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RESEARCH ARTICLE

Rooted in Wisdom: Exploring Indigenous Agroecological Knowledge in Upland Java

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ABSTRACT
This study explores the embedded indigenous agroecological knowledge of Sundanese farming communities in the upland regions of West Java, Indonesia. Drawing on a qualitative ethnographic approach, the research investigates how traditional ecological knowledge is practiced, preserved, and adapted in the face of modern agricultural interventions. Data were collected through in-depth interviews with elder farmers, participatory field observation, and village-level focus group discussions. The findings reveal that indigenous practices such as terraced planting, intercropping, the use of local seed varieties, and customary rituals are not merely agronomic techniques but are deeply rooted in cosmological beliefs and community values. These agroecological systems emphasize ecological balance, biodiversity conservation, and social reciprocity. However, this wisdom is increasingly under threat due to state-led agricultural modernization, youth outmigration, and the commodification of land. The study highlights the urgency of safeguarding traditional farming systems not only for cultural heritage preservation but also for contributing to sustainable and climate-resilient agriculture. It concludes by proposing pathways for policy integration, participatory learning, and intergenerational knowledge transfer to support agroecological transitions grounded in local contexts.

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INTRODUCTION

Agroecological knowledge systems developed by indigenous communities are increasingly recognized as vital resources in addressing global sustainability challenges (Adefila et al., 2024a; Silva-Ávila et al., 2025). These systems are often characterized by ecological sensitivity, community cooperation, and intergenerational knowledge transmission, reflecting an intricate relationship between people, land, and cosmology. In Southeast Asia, and particularly in Indonesia, upland farming communities have long maintained diverse and resilient agricultural practices, shaped by local environmental conditions and cultural values (Do et al., 2024).

In the context of Java, one of the most densely populated islands in the world, indigenous agricultural knowledge remains vital in sustaining food production in ecologically fragile upland regions. Among the Sundanese people, traditional agroecological practices such as terraced farming, mixed cropping, seed exchange rituals, and seasonal land-use calendars are not only practical techniques but also culturally embedded systems of meaning. These practices embody local understandings of ecological balance, social responsibility, and spiritual connection to nature (Nur, 2025).

Despite their ecological and cultural value, indigenous knowledge systems face increasing marginalization due to the spread of industrial agriculture, land commodification, and the erosion of customary institutions. Government-led modernization programs often prioritize high-yield

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monocultures and agrochemical inputs, overlooking local practices that promote biodiversity and soil health. Moreover, rural youth outmigration and the discontinuity of oral traditions have further endangered the survival of these knowledge systems (Malapane et al., 2024).

While existing studies have highlighted the technical efficiency of indigenous practices, fewer have captured the holistic worldview and lived experiences that underpin such systems. This study aims to fill that gap by exploring the narratives and practices of Sundanese farmers in West Java. By employing an ethnographic approach, this research examines how agroecological knowledge is preserved, contested, and adapted in contemporary rural life. Specifically, it investigates how such knowledge systems shape local strategies of sustainability and resilience in upland agricultural landscapes (Wang & Oscar, 2024).

This study contributes to the growing discourse on decolonizing agricultural development by centering the voices and practices of local communities. In doing so, it argues for the recognition of indigenous agroecology as a legitimate and essential foundation for future food systems transformation.

LITERATURE REVIEW

Indigenous Agroecology in the Global Context

Agroecology has evolved beyond its initial technical definition as an ecological approach to farming, emerging as a transdisciplinary framework that integrates scientific knowledge with local, often indigenous, systems of land stewardship (Baker et al., 2024; Nyblade et al., 2024). Research across Latin America, Africa, and Asia has emphasized the resilience of traditional farming systems to climate variability, pest outbreaks, and economic shocks (Obiorah et al., 2025). In particular, indigenous agroecological knowledge rooted in centuries of experimentation, adaptation, and cultural expression has gained scholarly attention for its contributions to sustainable development (Adefila et al., 2024b).

