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Stakeholder Analysis of a Climate-Smart Agroforestry Community Service Program in the Dieng Highlands

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ABSTRACT

Background: Highland farming in the Dieng landscape faces land degradation and climate uncertainty. Technical recommendations may not endure when authority, work, and benefits are not negotiated among local actors.
Aims: This community-service evaluation mapped stakeholder interests, influence, participation, and relationships in a climate-smart agroforestry program in Serang Village, Central Java.
Methods: Activities were held on 4–5 October 2025, with 18 attendance records on the first day and 19 on the second. Evidence came from documents, field observation, group dialogue, semi-structured conversations, and UII–UNSIQ team validation.
Result: Stakeholders were assessed through a power–interest matrix, salience attributes, and the IAP2 participation spectrum. Farmer groups, UII, and UNSIQ emerged as key players; the village government as a context setter; and KWT/PKK and students as interested actors with limited decision power. Participation remained at involve–collaborate rather than empowerment. Priorities are a joint demonstration plot, stronger KWT/PKK decision roles, village coordination, shared monitoring, and selective engagement with extension and government. The findings also show that combining power–interest, stakeholder salience, and participation analysis can reveal differences in influence that may not be visible from attendance or participation records alone.

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1. Introduction

Highland agriculture is an important source of food and rural income, yet it is also unusually exposed to environmental change. Steep slopes, repeated soil disturbance, short horticultural rotations, and limited permanent cover can turn intense rainfall into rapid runoff and soil loss. Climate change adds another layer of uncertainty through shifting seasons, more variable rainfall, and a growing risk of production disruption. The IPCC (2022) notes that adaptation becomes more difficult when climatic hazards interact with already degraded land and unequal access to resources. This interaction is particularly relevant in smallholder systems, where a technical failure is quickly translated into household income pressure.

The Dieng Highlands illustrate this challenge. Potato, cabbage, carrot, and other vegetable crops underpin local livelihoods, but intensive cultivation on sloping land has also contributed to erosion and declining ecological functions. Earlier work linked land-use change in Dieng with accelerated soil erosion (Rudiarto & Doppler, 2013). More recent studies found that agroforestry adoption on potato farmland is shaped not only by biophysical suitability but also by planting space, farm management, access to knowledge, and farmers' assessment of the trade-offs between trees and annual crops (Pujiwinarko *et al.,* 2023, 2024). These findings suggest that land restoration cannot be separated from everyday livelihood decisions.

Climate-smart agroforestry offers a way to bring ecological and livelihood objectives into the same design. Trees and perennial vegetation may improve ground cover, water regulation, nutrient cycling, product diversity, and farm resilience, but the outcome depends on species choice, spatial arrangement, labour, tenure, and market opportunity. Indonesian evidence shows that diversified agroforestry can support social–ecological recovery after a major shock, while adoption studies point to the importance of reliable information, community participation, and institutional support (Nöldeke *et al.,* 2021; Sari *et al.,* 2023; Ullah *et al.,* 2023). In other words, agroforestry is not simply a tree-planting exercise. It is a negotiated change in the farming system.

That negotiation makes stakeholder configuration central to community development. A stakeholder map can identify who controls land, knowledge, authority, equipment, finance, or networks; who bears the costs of change; and whose interests are easily overlooked. Recent methodological work has shown the value of combining positional mapping with evidence about relationships and engagement (Styk & Bogacz, 2022). Research on agroforestry actor networks also shows that scaling depends on bridging organizations and on connections across local, technical, market, and government arenas (Rodríguez *et al.,* 2023). At the same time, Indonesian experience cautions that a multistakeholder forum can remain formally inclusive while unequal resources continue to shape whose views influence decisions (Muttaqin *et al.,* 2023).

For a community-service program, this issue is especially important. Universities commonly enter villages with short schedules, specialist language, project resources, and reporting obligations. Communities contribute land, local knowledge, time, and the practical burden of maintaining any intervention after the project team leaves. A productive partnership therefore requires more than knowledge transfer. It requires a clear account of who decides, who implements, who benefits, and who remains responsible. Studies of community–university partnerships describe durable collaboration as a process of mutual learning, shared problem definition, and locally useful outputs rather than a one-way delivery of expertise (Mancini *et al.,* 2022; Bhatt & Singh, 2023; Kitamura *et al.,* 2023).

Participation within the community also needs to be read carefully. Women's farmer groups and family welfare groups may be highly active in composting, household waste management, and food security, yet activity does not automatically translate into influence over budgets, technology choice, or benefit distribution. Evidence from West Java shows that social norms and perceptions continue to shape women's role in agricultural decisions (Qanti *et al.,* 2022), while Indonesian agroforestry programs have

reported both opportunities and barriers to women's effective participation (Dwiyati, 2022; Dharmawan *et al.,* 2023). A community-development perspective therefore asks not only who attended, but whose knowledge entered the design and whose authority increased.

Although stakeholder analysis is widely used in agroforestry and natural-resource management, fewer studies have examined it in short-term community–university service programs in Indonesian highlands. Existing studies often focus on who participates, but pay less attention to differences in influence, decision-making power, and participation quality. This study addresses that gap by examining stakeholder positions, participation, and power relations within a community-service program.

