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# Hybrid Agroecology Model: Indigenous Knowledge Innovation for Sustainable Food Security in Sabah

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### ABSTRACT

Food security among Indigenous communities in Sabah is increasingly under strain due to agrarian reforms, environmental change, and governance challenges that undermine local agroecological systems. While past discussions have highlighted issues of resource dispossession and policy impacts, little attention has been given to how Indigenous knowledge is reorganised and adapted to address these pressures. This study aims to develop a Hybrid Agroecology Model that integrates Indigenous ecological knowledge with modern scientific practices to strengthen food security in Sabah. By focusing on how these two knowledge systems can be combined, the research explores pathways for enhancing productivity, ecological resilience, and cultural continuity within Indigenous farming communities. The study employed a qualitative research design in Telupid, Sabah, using interviews, observations, and focus group discussion to capture the perspectives of farmers and local leaders. Data were analysed to identify practices, values, and innovations that contribute to sustaining food systems under changing socio-ecological conditions. Findings from this research reveal that the hybrid model helps communities improve agricultural output while preserving ecological stability. It also highlights the role of Indigenous knowledge in preserving cultural values, reinforcing social networks, and reducing reliance on external markets. Importantly, the integration of scientific innovations supports adaptive strategies that help communities respond more effectively to environmental and economic pressures. In conclusion, the Hybrid Agroecology Model shows potential as a framework that balances local knowledge and scientific approaches, ensuring that Indigenous communities in Sabah can secure their food systems in a sustainable and culturally meaningful way. The study provides practical insights for strengthening food security through approaches that are both resilient and socially inclusive.

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## 1. Introduction

The food security of Indigenous communities in Sabah is increasingly exposed to intersecting pressures from neoliberal agrarian reforms, environmental change, and uneven governance. The expansion of market liberalisation, profit-oriented agricultural models, and cash-crop production has transformed local food systems, often favouring capital-intensive agriculture over local agroecological practices grounded in collective values and sustainability. For communities whose food security depends on land, forests, and water resources, these changes carry profound political and ecological implications [5].

From an environmental sociology perspective, food security extends beyond the aspects of availability, accessibility, affordability, or distribution; it is also deeply connected to social relations, power asymmetries, governance regimes, and competing knowledge systems [1,7,13,10]. Political ecology offers a critical framework for understanding how political economy shapes ecological change and access to resources. At the same time, Traditional Ecological Knowledge (TEK) serves as the foundation for sustaining agroecological systems. This knowledge is not a static cultural artefact; rather, it is a dynamic process that continually responds to political, economic, and environmental changes.

In Malaysia, the orientation of “modern” agricultural policy towards monoculture covering commodities such as oil palm and rubber has often come at the expense of traditional agroecological systems rooted in the rural moral economy, which emphasises cooperation, mutual care through the creation of safety nets, and sustainable resource management [6,15]. This policy orientation is reinforced by uneven recognition of Indigenous land and resource rights, which, although nominally protected under policies such as the Bumiputera Policy, remain inconsistently applied [9]. As a result, market and state power frequently sideline Indigenous knowledge and practices, further eroding the ecological and cultural foundations of local food systems.

Nevertheless, Indigenous communities are not passive recipients of these structural pressures. They adapt modern technologies in ways that align with their traditions, including the use of innovative organic fertilisers and water-efficient cultivation methods. These approaches retain elements of traditional agroecology through mixed cropping and customary water resource management. This integration has given rise to the Hybrid Agroecology Model, an innovative combination of modern science and TEK that enhances productivity, strengthens ecological resilience, and preserves cultural identity.

However, power asymmetries in food governance often position scientific knowledge as superior, leading to the neglect of the value and effectiveness of traditional knowledge. This raises critical questions: whose knowledge is considered legitimate, and who has the authority to determine the future of food systems? The process of decolonising knowledge becomes essential in addressing the politics of power in knowledge production, while recognising the innovations of communities as central to inclusive and sustainable food security policy. Despite increasing research on Indigenous food systems in Malaysia, little attention has been given to how TEK can be systematically integrated with modern science to address food security challenges in Sabah. This gap is particularly evident in the lack of models that position Indigenous communities as active decision-makers rather than passive beneficiaries.