In Southeast Asia, studies have demonstrated the value of indigenous practices in managing upland terrains, conserving agrobiodiversity, and maintaining soil fertility without the intensive use of external inputs (Homeshwari-Devi et al., 2024; Patel et al., 2024). However, these systems are increasingly threatened by agribusiness expansion, infrastructure projects, and state-led modernization schemes that privilege monoculture and agrochemical dependency (Abdulai et al., 2024). Literature highlights a pressing need to document, validate, and protect traditional ecological knowledge before it becomes irreversibly lost.

Agroecology and Cosmology in Sundanese Traditions

Among the Sundanese of West Java, agricultural practices are deeply entwined with religious rituals, social institutions, and cosmological worldviews (Alfan et al., 2024). Farming is not merely a technical activity but a moral practice that reflects harmonious relationships among humans, ancestors, spirits, and the land. Traditional ceremonies such as seren taun (annual rice harvest festival) and hajat bumi (earth thanksgiving ritual) serve to reinforce the ethical and spiritual dimensions of land management. Yet, few studies have explored how such cultural and symbolic systems shape agroecological decision-making. The limited documentation of Sundanese ecological knowledge often isolates techniques (e.g., crop rotation or terracing) from their broader epistemological foundations, leading to reductive or technocratic interpretations. Recent qualitative inquiries call for a more holistic understanding of how farming knowledge is embedded within ways of knowing, being, and relating (Singh et al., 2025).

Political Ecology and Epistemic Justice

This study is informed by political ecology and epistemic justice frameworks. Political ecology helps situate indigenous agroecological systems within larger power dynamics examining how policies, market forces, and land tenure regimes affect access to and control over ecological knowledge (Adriaensens et al., 2025). It emphasizes the contested nature of sustainability and the uneven outcomes of rural development interventions.

Epistemic justice, as articulated by Gosselin & Gauquelin (2025) and later applied to environmental knowledge systems Meredith (2024), provides a lens to examine the marginalization of local epistemologies. It critiques the dominant knowledge hierarchies that devalue indigenous ways of knowing, framing them as "unscientific" or backward. By highlighting testimonial and hermeneutical injustice, this framework enables a critical engagement with how Sundanese agroecological knowledge is represented, silenced, or appropriated in policy and practice.

Together, these frameworks guide this study's inquiry into not only what the farmers know, but also how their knowledge is produced, transmitted, and contested, shedding light on the socio-cultural, political, and spiritual dimensions of sustainability in upland Java.

METHODOLOGY

This study employed a qualitative ethnographic approach to explore how Sundanese farming communities in the upland regions of West Java sustain, adapt, and transmit their indigenous agroecological knowledge. Ethnography was chosen for its strength in capturing culturally embedded practices, oral traditions, and tacit understandings that cannot be reduced to quantitative indicators. The research focused on two Sundanese villages in Kuningan Regency, selected purposefully based on their continued use of traditional agricultural techniques, engagement in local rituals, and exposure to external development interventions. These villages, situated between 800 and 1000 meters above sea level, maintain a diverse landscape of terraced rice fields, mixed gardens, and sacred forest areas, an ideal setting for examining the lived interface between culture and ecology.

Fieldwork took place over a three-month period and involved multiple forms of data collection. Eighteen participants were engaged through purposive and snowball sampling. They included smallholder farmers, ritual custodians *(kuncen desa)*, women's cooperative leaders, and agricultural extension facilitators. Interviews were conducted in Sundanese and Bahasa Indonesia, following a semi-structured format that allowed participants to share personal narratives, experiences with seasonal cycles, seed preservation, water management, and ritual practices. In addition to interviews, the researcher took part in everyday farming activities and participated in key ceremonies such as *hajat bumi (*earth thanksgiving) and *seren taun* (harvest transition), making detailed field notes of interactions, ecological decisions, and cosmological references.