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To address this gap systematically, this study is guided by three interconnected research questions:

1. Who are the key stakeholders directly involved in this community–university agroforestry program, and what are their respective interests, sources of power, and salience?
2. How do power asymmetries and the quality of participation among these stakeholders influence the design, local ownership, and immediate outputs of the collaborative interventions?
3. What differentiated engagement and monitoring strategies can be formulated to address these asymmetries and sustain multi-stakeholder collaboration beyond the project cycle?

Guided by these questions, This article evaluates a collaborative community-service program conducted by the Department of Environmental Engineering at Universitas Islam Indonesia (UII) and the Department of Mechanical Engineering at Universitas Sains Al-Qur'an (UNSIQ) in Serang Village, Wonosobo. The program combined field observation, dialogue with farmers, introductory soil and water screening, organic-waste training, biochar and appropriate-technology demonstrations, agroforestry simulation, action planning, and an institutional roadmap. The article aims to: (1) identify the stakeholders directly involved; (2) examine their power, interest, salience, and participation; (3) interpret the stakeholder configuration through a community-development lens; and (4) propose differentiated engagement and monitoring strategies for the next phase. The analysis does not claim to represent all actors in the Dieng agricultural system; it focuses on the relationships documented within this program.

2. Methods

2.1 Service Setting and Community Partners

The stakeholder analysis was embedded in a two-day community-service program held on 4–5 October 2025 in Serang Village, Kejajar District, Wonosobo Regency, Central Java. The village lies within the Dieng highland agricultural landscape. The village hall was used for discussion, training, and coordination, while nearby farms and water sources were used for field observation. Attendance records documented 18 participants on the first day and 19 on the second. Across the program, the community participants consisted of 12 farmers, 19 members of women's farmer groups and Family Welfare Empowerment groups (KWT/PKK), and 6 village representatives. The daily attendance figures are reported separately from this stakeholder-group profile and were not used as the basis for the stakeholder analysis.

The community partners therefore represented farmer groups, KWT/PKK, and the Serang Village Government. No separate individual informants were involved in the analysis; stakeholder information was obtained through field dialogue, group discussions, observation, and program documentation. Participants were selected purposively based on their direct roles in land management, household

organic-waste activities, and village coordination, as well as their involvement in the program. The academic team involved lecturers from UII and UNSIQ, two administrative or technical staff members, and four undergraduate and graduate students. The first day concentrated on farmer dialogue, environmental observation, and preliminary field screening. The second day focused on KWT/PKK training, demonstrations of organic-waste processing and appropriate technology, reflection, and preparation of a simple action plan. A separate UII–UNSIQ discussion produced a collaboration roadmap and an Implementation Agreement.

The unit of analysis was the stakeholder group or institution, rather than the individual participant. This choice reflects the way decisions were made in the program. Land-use decisions were located mainly with farmers; community mobilization and local legitimacy were linked to the village government; technical design and evaluation were associated with the universities; and household-scale organic-resource management involved KWT/PKK. Treating these collective roles as the unit of analysis also avoided overstating the meaning of a short attendance list (Table 1).

Table 1. Stakeholders, program positions, interests, and evidence sources.

Stakeholder	Program position	Main interests	Primary evidence
Farmer groups	Land managers and principal users of field recommendations	Productivity, soil condition, water, costs, labour, and crop risk	Field dialogue, observation, group discussion, action planning
KWT and PKK	Household/community organic-resource managers	Feasibility of compost/POC, workload, benefits, and group organization	Training, practice, questions, reflection
Serang Village Government	Local gatekeeper and institutional convener	Coordination, village-program alignment, legitimacy, and continuity	Coordination records, statements, interviews, program documents
UII Environmental Engineering	Environmental knowledge, facilitation, screening, and evaluation	Conservation, environmental quality, climate adaptation, research and service outputs	Training materials, field notes, equipment use, roadmap
UNSIQ Mechanical Engineering	Local technical partner and appropriate-technology support	Design, operation, maintenance, and local follow-up	Demonstration, coordination, roadmap, Implementation Agreement
Students and staff	Field, facilitation, documentation, and logistical support	Learning, service delivery, documentation quality, and operational continuity	Task records, observation, photos, and team reflection

2.2 Data Collection and Stakeholder Identification

Evidence was assembled from five sources: program documents, participant lists, direct observation, group dialogue, and group-based semi-structured conversations. Document review covered the objectives, activity sequence, division of roles, outputs, roadmap, and Implementation Agreement. During field activities, the team noted who provided information, controlled access to locations, mobilized participants, supplied tools or technical knowledge, made decisions, and carried responsibility for follow-up. Group dialogue was used to identify concerns related to land, water, input use, organic residues, labour, and technology. Semi-structured conversations with local coordinators, village representatives, farmers, and university personnel were used to clarify roles and expected contributions. The conversations were conducted with farmers, KWT/PKK members, village representatives, and university personnel during field and village-based activities, typically lasting approximately 30 minutes per discussion. They focused on stakeholder roles, local concerns, expected contributions, and possible follow-up actions. No separate individual interviews were conducted.