This paper develops and analyses the Hybrid Agroecology Model among Indigenous communities of the Kadazan-Dusun ethnic group in Telupid, Sabah, to demonstrate how integrating traditional and modern knowledge can serve as an effective innovation strategy for building equitable, sustainable, and crisis-resilient food systems. It offers a novel contribution by introducing the Hybrid Agroecology Model, which not only integrates TEK and modern science but also positions Indigenous communities

as key actors in food governance. Emphasising the role of communities as decision-makers in agricultural modernisation and resource management remains rare in the context of Sabah. This approach is not merely a technical strategy, but a reframing of power and knowledge within food systems, challenging the dominance of market-oriented development models.

## **2. Research Methodology**

This study examines and develops the Hybrid Agroecology Model among Indigenous communities in Telupid, Sabah, through the lens of political ecology. Sabah, one of the states with the lowest economic standing in Malaysia, faces persistent food security challenges due to rising global food prices, environmental change, and a heavy reliance on imported food. Statistics indicate that the state's annual food import bill is estimated at between RM900 million and RM1.3 billion. This figure includes approximately 75 per cent of Sabah's rice supply, as only 25 per cent of its rice demand is met through local production [17]. Such dependency weakens food resilience, particularly for Indigenous communities.

To achieve the goal of reducing reliance on imported food, it is essential to understand how communities integrate TEK with modern scientific innovations to strengthen local food systems. Accordingly, a case study design was adopted to enable an in-depth investigation into community practices, strategies, and innovations. Two Indigenous villages, Lumou and Kopuron in Telupid, were selected because both exemplify a combination of traditional practices and modern technological adaptations in agriculture. Participant selection was conducted using purposive sampling and snowball sampling techniques to ensure representation across diverse demographic groups and community roles.

All participants in this research were provided with clear information about the purpose of the study, methods, potential risks, and expected benefits. Informed consent was obtained verbally and in writing prior to participation, and participants were assured of their right to withdraw at any stage. Given the involvement of Indigenous communities, particular attention was paid to respecting cultural protocols, ensuring confidentiality, and securing both individual and collective consent in line with community norms. Ethical approval for this study was obtained from the Human Research Ethics Committee [B] UNSW on 27 October 2020 with approval number HC200536, and all research procedures complied with international standards for research involving Indigenous peoples.

In-depth interviews were carried out to explore community experiences, strategies, and innovations in integrating traditional knowledge with modern technology. A total of 14 key informants were interviewed, comprising five Indigenous community leaders, two NGO representatives, one oil palm company representative, two government department officers, and four smallholder farmers. The interviews also examined the effectiveness of integrating TEK with modern technology and the challenges in securing policy-level recognition for community innovations.

Focus Group Discussions (FGDs) were also conducted, involving 28 participants divided into six groups (women, men, and youth in each village) with four to six members per group. The discussions focused on the impacts of commercialisation and modernisation on food strategies, shifts in agricultural techniques, and the potential for building the Hybrid Agroecology Model. Field observations were also undertaken to identify key food sources, agricultural practices, and forms of technological adaptation, including visual documentation through photographs and videos.

Qualitative data from interviews, FGDs, and observations were thematically analysed using NVivo software. The analysis centred on identifying elements of traditional and modern knowledge that could be combined in the Hybrid Agroecology Model, as well as institutional and ecological factors

influencing the model's effectiveness. This multi-method approach not only enhanced the accuracy of findings through triangulation but also enabled the development of an innovation model grounded in the lived realities of local communities.

### **3. Social Dynamics and Their Influence on the Politics of Knowledge**

Telupid is located in the central region of Sabah, serving as a connecting corridor between the state's east and west coasts. The area encompasses lowland forests, major rivers such as the Labuk River, and fertile agricultural land. Its population comprises various ethnic groups, including Kadazan-Dusun, Orang Sungai, and other minorities, with the Kadazan-Dusun community forming the dominant group in the interior areas. Although basic infrastructure such as roads, electricity supply, and healthcare facilities is available, access remains uneven across the district, leaving some villages, particularly in remote areas, still dependent on community support networks and local resources for their daily needs.