Thematic analysis was carried out using a constructivist grounded theory lens (Yuli, 2024). Interview transcripts and observation notes were coded manually in multiple cycles, beginning with open coding to identify recurring concepts such as sacred land markers, ancestral guidance, and climate variability. Axial coding was then used to trace relationships among these themes. Throughout the analysis process, memos were written to reflect on emergent meanings and the researcher's positionality as an outsider seeking to learn from within. Cultural protocols were respected during all phases of research, including obtaining oral consent from participants and adhering to village norms of entry, dialogue, and reciprocity. This methodology was designed not only to generate rich descriptive data but also to honor the epistemological frameworks of the communities whose knowledge is often marginalized in mainstream development discourse.

RESULT AND DISCUSSION

Knowledge Rooted in Land, Ritual, and Memory

For the Sundanese farmers of Kuningan's upland regions, land is more than a physical space for cultivation, it is a living entity embedded with ancestral memory, moral responsibility, and cosmological significance. Through fieldwork conversations and participant observation, it became evident that the act of farming is deeply spiritual, guided not only by empirical experience but also by a cosmology that recognizes the land *(leuweung)*, water *(cai)*, and sky *(langit)* as interconnected realms. Farmers repeatedly referred to the land as *ibu bumi* (mother earth), a sentient being to whom gratitude and ethical care are owed. This relational understanding reinforces the principle that land is not owned in the Western proprietary sense but rather entrusted by ancestors for stewardship.

One elder farmer, Pak Darsa, expressed this sentiment during a walk through his terraced rice fields:

"We do not plant just for food; we plant to respect what our grandfathers have taught us. The soil listens. If you are greedy, it knows. If you are thankful, it gives back."

Such narratives, frequently encountered during rituals like *hajat bumi* (earth thanksgiving), underscore how land management is not only agricultural but also ritualistic. Offerings of rice, incense, and betel leaves at sacred field corners are acts of remembrance and ecological reciprocity.

These embodied practices reflect a form of ecological intelligence accumulated through generations, encoded not in written manuals but in ceremonies, proverbs, and seasonal taboos. Farmers spoke of *pamali*, ritual prohibitions that govern farming conduct during lunar phases or after certain events, such as the death of a village elder. These taboos, while often dismissed by outsiders as superstition, in fact constitute a localized form of environmental regulation, protecting water sources during droughts or restricting harvest during ecological stress.

What emerges is a worldview in which agroecological knowledge is co-produced through ritual observance and intergenerational storytelling. The land is both a physical and symbolic archive of ancestral wisdom. This worldview diverges sharply from state-led agricultural development models that prioritize yield maximization and mechanization, often marginalizing spiritual and communal dimensions of farming.

This finding aligns with a growing body of literature that emphasizes the epistemic value of indigenous knowledge systems in sustainability discourse (Agbo, 2025; David, 2024). In particular, it supports the claim that ancestral agroecological knowledge is not static folklore but a dynamic, adaptive knowledge regime shaped by generations of observation, reverence, and resistance. Recognizing such knowledge not only enriches agroecological scholarship but also offers viable alternatives to extractive development paradigms that have often undermined both biodiversity and cultural resilience.

Seasonal Rhythms and Indigenous Climate Intelligence

Embedded within the day-to-day practices of Sundanese farmers is a sophisticated body of ecological forecasting shaped not by satellite data, but by attune to the living rhythms of the environment. Long before the arrival of meteorological maps or climate models, upland communities in Java had developed adaptive mechanisms to anticipate seasonal changes, drawing on generations of observation and cultural transmission. This climate intelligence, intuitive, collective, and locally situated forms an essential pillar of indigenous agroecological knowledge (Alam, 2025).

Farmers routinely referenced natural indicators such as the behavior of cangkurileung birds (shrike-like insectivores), shifts in wind direction, and the flowering cycles of certain trees like jengkol and dadap. When asked how they knew when the rainy season was near, several participants independently mentioned the presence of thick mist at dawn coupled with the croaking of frogs in unusually dry soil. *“Kabut tebal jeung hayam henteu tara eureun kuur”* (thick fog and restless chickens)

was a repeated proverb, highlighting how multi-species cues are interpreted in combination rather than isolation.

