007/s11625-023-01303-6>
- Siagian, K., Karuniasa, M., & Mizuno, K. (2024). The Estimation of Economic Valuation on Carbon Sequestration of Agroforestry Land System. *Journal of Natural Resources & Environment Management/Jurnal Pengelolaan Sumberdaya Alam Dan Lingkungan*, 14(2), 231.
<https://doi.org/10.29244/jpsl.14.2.231>
- Sudomo, A., Leksono, B., Tata, H. L., Rahayu, A. A. D., Umroni, A., Rianawati, H., Asmaliyah, Krisnawati, Setyayudi, A., & Utomo, M. M. B. (2023). Can agroforestry contribute to food and livelihood security for Indonesia's smallholders in the climate change era? *Agriculture*, 13(10), 1896.
<https://doi.org/10.3390/agriculture13101896>
- Sumaila, S., Bempah, I., & Bakari, Y. (2022). Akses masyarakat miskin pedesaan terhadap sumberdaya alam di Desa Bonedaa Kecamatan Suwawa Selatan Kabupaten Bone Bolango. *AGRINESIA: Jurnal Ilmiah Agribisnis*, 7(1), 76–83.
<https://doi.org/10.37046/agr.v7i1.18959>
- Tarigan, V. C. E., Siregar, M., Ekaputra, M., Rauf, A., & Idris, S. H. (2025). Perdagangan Karbon Dan Desa Ketahanan Iklim. *Talenta Conference Series: Local Wisdom, Social, and Arts (LWSA)*, 8(2), 32–37.
<https://doi.org/10.32734/lwsa.v8i2.2424>
- Tranchina, M., Reubens, B., Frey, M., Mele, M., & Mantino, A. (2024). What challenges impede the adoption of agroforestry practices? A global perspective through a systematic literature review. *Agroforestry Systems*, 98(6), 1817–1837.
<https://doi.org/10.1007/s10457-024-00993-w>
- Wiati, C. B., Dharmawan, I. W. S., Sakuntaladewi, N., Ekawati, S., Wahyuni, T., Maharani, R., Hadiyan, Y., Naibaho, Y., Satria, W. I., & Ngatiman, N. (2022). Challenges to and strategies for the climate village program plus: A lesson learned from Indonesia. *Sustainability*, 14(9), 5530.
<https://doi.org/10.3390/su14095530>
- Yu, X., Shi, J., Wan, K., & Chang, T. (2022). Carbon trading market policies and corporate environmental performance in China. *Journal of Cleaner Production*, 371, 133683.
<https://doi.org/10.1016/j.jclepro.2022.133683>
- Yusuf, M., & Astiko, W. (2025). Agroforestry As an Ecological Approach to Support the Sustainability of Dryland Agroecosystems in Pringgabaya District, East Lombok. *Jurnal Biologi Tropis*, 25(4), 5309–5324.
<https://doi.org/10.29303/jbt.v25i4.10016>