Telupid's economy is fundamentally based on agriculture, with oil palm as the main crop. The idea of expansion, which existed even before independence, gained momentum in the early 2000s through state policies and private sector investment. Nevertheless, many Indigenous smallholders continue to cultivate hill paddy, rubber plots, and home gardens for subsistence purposes. Local data indicate a large-scale shift from customary land to large oil palm plantations, which has altered land ownership structures and affected community access to forest and river resources. This land-use change has also reshaped employment patterns, with many youths working in the plantation sector or migrating to towns such as Sandakan and Kota Kinabalu.

The communities in Telupid possess a rich heritage of TEK, including land management, integrated farming practices, and the use of medicinal plants. Village leadership institutions play a key role in preserving customary laws and collective values, including community-based governance of natural resources. However, the introduction of modern technology and the pressures of the global market through the expansion of cash crop agriculture have transformed some of these traditional practices. As a result, although TEK is still practised, it is often marginalised in development planning processes dominated by scientific-technical frameworks. This reflects the presence of a power-knowledge asymmetry, where local community voices are insufficiently recognised, even though TEK has proven effective in ensuring resource sustainability and community level food security.

### **4. The Dominance of Scientific Knowledge**

Food governance in Telupid reflects the dominance of scientific knowledge grounded in the state's technocratic framework, where government agencies and formal institutions hold epistemic authority to determine what is deemed legitimate as 'modern agricultural knowledge.' Progress benchmarks are often measured through the use of mechanised technology, laboratory-tested crop seeds, standard planting schedules, and cash crop orientations aligned with market logic. This modernisation narrative not only reinforces the position of scientific knowledge as the primary reference point but also displaces TEK, which has long formed the foundation of Indigenous communities' subsistence systems. As a result, community autonomy in determining their food systems is increasingly diminished.

The dominance of scientific knowledge in Malaysia's agricultural sector is not merely a technological issue but reflects power relations between the state, the global market, and local communities. Over the past few decades, agencies such as the Department of Agriculture and the

Federal Agricultural Marketing Authority (FAMA) have positioned themselves as the sole arbiters of legitimised agricultural knowledge, prioritising a scientific–technical framework that promotes legally protected, laboratory-tested seed varieties, large-scale farm mechanisation, and standardised planting schedules.

This policy narrative strengthens the perception that scientific knowledge is superior to local agroecological practices. For instance, hybrid rice varieties such as MR219 and MR297 are widely promoted, even though traditional varieties such as *Parai Tadong* and *Parai Tondui*, which informants claim are more resistant to paddy diseases like blight, are overlooked. Research shows a significant increase in farmers' dependence on subsidised varieties, particularly among commercial paddy farmers in Sabah [16]. This shift reflects the replacement of ecologically based subsistence systems with market systems governed by the logic of productivity and profit.

From a political ecology perspective, this dominance is a direct outcome of neoliberal policy interventions since the 1980s, which have favoured export-oriented cash crops such as oil palm and rubber. Oil palm plantation areas in Sabah expanded to 194,266.3 hectares in 2023 [12], replacing many areas of traditional agriculture. Amendments to the Sabah Land Ordinance, the gazettment of forest reserves, and agricultural loan incentives have institutionalised a development model that prioritises this scientific–technical logic, thereby reducing the role of TEK.

The impact on food security is significant. Field research found that about 70 per cent of villagers now rely more on market-bought food due to difficulties in accessing traditional food sources such as wild vegetables and river fish. The adoption of modern technology without an understanding of the local ecological context has created a dual dependency on external inputs (seeds, fertilisers, pesticides) and on the power structures that control access to these inputs. This dependency becomes highly vulnerable during crises, such as the COVID-19 pandemic, when fertiliser prices rose and seed supplies were delayed.

## 5. Marginalisation of Indigenous Agroecological Knowledge

The marginalisation of TEK in Telupid stems from the complex interplay between national policies, market ideology, and environmental change. TEK, rooted in generations of lived experience, careful observation of local ecosystems, and social traditions such as *mitatabang-tabang* (communal labour) and collective land management, is increasingly excluded from the formal frameworks of agricultural and food governance.