Stakeholder identification followed an iterative process. The initial list was derived from the program design. It was then revised after observing actual participation and discussing the list during team reflection. This step was important because a formal invitation does not necessarily indicate practical

influence, while some operational actors may exercise influence without a formal title. The process therefore combined stated roles with observed behaviour (Figure 1).

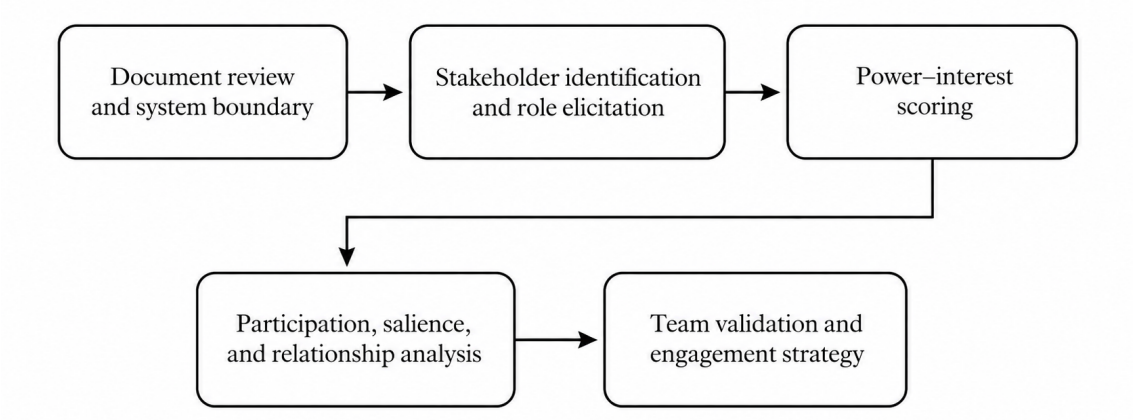


Figure 1. Sequence of participatory stakeholder analysis and triangulation.

2.3 Analytical Framework

Power and interest were scored on an ordinal scale from 1 to 5 (Table 2). Power referred to the ability to influence program decisions through formal authority, control of land or resources, technical knowledge, mobilization capacity, or access to strategic networks. Interest referred to the extent to which a stakeholder was directly affected by the problem, expected benefits or costs, had a relevant institutional mandate, and showed willingness to remain involved. Scores of 4–5 were treated as high, 3 as moderate, and 1–2 as low. These scores represent comparative judgments within the context of this program rather than direct ratings provided by the stakeholders themselves. They are not psychometric measures or permanent attributes of the actors.

The power–interest matrix was complemented by stakeholder salience and participation. Salience was interpreted through power, legitimacy, and urgency. Participation was assessed using the IAP2 spectrum—inform, consult, involve, collaborate, and empower (IAP2, 2018). The distinction between collaborate and empower was applied conservatively. A stakeholder was not considered empowered unless it had meaningful control over resources, final design, monitoring, and continuation. This prevented active attendance or practical assistance from being interpreted as a transfer of decision power.

The scoring process relied on analytic consensus. Each stakeholder was first assessed against the same rubric. The team then compared the scores with field notes, program documents, and observed roles. Disagreement was resolved by returning to the evidence rather than averaging personal impressions. Recent stakeholder-mapping methods similarly emphasize transparent criteria and traceable justification rather than treating a matrix as a purely visual exercise (Styk & Bogacz, 2022).

Table 2. Operational rubric for power, interest, and participation.

Dimension	Low (1–2)	Moderate (3)	High (4–5)
Power	Limited operational support; no control of key decisions or resources	Influences implementation within a specific domain	Controls land, authority, expertise, resources, mobilization, or strategic networks
Interest	Indirect benefits or costs; limited commitment	Relevant interest, but not a central priority	Directly affected; bears or receives benefits/costs; strong commitment
Participation	Inform/consult: receives information or provides comments	Involve: joins activities and local adjustments	Collaborate/empower: shares decisions or controls resources and continuation

Note: The participation categories operationalize the IAP2 spectrum. Empowerment was only assigned where decision and resource control were demonstrably transferred.

2.4 Data Analysis, Validation, and Limitations

Field notes and documents were coded into role, resource, interest, influence, legitimacy, urgency, participation, relationship, risk, and follow-up categories. The analysis used a reflexive thematic approach: the material was read repeatedly, initial codes were compared, related codes were grouped, and interpretations were checked against the original evidence. This procedure follows the emphasis of Braun and Clarke (2021) on coherent, transparent, and theoretically informed thematic analysis. Triangulation was used to test consistency between what stakeholders said, what they did during the activities, and what was recorded in program documents (Patton, 2015). The preliminary stakeholder classifications were reviewed within the analytical team against the available field evidence before the final matrix was agreed. No separate community validation of the final power–interest positions was conducted.

The analysis has several limitations. First, the observation period covered only two days and cannot show how relationships change during implementation. Second, the mapping prioritizes actors who attended or were recorded in the program. Government agencies, extension workers, finance providers, seedling suppliers, and market actors are discussed as prospective stakeholders but were not given participation scores. Third, the ordinal values represent contextual judgments and the final stakeholder positions were not independently validated by the community participants. They should be updated when the program moves from training to demonstration, adoption, or scaling. Finally, the program did not collect a standardized social baseline, household survey, or longitudinal environmental indicators. The results therefore describe institutional readiness and early learning, not causal impacts.