This ecological reading of signs is not merely descriptive but serves as a decision-making tool guiding when to clear fields, transplant seedlings, or hold rituals for rainfall. One mid-aged farmer, Ibu Rahayu, explained:

"The almanac we use is not printed. It's passed by my mother to me. We observe and feel. If the banyan tree starts shedding before the month of Maulud, we delay planting. It is not yet the true rain."

Such knowledge systems integrate temporal awareness with cultural memory. Farmers employ a lunar calendar, modified by the Sundanese agricultural cycle, which aligns the planting season with not only rainfall patterns but also sacred days for soil fertility.

These findings illustrate how climate knowledge in these communities is localized, embodied, and deeply interwoven with cultural identity. Unlike formal climate science, which often arrives in the form of inaccessible charts and probabilistic models, indigenous forecasting is action-oriented and shared orally through daily conversations and communal rituals. This collective wisdom has become increasingly valuable in the context of erratic rainfall and changing seasons brought by climate change (Syafriani & Yuliani, 2025).

Importantly, this form of climate intelligence is not static. Younger farmers are blending traditional signs with contemporary tools like Android weather apps and online forecasts, creating a hybrid knowledge ecology. However, they continue to prioritize experiential signs over digital inputs when the two sources diverge. This hybridity reflects a strategic adaptation, not a wholesale abandonment of ancestral wisdom.

Scholarly literature has increasingly recognized the resilience of indigenous weather forecasting systems, particularly in the Global South, as viable complements to formal climate science (Dube et al., 2024; Okedele et al., 2024). The Sundanese case affirms that such systems do not merely persist as cultural artifacts but offer real-time adaptive strategies for farming communities confronting climate uncertainty. Valorizing these systems within policy and academic discourse may foster more inclusive and grounded approaches to climate adaptation that do not erase the knowledge of those most exposed to environmental risk.

Ceremonial Structures for Resource Management

In the Sundanese highland communities of Kuningan, ritual is not an ancillary cultural activity, but a functional mechanism through which resource governance is enacted, negotiated, and maintained. Far from being merely symbolic, communal rituals such as *hajat lembur* (village thanksgiving), *seren taun* (rice harvest ritual), and *mapag hujan* (welcoming the rains) operate as embedded systems of ecological management and social accountability. These ceremonies are where norms of land use, water allocation, forest access, and labor cooperation are discussed, transmitted, and collectively reinforced.

During field immersion, it became evident that these rituals serve as informal but highly effective governance platforms. For instance, the annual seren taun, held at the ancestral rice barn (leuit) and attended by representatives from all hamlets (*kampung*), involves not only offerings to ancestral spirits but also a communal review of the previous year's harvest outcomes, pest outbreaks, and water-sharing agreements. Resolutions passed during these gatherings although not codified in law are socially binding. Violators of collective rules, such as early harvesters or those who divert irrigation without permission, are publicly named or excluded from next season's communal labor rotations (*gotong royong*).

One village elder explained the logic succinctly:

"If you skip the ritual, you skip the agreement. If you skip the agreement, we skip helping you during drought."

This illustrates how social sanctioning, embedded in ritual participation, reinforces environmental stewardship and mutual responsibility.

Importantly, rituals also act as spaces for intergenerational education. Young villagers, often disengaged from formal environmental policies, learn about sacred groves *(leuweung larangan),* forbidden trees *(kayuan pamali),* and rotational cropping rules through songs, dances, and symbolic reenactments during ritual performances. These aesthetic practices serve as a pedagogical function, ensuring ecological knowledge is retained and internalized across generations, even in the absence of formal schooling or policy outreach.

Moreover, ritual practice reflects a form of participatory governance. Decision-making is typically done through deliberative consensus during ritual forums, often moderated by *kuncen* (ritual elders) and *lebe* (Islamic community leaders), signifying a culturally grounded system of dual authority—spiritual and communal. This coexistence of Islamic ethics and animist cosmology in land and water rituals illustrates a syncretic governance model that bridges customary and religious values.