This shift is evident in the replacement of practices such as traditional seed saving, mixed cropping systems, and customary water management with monoculture techniques driven by externally derived scientific knowledge. Commercialisation programmes and incentives for cash crops such as oil palm and rubber have transformed the agricultural landscape from one focused on household subsistence to one oriented towards profit. A study in Telupid District found that more than 60 percent of agricultural land in the area is now used for cash crops. As a result, fertile land for food cultivation is shrinking, eroding the foundations for sustaining agroecological practices.

This phenomenon is not merely a technical issue but also a question of power. Market ideology has shifted the social values of Indigenous communities from sharing resources to ensure collective food security, towards a “store or sell” logic for cash income. The community safety nets that once ensured no household went hungry through the sharing of harvests have weakened, leaving communities more vulnerable to food price fluctuations or supply disruptions caused by natural disasters.

From a political ecology perspective, the marginalisation of TEK occurs through three interrelated structural mechanisms: land acquisition, the criminalisation of traditional farming practices, and

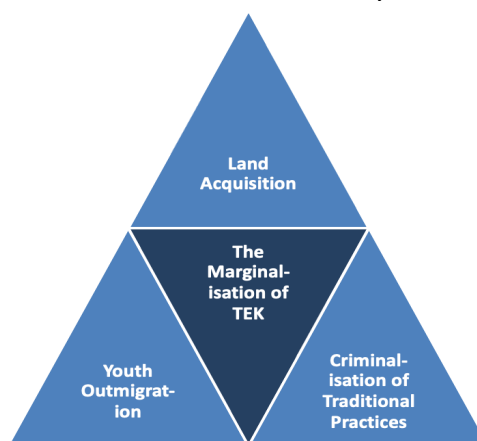
youth outmigration. Rotational farming areas, wild food gathering, and hunting have declined due to the gazettement of protected areas, the expansion of commercial plantations, and resettlement schemes. In Telupid, the gazettement of Forest Reserves, the establishment of oil palm plantations, and logging activities have reduced access to traditional farming land. As one informant explained during an interview:

“Saya tidak setuju sepenuhnya bah dengan undang-undang yang terlalu ketat ini. Kalau undang-undang senjata api mahu diperketatkan, itu perkara biasa. Tetapi jika Orang Asal memiliki senjata api berlesen, mereka sepatutnya dibenarkan memburu babi hutan. Babi hutan ini membiak dengan cepat, jadi sepatutnya kita membenarkan pemburuan ini demi keselamatan makanan Orang Asal kita. Di negara maju pun, ada musim tertentu yang membenarkan pemburuan di hutan. Mengapa kita di negara membangun tidak boleh melaksanakan peraturan seperti itu?” (*I don't fully agree with these really strict laws. If they want to tighten gun laws, that's fine. But if Indigenous people have a licensed gun, they should be allowed to hunt wild boars. These animals breed so fast, and hunting them helps with our food security. Even in developed countries, there are certain seasons when hunting is allowed. So why can't we have something like that in a developing country?*)

(Semi-structured interview with Mr. Lasi, 2021).

Land-related regulations and ordinances also overlook local ecological realities. For example, prohibiting controlled forest burning for agriculture, an essential part of rotational farming, has restricted farming methods considered sustainable by Indigenous communities. The instability of the agricultural sector has contributed to the migration of younger generations to urban areas for formal employment, severing the intergenerational transfer of knowledge. In Telupid, a significant proportion of youth choose to work in towns, leaving the older generation to manage farms and paddy fields. Without active successors, techniques such as planting calendars based on natural signs or traditional seed storage risk being lost entirely.

The interaction of the three main marginalisation factors identified, as shown in Figure 1, land-use change, the criminalisation of traditional farming practices, and youth outmigration, has resulted in the systematic erosion of TEK. These processes have disrupted the continuity of Indigenous knowledge. However, this erosion also presents an opportunity for the development of the Hybrid Agroecology Model as an integrative approach that combines the strengths of modern science and TEK. Cajete [4] and Cai *et al.*, [3] emphasise that TEK functions as an adaptive knowledge system arising from the continuous interaction between communities and their environment. When combined with modern science, it can enhance sustainability.