3. Results and Discussion

3.1 Result

3.1.1 Stakeholder Profile

Attendance records documented were treated as daily attendance counts rather than as unique individuals. At the descriptive-profile stage, six directly involved stakeholder groupings were documented: farmer groups, KWT/PKK, Serang Village Government, UII Environmental Engineering, UNSIQ Mechanical Engineering, and students/staff. In the final power–interest matrix, students and administrative/technical staff were reported separately, resulting in seven scored stakeholder categories.

Farmer groups were the principal land managers and users of the field recommendations, with interests centred on productivity, soil condition, water, costs, labour, and crop risk. KWT/PKK were involved in household and community organic-resource management, particularly compost and liquid organic fertilizer practices. The village government provided local coordination, legitimacy, participant mobilization, and alignment with village activities. UII contributed environmental assessment, facilitation, field equipment, training, and evaluation, whereas UNSIQ contributed local coordination and engineering support for appropriate technology. Students and administrative/technical staff supported field activities, facilitation, documentation, and logistics.

From field dialogue, observed resource control also differed among actors (Figure 2). Farmer groups controlled whether proposed practices would be tested on their land and contributed local knowledge on rainfall, soil behaviour, labour, input costs, crop timing, and productive-space constraints. The village government controlled convening and institutional access. UII and UNSIQ controlled different forms of technical expertise, equipment, training design, and institutional networks. KWT/PKK contributed experience in household-scale organic-resource practices but did not control most land or project resources.



Figure 2. Field dialogue used to identify experience, interests, and stakeholder relationships.

3.1.2 Power–Interest Positions and Practical Implications

The power–interest scoring placed farmer groups, UII Environmental Engineering, and UNSIQ Mechanical Engineering in the key-player quadrant. Farmer groups and UII each received power and interest scores of 5 and 5, while UNSIQ received scores of 4 and 5. UII's position reflected its coordination role, environmental expertise, field equipment, and responsibility for evaluation. UNSIQ combined technical influence with local proximity and a commitment to technology development. These positions do not mean that the three actors were equally powerful in every decision. Rather, each controlled a resource that the others needed. Furthermore, Serang Village Government was classified as a context setter with power 4 and interest 3. KWT/PKK were classified as a subject with power 3 and interest 5; students were also classified as a subject with power 2 and interest 4. Administrative/technical staff were placed in the crowd/support position with power 2 and interest 3 (Figure 3 and Table 3).

The evidence associated with the scores differed by actor. Farmer-group power reflected control of land and adoption decisions; UII power reflected coordination, environmental expertise, equipment, and evaluation; and UNSIQ power reflected local technical coordination and engineering support. Village-government power reflected formal authority, legitimacy, and mobilization capacity. KWT/PKK showed high interest in organic-resource management and household benefits but more limited control of strategic resources. Students and administrative/technical staff had operational roles but little formal authority over program decisions.