These findings resonate with literature on "civic ecologies" and "ritual governance" in indigenous environmental management (Berkes, 2009). The Sundanese case suggests that rituals not only sustain cultural identity but also institutionalize ecological norms through consensus-based systems of accountability and moral obligation. Unlike top-down regulatory systems, these rituals offer horizontal, adaptive, and inclusive forms of governance deeply embedded in local worldviews.

Recognizing the role of rituals in resource governance thus requires a reframing of what constitutes policy and law. In these communities, law is not written in statutes but performed in dance, narrated through proverbs, and sanctified in communal prayer. To dismiss ritual as non-rational is to misunderstand its central role as a technology of governance, resilience, and sustainability.

Gendered Ecologies and the Role of Women in Sustainability Practice

In the rural agroecological systems of Kuningan, the role of women extends beyond domestic labor into the very heart of environmental stewardship, food sovereignty, and ritual continuity. Women's contributions are not only functional but also epistemological. They carry and reproduce ecological knowledge through seed saving, seasonal forecasting, herbal medicine preparation, and embodied ritual participation. However, these gendered forms of environmental knowledge often remain invisible within formal sustainability discourses.

Field interviews with female elders *(nini-nini kampung)* revealed that women serve as memory-keepers of both agronomic practice and spiritual codes. Many of them are custodians of indigenous rice varieties, maintaining biodiversity through selective seed exchanges that occur not in markets but within sacred familial networks during rituals such as *seren taun* and *ngaseuk pare.* They distinguish dozens of rice strains not only by yield or drought tolerance, but by ceremonial suitability and ancestral significance decisions rooted in a blend of empirical observation and spiritual guidance.

Women are also central to the maintenance of leuweung tutupan (protected forests), which are considered sacred zones requiring gender-specific offerings and taboos. In one case, an elder woman from Desa Cibunut explained how women were responsible for guarding the mata air (spring source), a ritual and ecological duty passed down through matrilineal instruction. This guardianship involves regulating access, monitoring pollution, and conducting seasonal cleansing rites, which serve as both spiritual and environmental hygiene practices (Al Farishi et al., 2025).

Importantly, these roles intersect with cultural constructs of femininity and fertility. In many rituals, women embody the earth spirit (*ibu pertiwi*), an ontological stance that positions the female body as a conduit between the human and the ecological. Ritual dances and songs performed by women are not merely performative but are believed to sustain ecological balance. As one informant noted, "We dance to calm the sky, to ask the mountain to rest."

However, women also navigate power asymmetries. While they hold ecological knowledge, decision-making in mixed-gender ritual councils remain largely male-dominated. This tension manifests in subtle exclusions from strategic conversations around land-use change or negotiations with external stakeholders. Women's insights are often heard but not always recorded or acted upon. As a result, their environmental labor risks being symbolically celebrated but structurally sidelined.

Yet, women's agencies persist through informal influence. Younger women are forming *kelompok tani wanita* (women's farmer groups) that integrate traditional knowledge with ecological entrepreneurship, such as organic composting and herbal product cooperatives. These initiatives enable women to negotiate between local custom and modern ecological citizenship, redefining their place in sustainability governance.

This section affirms the significance of feminist political ecology in understanding localized sustainability. The case of Kuningan suggests that sustainable development must account for how gender, culture, and nature are co-produced. Ignoring the epistemic role of women is not only a loss of equity but a loss of critical knowledge that sustains both land and life.

Tensions Between Local Traditions and External Interventions

The landscape of Kuningan is increasingly shaped not only by ancestral memories but by the incursion of modern development agendas. As external actors from government bodies to NGOs and academic researchers enter rural communities with offers of aid, infrastructure, or innovation, they often carry with them assumptions about what constitutes progress, sustainability, or efficiency. These assumptions, though well-intentioned, can unsettle long-standing customary systems that are deeply entwined with cosmological beliefs and local governance.