**Fig. 1.** Factors contributing to the marginalisation of TEK

Successful examples of hybrid knowledge practices between TEK and modern science can be seen in the study by Bohensky *et al.*, [2] in the Solomon Islands, where communities integrated traditional knowledge of fishing seasons, tidal patterns, and reef ecology with scientific data to manage seasonal no-take zones. This strategy proved that such integration can restore biodiversity, strengthen food resources, and enhance community resilience. When applied to the agricultural context in Sabah, a similar approach has the potential to revitalise TEK while leveraging scientific innovation to build a more sustainable and resilient food system.

Research in Telupid found that households practising mixed cropping systems using traditional seeds, while also applying technological products such as pesticides and fertilisers in crop management, tended to achieve better yields. This, in turn, has a positive impact on efforts to improve food security among Kadazan-Dusun farmers in Telupid. As one informant explained during an interview:

“Kadang-kadang ada pakai baja. Baja yang sesuai memastikan benih padi tumbuh dengan baik. Jenis dan kuantiti baja yang digunakan pula bergantung kepada jenis padi dan keadaan tanah. Berapa jumlah baja diperlukan itu perlu tahu juga. Kadang-kadang kita tahu ini dari kursus yang dibuat oleh Jabatan Pertanian.” (*Sometimes we do use fertiliser. The right fertiliser ensures that the paddy seeds grow well. The type and quantity of fertiliser used depend on the variety of paddy and the condition of the soil. You also need to know how much fertiliser is required. Sometimes we learn this from courses organised by the Department of Agriculture.*)

(FGD session with the women’s group, Telupid, 2021).

To ensure that this innovation delivers long-term impact, institutional transformation is needed through epistemological bridging, as illustrated in Figure 2. This approach rejects the notion that innovation means replacing “the old” with “the new.” Instead, it builds a more inclusive, adaptive, and locally grounded agricultural system, aligning with the goals of the Hybrid Agroecology Model for sustainable food security in Sabah.

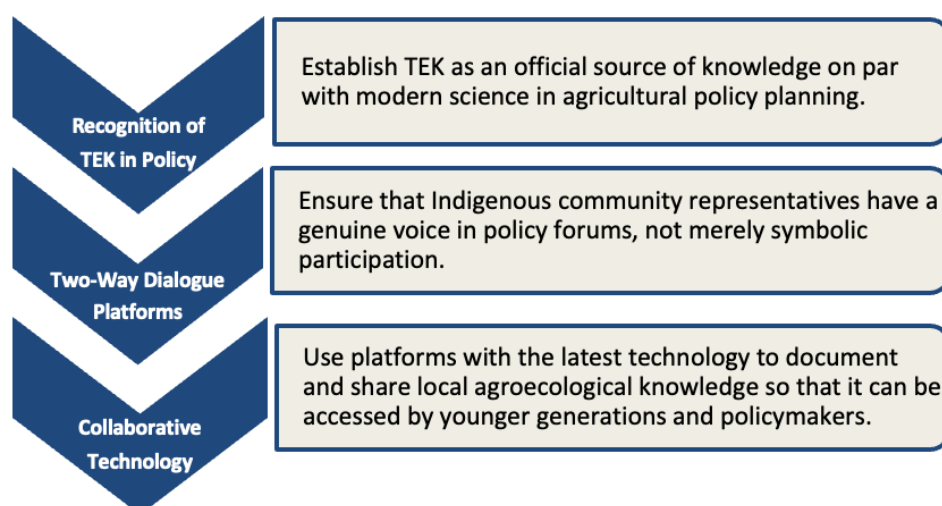


Fig. 2. Strategies for bridging epistemologies

## 6. Hybrid Knowledge as a Form of Resilience

The development reality that often sidelines TEK has created space for the establishment of the Hybrid Agroecology Model. This inclusive and adaptive approach combines the strengths of modern science with the resilience of local agroecology. This model is not intended to replace traditional knowledge, but rather to integrate it in order to build a sustainable, resilient, and culturally rooted food system. The study by Mulyoutami *et al.*, [14] on simpukng (forest gardens) among the Dayak communities in East Kalimantan demonstrates that agroforestry management based on customary regulations can prevent overexploitation and provide diverse yields, including food, medicine, building materials, and commodities for sale, thereby supporting biodiversity conservation and sustaining community livelihoods. Here, TEK has proven to be dynamic, embracing new scientific innovations such as tree management techniques, the cultivation of higher-yielding fruit varieties, and the intensive management of valuable medicinal herbs without undermining its traditional ecological foundations.