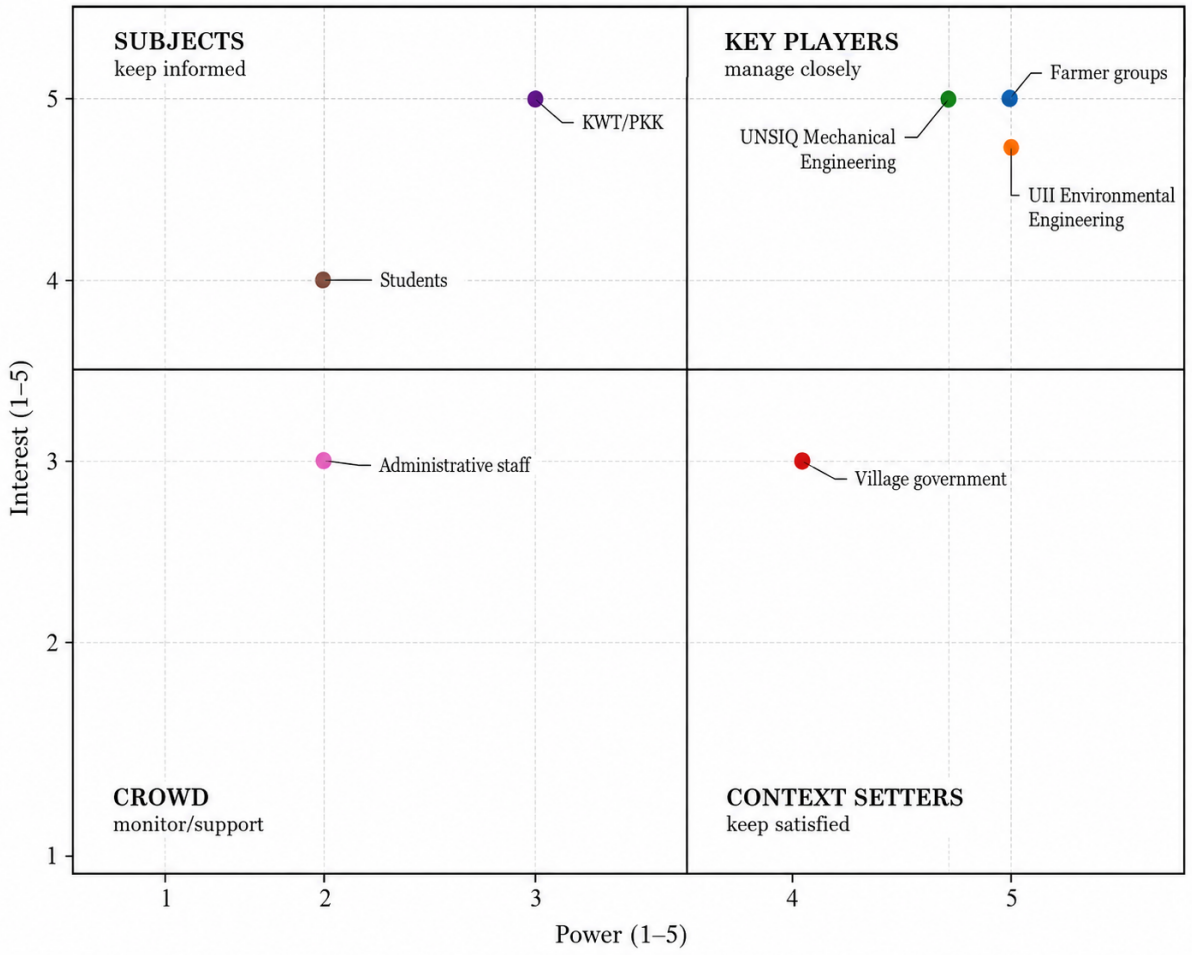


Figure 3. Power–interest matrix for stakeholders directly involved in the program.

Table 3. Stakeholder scores and the rationale for each matrix position.

Stakeholder	Power	Interest	Matrix position	Evidence-based rationale
Farmer groups	5	5	Key player	Control land and adoption decisions; hold local knowledge; directly bear livelihood and environmental risks
UII Environmental Engineering	5	5	Key player	Coordinates environmental assessment, facilitation, equipment, evaluation, and research–service agenda
UNSIQ Mechanical Engineering	4	5	Key player	Provides local coordination and engineering support for appropriate technology
Serang Village Government	4	3	Context setter	Provides authority, legitimacy, mobilization, and possible integration with village programs
KWT/PKK	3	5	Subject	High interest in organic materials and household benefits; limited control of strategic resources
Students	2	4	Subject	Active operational involvement and strong learning interest; no control of program decisions
Administrative/technical staff	2	3	Crowd/support	Important logistical role, but limited technical and policy authority

Note: Scores are ordinal judgments based on program evidence and represent relative positions, not permanent stakeholder characteristics.

3.1.3 Stakeholder Salience and Participation Quality

Salience analysis distinguished stakeholders by the observed combination of power, legitimacy, and urgency. Farmer groups, UII, and UNSIQ were assessed as having all three attributes. Serang Village

Government combined power and legitimacy with moderate urgency. KWT/PKK combined legitimacy and urgency but had more limited power. Students and administrative/technical staff were characterized primarily by operational legitimacy associated with their implementation roles (Table 4).

Table 4. Salience, actual participation, and priorities for stronger local ownership.

Stakeholder	Salience	Observed participation	Priority for stronger ownership
Farmer groups	Power–legitimacy–urgency	Collaborate	Joint control of the demonstration plot, indicators, seasonal review, and adaptation decisions
UII	Power–legitimacy–urgency	Collaborate	Transparent resources, shared data, method transfer, and an explicit exit or transition strategy
UNSIQ	Power–legitimacy–urgency	Collaborate	Prototype testing with users and locally available technical support
Village government	Power–legitimacy; moderate urgency	Involve/collaborate	Village focal person, program integration, schedule, and budget or in-kind commitment
KWT/PKK	Legitimacy–urgency; limited power	Involve	Right to choose technology, manage benefits, and hold seats in decisions
Students and staff	Operational legitimacy	Involve/support	Clear supervision, reflection, and standardized handover of records

No stakeholder was classified as empowered under the study rubric. The universities retained control over the activity schedule, most technical methods, documentation, and formal reporting. Farmer groups retained authority over land-use adoption, but a jointly governed demonstration plot had not yet been established. KWT/PKK completed practical activities, but no group-managed equipment, budget, or benefit-sharing arrangement was documented. The observed evidence therefore supported collaboration in selected decisions rather than community control of the program as a whole.

3.1.4 Relationship and Network Pattern

The observed network was centred on farmer groups, which were connected to the village government, KWT/PKK, UII, and UNSIQ. UII and UNSIQ also had a direct institutional relationship, while students and staff supported university-led field and operational activities. The differentiated functions recorded in the network were land management and adoption for farmer groups, legitimacy and coordination for the village government, organic-resource circulation for KWT/PKK, environmental and evaluation functions for UII, technology design and operation for UNSIQ, and field and logistical support for students and staff (Figure 4).

The direct network was dominated by village actors and the two universities. Agricultural and food agencies, environmental agencies, extension officers, Bappeda, finance providers, seedling suppliers, and market actors were not recorded as direct participants in the two-day program and therefore were not assigned participation scores in the analysis.