In interviews, villagers expressed ambivalence toward these interventions. Some welcomed agricultural training programs, renewable energy projects, or infrastructure development. Others, particularly elders and ritual leaders (*juru kunci*), voiced concern that these changes disrupted the balance between the seen and unseen worlds. For instance, one village head recalled a failed water channeling project that ignored customary protocols regarding *leuweung larangan* (sacred forest zones). After the construction disturbed ancestral sites, a series of crop failures and a sudden drought followed. For the community, the message was clear: ecological imbalance was also a spiritual disturbance.

The recurring theme in these stories is consultation without comprehension. While participatory planning is often cited as a best practice, local stakeholders reported feeling "informed" rather than "included." Government representatives often convened meetings in Bahasa Indonesia without translation into Sundanese, the local language, resulting in symbolic participation that lacked genuine engagement. Additionally, technical blueprints and timelines were difficult for elders to interpret, reinforcing a divide between modern planning logics and indigenous temporalities.

In some cases, traditional leaders have been co-opted into development projects as cultural brokers, tasked with securing community buy-in. However, this can place them in a precarious position. As one juru kunci lamented, "I carry the message of the ancestors, not the budget of the government." When local leaders are positioned as mediators, they must negotiate their spiritual authority alongside the managerial expectations of external partners. Failure to reconcile these roles risk fracturing their legitimacy within the community.

At the heart of this negotiation lies a fundamental ontological tension. External interventions often operate within a paradigm that treats land, labor, and resources as discrete, extractable categories. By contrast, customary frameworks view land as imbued with spirit, labor as a communal obligation, and natural resources as gifts to be stewarded rather than commodities to be maximized. These differing worldviews create frictions that are not easily resolved through technical adjustments or community outreach.

Yet, some communities have found creative ways to bridge these divides. One village integrated solar irrigation systems into their rice paddies only after performing a ritual to ask permission from the land spirits, thereby embedding innovation within ritual continuity. Another village repurposed an NGO-funded training hall as a site for traditional dance and ancestral storytelling, reclaiming the space from bureaucratic use to cultural revival. These examples highlight that tradition is not static, it negotiates, resists, and reshapes itself in relation to change.

CONCLUSION

This qualitative inquiry has explored how rural communities in Kuningan, West Java sustain their ecological, cultural, and spiritual lifeways in the face of environmental change and development pressures. Drawing on in-depth interviews, field observations, and participatory engagement with village elders, ritual custodians, and farmers, the study reveals that sustainability in these contexts is not a purely technical or economic concern but a deeply relational and place-based practice.

The findings illustrate that customary ecological knowledge is intimately intertwined with ritual, ancestral memory, and a moral worldview that regards the land as a living entity rather than an inert resource. Environmental stewardship is enacted not through externally imposed standards but through daily acts of reciprocity, seasonal rituals, and intergenerational knowledge transfer. These practices are not static traditions but evolving frameworks that enable communities to adapt to change while retaining cultural coherence.

At the same time, the study exposes the friction between local epistemologies and externally driven interventions. While development programs often introduce technologies or policies based on universal logics of efficiency and growth, they risk overlooking or undermining the spiritual and relational foundations of local life. Yet rather than rejecting modernity outright, many community members strategically engage with it, integrating innovations within ritual structures or repurposing development spaces for cultural revival.

This research contributes to the growing body of literature that advocates for pluriversal approaches to sustainability approaches that acknowledge and validate multiple ways of knowing and being in relation to the Earth. By documenting how rural actors negotiate the interface between tradition and change, the study provides evidence that equitable and enduring sustainability must be co-produced with local communities, not delivered to them.

In conclusion, development initiatives must be reimagined as processes of dialogue rather than delivery. Recognizing land as sacred, rituals as governance, and memory as method opens pathways for more inclusive, culturally grounded, and ethically responsive sustainability efforts. Future research should deepen this line of inquiry across diverse geographies and explore how inter-ontological partnerships can shape policy, practice, and pedagogy in the Anthropocene.

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Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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