The effectiveness of integrating TEK and modern science depends on two main prerequisites: secure community land and resource tenure, and respect for local regulations and values [14]. When both forms of knowledge are recognised, they produce more sustainable land-use patterns, stronger biodiversity protection, and reduced rates of deforestation, key elements for ethically modernising TEK. Conversely, the absence of tenure security and pressures from logging and mining industries have weakened the role of communities as resource managers. Therefore, resource governance reforms must be grounded in principles that position communities as key decision-makers, in line with the aspirations of the Hybrid Agroecology Model, which upholds the synergy between local knowledge and modern science as the foundation for food sovereignty and ecosystem sustainability [14].

This comparison shows that genuine innovation emerges from merging two forms of knowledge: scientific knowledge, which offers technical advantages, and TEK, which ensures ecological sustainability and cultural continuity. However, through the lens of epistemic injustice, many cases of integration remain symbolic, where community knowledge is taken as “input” without granting communities real power in decision-making [8,18,19]. If the Hybrid Agroecology Model is supported by policies that recognise epistemological equality, it has the potential to transform communities from mere recipients of technology into creators and decision-makers in modernisation. This would balance the one-way dominance of scientific knowledge, building a stronger and more crisis-resilient foundation for food security in the face of rapid socio-ecological change.

Despite facing systematic marginalisation due to national policies and global market pressures, Indigenous communities in Sabah continue to demonstrate significant resilience through the integration of scientific knowledge with traditional agroecological practices. A case study in Telupid found that farmers combine mixed-crop care for local seed varieties such as rice and vegetables with the use of modern organic fertilisers and planting schedules based on weather data from mobile applications, while also considering local weather forecasting knowledge. This pattern of adaptation shows that even though the political and economic space of the Kadazan-Dusun community is perceived as narrowing, hybrid knowledge has preserved their relative autonomy in food production systems. It therefore serves as a form of resilience consistent with the concept of adaptability in political ecology.

The practice of maintaining home gardens offers a concrete example of how hybrid knowledge operates in the daily lives of communities in Telupid. From the perspective of TEK, home gardens have long been part of the Kadazan-Dusun community’s livelihood strategies. Knowledge about plant variety selection, mixed-cropping techniques, and soil care is inherited through generations and



adapted to local conditions. In the current context, the function of these home gardens is strengthened through integration with modern elements, such as the use of agricultural inputs made possible through cash remittances. These remittances enable garden owners to purchase hybrid seeds, appropriate fertilisers, and regulated pesticides, which in turn increase productivity and protect food crops from damage. The combination of traditional knowledge and modern resources has created a form of hybrid safety net that links TEK and modern science to enhance community resilience. Home gardens managed through this combination not only ensure a stable local food supply but also provide communities with the flexibility to adapt to market changes or external disruptions such as food price crises and natural disasters, thereby strengthening the socio-ecological systems on which they depend. Figure 3 shows the setting of a home garden in the research area.



**Fig. 3.** Resident's home garden

The traditional practice of fish farming using natural water ponds, as depicted in Figure 4, is a form of TEK that utilises the natural features of an area for food production. In this context, the ponds formed from natural water sources such as springs, stream flows, or natural reservoirs are minimally enhanced by the community. Such ponds serve as natural habitats suitable for local fish species, such as lampam (barb), tilapia, or catfish, which breed easily in slow-flowing water of good quality. This practice often incorporates customary resource management, such as setting specific harvesting periods or limiting the catch to prevent overexploitation.