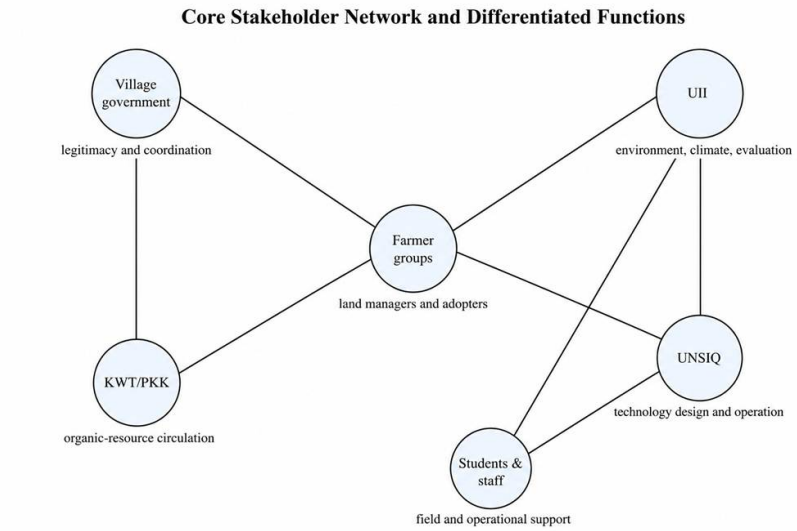


Figure 4. Core stakeholder network and differentiated functions observed in the program.

3.1.5 Validation Outcomes

Stakeholder identification and scoring were finalized through analytic consensus within the UII–UNSIQ team. The initial stakeholder list derived from program design was revisited after field observation and team reflection. Power, interest, salience, and participation classifications were cross-checked against field notes, program documents, and observed roles; when interpretations differed, the team returned to the recorded evidence rather than averaging individual judgments. The matrix and classifications reported in Figures 3–4 and Tables 3–4 represent the final consensus configuration used for this evaluation.

A separate UII–UNSIQ discussion produced a collaboration roadmap and an Implementation Agreement as immediate institutional outputs of the program (Figure 5). Validation was limited to stakeholder configuration, role interpretation, and immediate program records; the study did not collect a standardized social baseline, household survey, or longitudinal environmental and livelihood indicators. Consequently, no validation outcome was available for seasonal adoption, long-term behaviour change, or ecological and livelihood impacts.



Figure 5. UII–UNSIQ team associated with preparation of the collaboration roadmap and Implementation Agreement.

3.2 Dissussion

3.2.1 Stakeholder Configuration and Resource Complementarity

The stakeholder profile shows that program continuity depends on complementary rather than interchangeable resources. Farmers control the most consequential adoption decision—whether a practice is tested and maintained on productive land—while the universities contribute technical expertise, equipment, facilitation, and institutional networks. The village government contributes legitimacy and convening capacity, and KWT/PKK connect household organic materials with collective practices. No single actor therefore controls all resources required to move from short-term training to sustained implementation.

Seen through a community-development lens, this configuration can be interpreted as an asset base composed of natural assets (land, water, and biomass), human assets (farmer experience and technical expertise), social assets (farmer groups, KWT/PKK, and university relationships), political assets (village legitimacy), and limited built assets (field equipment and potential prototypes). The main institutional challenge is not the absence of assets, but the lack of an established mechanism for combining and governing them after a short service activity. Community–university partnership studies similarly emphasize that durable collaboration requires mutual learning, shared responsibilities, and locally accessible outputs rather than one-way transfer of academic expertise (Mancini *et al.,* 2022; Bhatt & Singh, 2023; Kitamura *et al.,* 2023).

3.2.2 Power Asymmetry, Participation, and Local Ownership

The distinction between active participation and empowerment is central to interpreting the matrix. Farmer groups and the universities collaborated in selected decisions, but control over land, technical methods, documentation, resources, and continuation remained distributed unevenly. This does not make the collaboration ineffective; specialized responsibilities may reasonably remain with institutions that hold particular equipment, expertise, or accountability. The concern arises when unequal control is obscured by high attendance or by the language of participation. Indonesian evidence from multistakeholder processes likewise shows that formally inclusive spaces can remain strongly shaped by actors with greater institutional resources (Muttaqin *et al.,* 2023).

The IAP2 spectrum is useful because it links each participation category to an explicit promise about influence (IAP2, 2018). On this basis, the next phase should make power and decision rights visible: who controls funds, data, equipment, agendas, technology specifications, and final approvals should be stated explicitly. Key players should be involved in co-design and joint evaluation; the village government should have a named focal role and a realistic resource commitment; KWT/PKK should receive decision rights over technology choice, workload, location, and benefit use; and students and staff should use standardized handover procedures so that records remain accessible to local actors. Local ownership should be assessed through observable arrangements—joint control of pilot sites, access to monitoring records, authority to modify technology, and agreed rules for benefits—rather than through attendance alone.

3.2.3 Community Learning and Knowledge Co-Production

The most important program output was not a single technical recommendation, but a shared way of reading the farming problem. Farmers brought observations about seasonal changes, water movement, soil condition, input use, labour, and crop risk. The academic team connected these observations with conservation, agroforestry, organic-resource management, and appropriate technology. Preliminary field screening helped structure the conversation, although it was not used to claim regulatory soil or water status. This combination converted technical assessment into a discussion about practical choices.