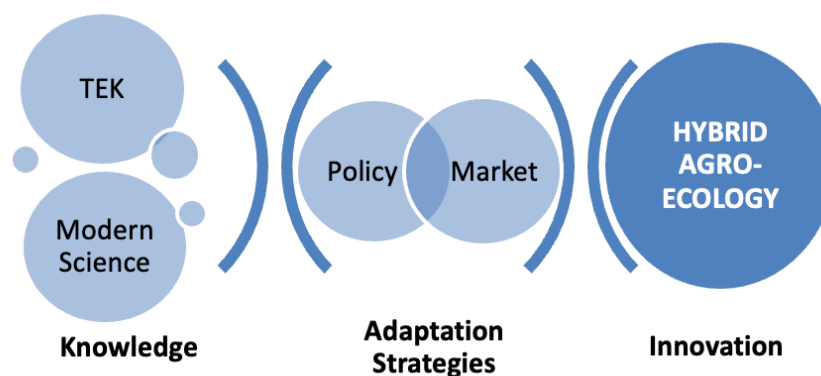
**Fig. 4.** Fish farming area and water source for crops

Observations indicate that some members of the community have adapted this fish farming technique by adding elements such as pipes to control water levels, fencing to protect fish from predators, or the use of supplementary feed to accelerate growth. However, its core principles remain rooted in traditional understandings of local ecology, making use of water resources and biodiversity without drastically altering the ecosystem. This approach not only provides a continuous source of protein but also forms part of an integrated system with surrounding crops. For example, organic waste from oil palm plantations or other crops can be used as natural fertiliser around the pond, while nutrient-rich pond water can be channelled to fertilise crops.

Alongside the benefits of the “hybrid safety net” identified in Telupid, community-based innovations in this area are still rarely given formal recognition. Agricultural policy continues to view such adaptations as a form of “partial modernisation” deemed unsuitable for large-scale agriculture. As a result, local innovations such as the reuse of organic waste as crop fertiliser or irrigation systems built upon traditional fish farming practices still receive little support, whether in the form of technical assistance or financial aid.

From a political ecology perspective, this situation reveals a paradox of power: although Indigenous communities have successfully developed sustainable solutions through their agricultural practices, recognition and validation of these innovations remain under the control of external actors. If the Indigenous community fully embraced integration of TEK and modern science within policy frameworks, it could give rise to a community-scale Hybrid Agroecology Model capable of reducing dependence on global markets, strengthening the resilience of food systems, and preserving local biodiversity.

Figure 5 illustrates the formation of an adaptive network within the Kadazan-Dusun community, linking TEK, modern science, policy, and markets in efforts to build food security resilience. The diagram shows that the combination of traditional strategies, such as home gardens and mixed cropping systems, with modern approaches has created a “Hybrid Safety Net.” If formally recognised within policy frameworks, this model could not only reduce reliance on global markets but also strengthen food sovereignty and ensure ecological sustainability, thereby positioning communities as key actors in food governance.



**Fig. 5.** Hybrid agroecology model

## 7. Conclusion

This study demonstrates that food security for Indigenous communities in Sabah is not merely a technical issue or a matter of increasing productivity; it is rooted in the politics of knowledge and power structures that determine who has the right to define, manage, and benefit from food systems. The dominance of state-driven scientific–technical frameworks has reinforced knowledge–

power asymmetries, eroded the capacity of TEK to realise its full potential, and displaced agroecological subsistence systems with market logics oriented towards commodities. Land policies, resource gazettelement, and land-use commercialisation have, to some extent, reduced community autonomy, even though the Kadazan-Dusun's status as *Bumiputera* provides a legal basis for protecting their customary rights. The case study in Telupid illustrates that this legal protection often fails in practice, supporting the political ecology argument that the interests of dominant actors frequently shape formal frameworks. These findings align with McMichael [11]'s concept of the corporate food regime, which argues that corporate dominance drives the homogenisation of global food systems and, in turn, undermines the diversity of local food production systems.

Integrating perspectives from political ecology and environmental justice, this study asserts that access to resources, knowledge, and political power are interlinked in shaping food system resilience. The paradox of state-led development in the name of modernisation has, in practice, marginalised Indigenous communities and constrained their adaptive capacity, particularly in rural and interior regions. In this context, the integration of hybrid knowledge, combining the strengths of modern science and TEK emerges as a key strategy for building inclusive, resilient, and culturally grounded food systems. This study underscores that the Hybrid Agroecology Model represents both a conceptual and practical innovation that positions communities at the centre of food governance, in contrast to conventional approaches that place the state or the market as dominant actors. The novelty of this model lies in its integration of TEK with modern science within a framework that recognises epistemological equality, while strengthening the political agency of marginalised communities to determine the future direction of their food systems.

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