Knowledge co-production was strongest when recommendations were treated as propositions to be tested rather than instructions to be followed. For example, adding trees to intensive horticulture may support ground cover and resilience, but it can also compete for space, light, nutrients, and short-term income. Participatory design studies have shown that farmers are better able to assess such trade-offs when they can compare species, arrangements, and management sequences rather than respond to a fixed package (Notaro *et al.,* 2022). The current program reached the stage of identifying design criteria, but not the stage of field comparison.

Skilled facilitation also shaped whose knowledge became visible. Evidence from agroforestry strategy development shows that facilitated groups can integrate scientific and social perspectives more effectively than less structured engagement (Bourne *et al.,* 2023). In Serang, the division between field dialogue on the first day and hands-on training on the second helped connect problems and solutions, but it also separated some participant groups. A follow-up workshop should deliberately mix farmer, KWT/PKK, village, and technical representatives around one concrete pilot design. That would allow participants to see the full chain from biomass and labour to soil management, equipment, costs, and farm benefits.

Social learning remains provisional until it changes routines and relationships. The immediate evidence—questions, explanations, practical demonstrations, and action-plan ideas—shows early learning. It does not show retention, adoption, or collective problem-solving across a season. Stakeholder learning research suggests that repeated interaction across relational and participatory networks is important because knowledge moves through trusted ties, not only through formal training (Teodoro *et al.,* 2021). The program therefore needs recurring local reflection, not simply another one-off seminar.

3.2.4 Gendered Roles, Workload, and Benefit Distribution

KWT/PKK participation broadened the program beyond field management. Organic residues move through households, food preparation, markets, gardens, and farms, so composting and liquid organic fertilizer are not only technical processes. They require sorting, collection, routine monitoring, space, water, and agreement about who uses the final product. The groups were therefore positioned at a strategic junction between household practices and agricultural soil management.

There is, however, a risk of assigning environmental work to women without expanding their influence. If KWT/PKK are expected to sort materials and operate a compost unit while others control

equipment, land, finance, and sales, the intervention may increase workload without changing decision power. Studies in Indonesia show that women's agricultural participation is closely related to social norms, perceptions, access to resources, and the structure of household decisions (Qanti *et al.,* 2022). Agroforestry programs can create new economic and organizational space for women, but only when participation includes access to assets and benefits (Dwiyati, 2022; Dharmawan *et al.,* 2023).

The next phase should therefore ask practical equity questions. Who chooses the technology? Who performs daily work? Who controls the product? Who receives savings or revenue? Who represents the group in village and university meetings? A pilot should include a simple workload record, group rules for use of compost or POC, and at least two KWT/PKK representatives in design and review meetings. These measures are modest, but they move the program from inviting women to sharing decisions with them.

3.2.5 Institutional Bridging and the Value of the UII–UNSIQ Partnership

The UII–UNSIQ relationship functioned as a bridging arrangement. UII contributed environmental assessment, climate framing, conservation, and evaluation. UNSIQ added local proximity and an engineering perspective on design, operation, and maintenance. This combination is useful because appropriate technology often fails when a prototype is separated from material availability, user routines, maintenance skills, and environmental safeguards. The partnership created a route for connecting these concerns.

The Implementation Agreement formalized the intention to continue collaboration. Its value lies less in the signature itself than in the institutional memory it can create. Community partnerships often weaken when they depend on one lecturer, one grant, or one annual event. Recent studies of rural university engagement emphasize the need for shared work plans, local repositories of knowledge, recurring contact, and outputs that communities can use after researchers leave (Mancini *et al.,* 2022; Bhatt & Singh, 2023; Kitamura *et al.,* 2023). The roadmap should therefore identify a responsible person in each institution and in the village, a calendar, minimum outputs, and a mechanism for returning findings to residents.

Formalization can also reproduce dependency if the universities remain the only actors able to convene, interpret data, or mobilize resources. The partnership should gradually shift routine coordination to a village-based working group. The universities can retain roles that require laboratories, specialist analysis, or external networks, while local actors manage meeting schedules, field records, basic monitoring, and pilot maintenance. This division would make the agreement a platform for capacity transfer rather than a permanent project dependency.

3.2.6 Stakeholder Gaps and a Pathway from Training to Community Action

The direct network was dominated by village actors and universities. Agricultural and food agencies, environmental agencies, extension officers, Bappeda, finance providers, seedling suppliers, and market actors were not recorded as direct participants. Their absence did not invalidate the early program, but it limits what the current network can do. Village and university actors can design a pilot; they cannot by themselves guarantee seedlings, extension continuity, policy integration, finance, certification, or stable market incentives.

Expansion should be selective. Inviting many institutions to a ceremonial forum may create visibility without solving a practical constraint. Each prospective stakeholder should enter because a specific contribution is needed. Extension officers could support seasonal monitoring. Agriculture or environmental agencies could align the pilot with technical programs. Bappeda could connect the activity with planning and replication. Finance and market actors should be approached only after a small pilot produces credible information about costs, labour, product quality, and benefits. Agroforestry adoption

research consistently shows that participation, seedling access, perceived compatibility, institutional support, and observable benefits affect uptake (Nöldeke *et al.,* 2021; Ullah *et al.,* 2023).

The pathway should also distinguish scale-out from scale-up. Scale-out means more households or plots trying an agreed practice. Scale-up means changes in village plans, institutional budgets, extension routines, or government programs. The first requires local proof and peer learning; the second requires evidence, documentation, and policy relationships. Actor-network research shows that agroforestry expansion is rarely a simple replication process. It depends on bridging actors who connect farm-level experience with organizations operating at other levels (Rodríguez *et al.,* 2023).

A staged sequence is therefore preferable. The first phase should establish one jointly managed demonstration plot and one organic-resource pilot. The second should compare performance across a season and document labour, survival, soil-cover, costs, and user experience. The third should invite prospective stakeholders around clearly defined needs. The final phase should consider replication only after farmers and KWT/PKK have reviewed the evidence and agreed that the practices are worthwhile.

3.2.7 Monitoring Framework, Risks, and Adaptive Management

Monitoring should distinguish process, outputs, adoption, outcomes, and equity. Process indicators include representation, distribution of speaking time, decisions completed, conflicts recorded, and follow-up attendance. Outputs include a work plan, pilot unit, demonstration plot, trained local focal persons, and accessible records. Adoption indicators include the number of households or plots trying a practice, the area maintained, and continuation after external support declines. Environmental and livelihood outcomes require longer observation: ground cover, tree survival, selected soil and water indicators, labour, input costs, yields, product use, and household benefits.

Equity indicators are necessary because an average participation figure can hide unequal burdens. The program should record who attends, who speaks, who performs routine work, who controls equipment, and who receives benefits. It should also watch for local elite capture, where land or resources are concentrated among already influential actors. Power can shift over time; a stakeholder placed in the subject quadrant during training may become a key player after receiving equipment or managing a successful enterprise. The map should therefore be revised at the preparation, pilot, evaluation, and scaling stages.

Several implementation risks are already visible. Farmers may prioritize short-term crop income over benefits that emerge slowly. A tree design may reduce annual cropping space. Composting may become labour-intensive. Equipment may remain unused when parts or maintenance are unavailable. University involvement may decline after funding ends. These risks argue for small tests, transparent cost–benefit records, locally serviceable designs, and decisions that can be reversed or adjusted. Business-model work in Indonesian restoration settings similarly shows that ecological proposals need a credible operational and livelihood logic (Applegate *et al.,* 2022).

The most realistic measure of success in the next year is not landscape transformation. It is whether the stakeholder arrangement becomes capable of learning and acting without constant external direction. That means local meetings occur, records are kept, decisions are revisited, problems are reported early, and the technical design changes in response to user experience. Such adaptive capacity is a community-development outcome in its own right.

Table 5. Differentiated engagement strategy and minimum follow-up indicators.

Stakeholder/group	Engagement strategy	Frequency or arena	Minimum indicators
Farmer groups	Co-design the demonstration plot, species choice, cost–benefit sharing, and seasonal evaluation	Initial design and review each season	Active plot; documented decisions; survival and maintenance records
KWT/PKK	Pilot compost/POC, manage equipment and benefits, and hold formal representation	Monthly monitoring	Operating unit; process quality; product use; workload and decision participation
Village government	Appoint focal person, integrate work plan, and support resources	Quarterly coordination	Named focal person; schedule; budget/in-kind support; village reporting
UII–UNSIQ	Technical mentoring, baseline, prototype improvement, evaluation, and dissemination	Quarterly and seasonally	Baseline data; prototype revisions; community feedback; accessible outputs
Agencies/extension/Bappeda	Policy alignment, extension, seedlings, replication, and funding	Semi-annual multistakeholder forum	Specific support commitment; program alignment; additional locations only after review
Market/finance actors	Feasibility analysis, incentives, product market, and microfinance	After pilot evidence is available	Cost–benefit estimate; market pathway; appropriate financing option

4. Conclusions

The stakeholder analysis shows that the climate-smart agroforestry program in Serang Village involved actors with complementary but unequal roles. Farmer groups, UII, and UNSIQ were positioned as key players, while the village government acted as a context setter. KWT/PKK and students showed strong interest but had more limited influence over program decisions.

The findings also show that participation should not be judged only from attendance or involvement in activities. Combining the power–interest matrix, stakeholder salience, and the IAP2 participation spectrum helped reveal differences in influence and decision-making authority. In this program, active participation had not yet reached the level of empowerment because community actors did not control key resources, final design, monitoring, or continuation.

For future community-service activities, the stakeholder analysis should be used as a practical guide for strengthening collaboration. Priority actions include a jointly managed demonstration plot, stronger KWT/PKK involvement, a village focal mechanism, shared monitoring, and selective engagement with

government, extension, finance, and market actors. Because stakeholder positions may change over time, the analysis should be reviewed as the program moves from training to implementation and scaling.

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6. Conflict of Interest Declaration

The authors declare that there is no conflict of interest regarding the publication of this article. The authors also confirm that the manuscript is an original work and has been reviewed for similarity before submission.

7. Author Contribution Statement

All authors contributed equally to the conduct community service project, data analysis, and writing and preparation of this article.

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